WENCK ASSOCIATES

Responsive partner.
Exceptional outcomes.

April 28, 2016

Laura Jester
BCWMC Administrator
Bassett Creek Watershed Management Commission
c/o 16145 Hillcrest Lane
Eden Prairie, MN 55346

RE: Proposal for 2017 Water Monitoring Services

Dear Ms. Jester:

Thank you for the opportunity to submit this proposal to provide 2017 Water Monitoring Services to the Bassett Creek Watershed Management Commission (BCWMC). Wenck is well positioned to perform all of the projects described in the RFP. Specifically, Wenck offers the following experience and expertise to these projects:

- ***Leader in Lake Management.*** Wenck's staff has been managing lakes in Minnesota for over 30 years, including projects such as routine monitoring, vegetation management, alum addition, and hypolimnetic aeration. Wenck has developed over 50 lake management plans ranging from watershed and internal nutrient management to invasive fish management such as common carp. Joe Bischoff, the proposed Project Manager is a NALMS Certified Lake Manager.
- ***Experts in Sediment Chemistry and Internal Load Management.*** For the past ten years Wenck has partnered with Bill James in studying sediment phosphorus release in both deep and shallow lakes. Through this partnership, we have developed internal load management strategies for more than 30 local lakes including Twin Lakes, Bald Eagle Lake, Crystal Lake, and Burandt Lake.
- ***Multidisciplinary Approach.*** Wenck staff includes limnologists, fisheries biologists, botanists, and wetland ecologists to support our extensive water resources engineering capabilities. Wenck believes this multidisciplinary approach provides a comprehensive understanding of lake management and developing appropriate strategies to improve lakes ecosystems.

On behalf of the 250+ employee-owners of Wenck, thank you for this opportunity to work with BCWMC. Should you have any questions please do not hesitate to contact me at 763-252-6829 or jbischoff@wenck.com.

Sincerely,

Wenck Associates, Inc.

Joe Bischoff
Principal Aquatic Ecologist

Wenck provides the following Scope of Work for each of the three water monitoring projects listed in the RFP.

1. Routine Lake Monitoring

Project Understanding and Description of Tasks

It is our understanding that the BCWMC would like assistance in its 2017 priority lake monitoring. Lakes scheduled for regular monitoring in 2017 include Twin Lake, Sweeney Lake, and Lost Lake. Wenck will assist the BCWMC in performing all monitoring objectives outlined in the RFP and Appendix A of the 2015 BCWMC Watershed Management Plan. Below is a list of tasks identified in these documents:

- Detailed water quality, zooplankton and phytoplankton monitoring on six occasions from April through September for each lake. Monitoring will be conducted at two locations on Sweeney Lake and one location on Twin and Lost Lakes according to the methods outlined in the RFP and Appendix A of the 2015 BCWMC Watershed Management Plan.
- Two qualitative, point intercept aquatic plant macrophyte surveys on each lake. The surveys will be performed in June and August according to the methodologies described in Appendix A of the 2015 BCWMC Watershed Management Plan and the Minnesota DNR protocol for aquatic vegetation surveys.
- Submission of all water quality data collected in 2017 to the State's EQuIS database.
- Final report that presents all of the 2017 data and survey results along with trend analyses using historic data provided by BCWMC. Wenck will also present results of the report/project at a regular BCWMC meeting.

The proposed monitoring plan for Sweeney Lake is quite robust and is more detailed than typically required to fully understand lake functioning. Wenck has identified a few ways to reduce the overall cost of the routine lake monitoring project without compromising the quality of analyses and conclusions. The current BCWMC Monitoring Plan, as outlined in Appendix A, calls for one phytoplankton and one zooplankton sample collection and analysis during each of the six routine sampling events. This level of analysis requires 24 phytoplankton and 24 zooplankton samples throughout the year at a total lab cost of $12,336. To save on cost, Wenck proposes decreasing phytoplankton and zooplankton sample frequency from six times per year to three times per year between June and September. Previous phytoplankton and zooplankton monitoring results in Sweeney and Twin Lakes (Barr Engineering, 2015) indicate the severe algal blooms in these lakes occur between June and September (summer growing season). Wenck believes sampling phytoplankton and zooplankton outside of the summer growing season is unnecessary and an added expense. Additionally, Wenck proposes reducing phytoplankton and zooplankton monitoring on Sweeney Lake from two sites to one site. It is unclear from the Sweeney Lake Monitoring Report whether two sites on Sweeney have been sampled in the past for phytoplankton and zooplankton. These changes would reduce the number of samples to 9 phytoplankton and 9 zooplankton samples and save the BCWMC approximately $7,710 in lab costs while still providing the necessary level of detail required to fully characterize zooplankton and phytoplankton characteristics in the lake.

Cost Estimate

The cost estimate in the table below includes two separate pricing options for Task 1. The first option includes phytoplankton and zooplankton monitoring on three occasions for each lake (one site on Sweeney). If this option is selected, Wenck will complete all of the work outlined

above on a time and materials basis for an amount not to exceed $30,567. Alternatively, the second option for Task 1 covers the six phytoplankton and zooplankton samples on each lake (two sites on Sweeney) as defined in Appendix A of the BCWMC Watershed Management Plan. If the second option is selected, Wenck will complete the work for this project on a time and materials basis for an amount not to exceed $38,277.

Description	Labor Cost	Lab Cost	Equipment & Mileage	Total Cost
Task 1 Lake Monitoring (Option 1: 3X/yr plankton monitoring)	$8,088	$9,042	$686	$17,816
Task 1 Lake Monitoring (Option 2: 6X/yr plankton monitoring)	$8,088	$16,752	$686	$25,526
Task 2 Macrophyte Surveys	$3,370	--	$229	$3,599
Task 3 EQuIS Submittal	$240	--	--	$240
Task 4 Final Report and Presentation	$8,912	--	--	$8,912
Total (Option 1 for Task 1)	$20,610	$9,042	$915	**$30,567**
Total (Option 2 for Task 1)	$20,610	$16,752	$915	**$38,277**

List of Subcontractors and Laboratories

Wenck will use Pace Analytical Services, Inc. for laboratory analysis of all water quality samples. PhycoTech, Inc. will be used for all phytoplankton and zooplankton sample analysis.

Deliverables and Timeline

- Sample collection and surveys (April through September, 2017)
- All raw data submitted to EQuIS (September, 2017)
- Final report submitted to BCWMC and presentation of results at a BCWMC meeting (November, 2017)

Information needed from BCWMC

- Historic water quality data and phytoplankton and zooplankton data for Twin, Sweeney, and Lost Lake
- Historic macrophyte survey results and point locations (if available)

2. Sweeney Lake Aeration Study

Project Understanding

Wenck understands that the Sweeney Lakeshore Homeowners Association currently operates an aeration system in Sweeney Lake to maintain high levels of oxygen near the lake bottom to prevent the anoxic release of phosphorus bound in lake sediments. During the development of the TMDL completed in 2011, a study was completed (Braun Intertec Corporation, 2010) to evaluate the effects of whole lake aeration on water quality in Sweeney Lake. This study involved turning off the aerators for two years (2007 and 2008) and measuring water quality changes. During 2009, there was an increase in algal biomass after the aerators were turned back on (Braun Intertec Corporation, 2010), but it was difficult to

discern if this was a result of entrainment of dissolved P from bottom waters or was a result of seasonal changes in runoff phosphorus from the watershed. As a result, we understand that the BCWMC would like to evaluate the effectiveness of aeration on Sweeney Lake to improve water quality through the development of water quality model that can account for changes in climatic conditions.

A two or three dimensional model such as ELCOM coupled with CAEYDEM or CE-QUAL-W2 would provide a platform for evaluating the mixing and oxygenation dynamics in the lake and, if properly calibrated, assess the overall impacts on water quality while controlling for seasonal differences.

Before making a decision on a modeling approach, several considerations should be addressed to determine the questions to be answered by the model and current conditions in the lake. First, the goal of the aeration system is to maintain high levels of oxygen near the lake bottom to prevent the anoxic release of phosphorus bound in lake sediments. However, it is important to note that the aerobic (when oxygen is present) release of phosphorus was quite high (1.6 to 3.3 mg/m^2/day; James 2007). Studies completed by Wenck on over 20 lakes in Minnesota determined typical aerobic release rates to be less than 0.5 mg/m^2/day. Because the aerobic release rate is so high, aeration will result in more muted improvements in water column phosphorus. Furthermore, the iron:phosphorus ratio in the North Basin is only 18 suggesting that aeration may not be completely effective at preventing release of phosphorus from the sediments. Based on these results, aeration may improve water quality by reducing the very high anaerobic phosphorus release (15.6 to 17.3 mg/m^2/day), but overall results will be muted due to potential limits in sediment iron concentrations and the high aerobic release of phosphorus. Furthermore, insufficient aeration or failure of the system will result in significant algae blooms due to entrainment.

Second, the model cannot address questions related to the impacts of aeration on the submersed aquatic vegetation (SAV) community. Wenck recognizes that many of the lakeshore residents anecdotally report that aeration of the lake results in reduced SAV abundance. To date, we are not aware of any peer reviewed literature studies that demonstrates that aeration will reduce SAV abundance. Wenck staff conducts routine literature reviews on this topic to stay abreast of current research. Wenck is also actively involved in the North American Lake Management Society to assess national research on lake management.

Based on this understanding of Sweeney Lake and the goals of the aeration system, we believe there are better solutions to reducing eutrophication than ongoing aeration which is highly susceptible to breakdown, requires ongoing maintenance and operation expenses, and isn't well suited to the sediment conditions in Sweeney Lake. Rather, we believe an application of aluminum sulfate, or alum, provides a long term solution to internal phosphorus loading without long term maintenance and operation costs. Alum has been used in lakes and for drinking water for over 50 years and is safe for this type of application. An alum application to Sweeney Lake would cost between $85,000 and $200,000, which is fairly inexpensive relative to the long term cost of aeration, especially when the cost of modeling requested in this RFP is also taken into account.

In order to be responsive to this RFP, Wenck is providing a cost estimate for the modeling approach requested in this RFP. However, we are also providing a cost estimate for completing an alum treatment on the lake for comparison purposes. It is Wenck's opinion that pursuing an alum application is a much more cost effective approach for improving water quality in Sweeney Lake. In fact, based on the previous water quality and sediment analyses, the alum treatment alone should bring Sweeney Lake into compliance with State of Minnesota water quality standards and result in dramatic improvements in water quality. One primary

advantage of alum over aeration is that it will address aerobic phosphorus release as well as anaerobic release whereas aeration only addresses the latter.

Description of Tasks

Lake Modeling

To evaluate the effectiveness of aeration on water quality in Sweeney Lake, Wenck proposes the use of CE-QUAL-W2, a widely used lake and reservoir model in the United States. We believe that CE-QUAL-W2 is a better choice than ELCOM coupled with CAEYDEM due to its wide application in the United States, its ease of use, and significant literature database to support development of the model. CE-QUAL-W2 is a two-dimensional, laterally averaged, hydrodynamic and water-quality model that can model the impacts of aeration on lake water quality and phytoplankton. CE-QUAL-W2 has over 300 applications worldwide and has been applied to the Minnesota River. CE-QUAL-W2 is the preferred two dimensional models of the United States Geological Survey, Army Corps of Engineers, Environmental Protection Agency, and Tennessee Valley Authority. Wenck has reviewed and used the model to evaluate potential water quality conditions in drinking water reservoirs in Wyoming.

To apply CE-QUAL-W2, Wenck will complete the following tasks:

- The first step is to compile the necessary existing data and models to populate and validate the CE-QUAL-W2 model. Wenck will need to obtain all water quality monitoring data in the watershed, the existing P8 model, data from the Schaper Pond monitoring project, and existing watershed. Wenck will also compile a complete understanding of the aeration system currently installed.
- The routine monitoring covers most of the required data to develop the CE-QUAL-W2 model. However, some vertical profiles of total dissolved phosphorus and total and dissolved iron to quantify vertical gradients in these parameters is required. This data will help quantify sediment release of phosphorus and controlling factors. These samples would be collected during routine monitoring.
- Once all of the data are compiled, Wenck will construct the CE-QUAL-W2 model for Sweeney Lake. The P8 model will first be updated with the Schaper Pond monitoring results and then be used to develop watershed inputs for the CE-QUAL-W2 model. The model will be calibrated to existing data and then validated to past data sets.
- Once the model is validated, Wenck will develop a list of appropriate scenarios to assess the role of aeration in controlling water quality. Some scenarios may include, but are not limited to, water quality during wet, dry and average years with and without aeration, different diffuser settings and options, and changes in sediment chemistry that may limit aeration performance.
- Once all of the scenarios are done, Wenck will provide a final report of the model findings. Wenck will also attend and present at up to 3 meetings for the project. One of these meetings includes presenting the results to the BCWMC and one of their regular meetings.

Cost Estimate

The following table outlines Wenck's proposed budget for completing the modeling and reporting to assess the water quality impacts of aeration on Sweeney Lake. Wenck will complete all of the work outlined above on a time and materials basis for an amount not to exceed $44,447. This assessment assumes that additional data collection will be completed as a part of the routine monitoring of Sweeney Lake.

Description	Labor Cost	Lab Cost	Mileage	Total Cost
Task 1 Compile Existing Data and Models	$3,260	--	--	$3,260
Task 2 Additional Data Collection	--[1]	$3,216	--	$3,216
Task 3 Update P8 Model and Calibrate CE-QUAL-W2 Model	$20,056	--	--	$20,056
Task 3 Develop and Model Aeration Scenarios	$7,408	--	--	$7,408
Task 4 Report and Meetings	$10,432	--	$75	$10,507
Total	$41,156	$3,216	$75	**$44,447**

[1]Labor for collecting the sample is assumed to be included in the routine monitoring effort

Deliverables and Timeline

Following is a list of deliverables and a timeline for the project. We are assuming that the modeling will begin after completion of the Schaper Pond monitoring.

- Additional data collection and compilation of existing data and models (April through October 2017)
- Updated P8 and calibrated CE-QUAL-W2 model (March 2018)
- Completed model scenarios and results (April 2018)
- Final report and meetings (June 2018)

Information needed from BCWMC

- Historic water quality data, the existing P8 model, subwatershed GIS files, and all monitoring data not currently available in EQuIS or other public databases (June 2017).
- Existing sediment chemistry data (June 2017).

Alternative Approach: Alum Dosing and Application

Alternatively, Wenck believes the dollars allocated for a complex modeling study would be better used to complete an alum treatment on Sweeney Lake. Based on our experience applying alum in over 10 lakes in Wisconsin and Minnesota including Bald Eagle Lake in White Bear Township, a typical dose of aluminum would be 100 g/m^2 to be effective in the long term. However, we do recommend some additional coring to refine the dose to ensure we are not over-applying the alum and wasting money in the process. Using this as an estimate, treating the entire lake is approximately $220,000. A more likely scenario is treating the areas deeper than 15 feet, which results in a cost of approximately $86,000. However, a new coring study would need to be completed to “dial-in” the alum dose. To that end, Wenck offers an alternative approach and cost estimate to complete an alum treatment project on Sweeney Lake as a comparison to the modeling project. It is our opinion that pursuing an alum treatment for Sweeney Lake is a more effective approach to improving water quality in Sweeney Lake and will save the BCWMC significant money over the continued study and operation of aerators in Sweeney Lake.

Wenck proposes the following tasks for completing an alum treatment on Sweeney Lake.

- Collect sediment cores from 4 locations in Sweeney Lake. Each core will be section in 1 cm intervals for the top 10 cm, and then every 2 cm from 10 to 20 cm in depth. Each

section will be analyzed for bulk density, organic matter, redox phosphorus, total iron, and total aluminum.

- Wenck and the University of Wisconsin-Stout will use the sediment chemistry data to determine the required sediment depth of treatment as well as the appropriate aluminum:phosphorus ratio to eliminate phosphorus release from the sediments. Wenck and the University of Wisconsin-Stout recent published a paper providing a cost effective way to determine the required binding ratio (James and Bischoff, 2015).
- Develop the plans and specifications and permitting for the alum application project. Wenck is currently completing alum treatment projects for Bald Eagle Lake in White Bear Township and Lake Riley in Eden Prairie.
- Provide construction oversight for the application of alum to Sweeney Lake.

Estimated costs to complete these tasks are provided in the table below. Wenck will complete all of the work outlined above on a time and materials basis for an amount not to exceed $29,544 which continues through the completion of an alum treatment. This budget does not include the cost of the treatment itself. Using this cost estimate and assuming a dose of 100g/m^2 below 15 feet suggests the entire alum project can be completed for approximately $116,000. The cost associated with this approach is much less than aeration and results in significant improvements in lake water quality much sooner and for much less cost than the modeling and lake aeration approach.

Description	Labor Cost	Lab Cost	Equipment & Mileage	Cost
Task 1 Collect and analyze sediment cores from Sweeney Lake	$1,897	$14,223	$350	$16,470
Task 2 Develop alum dose and engineers cost estimate for the project	$2,058	--	--	$2,058
Task 3 Develop plans and specification for the application of alum to Sweeney Lake	$6,312	--	--	$6,312
Task 4 Provide application oversight	$2,268	--	--	$2,268
Task 5 Provide final report	$2,436	--	--	$2,436
Total	$14,971	$14,223	$350	**$29,544**

List of Subcontractors and Laboratories

Wenck will partner with Bill James at the University of Wisconsin-Stout to complete to sediment chemistry analysis and alum dosing. All analyses will be conducted by the University of Wisconsin-Stout except for total iron and total aluminum, which will be completed by Pace Analytical.

Deliverables and Timeline

- Sediment chemistry, alum dose and engineer's cost estimate in final report (July 2016)
- Plans and specifications and permit letter (August 2016)
- Application oversight (September/October 2016)

Information needed from BCWMC

- Standard plans and specification material if available (August 2016)

3. Schaper Pond Effectiveness Monitoring

Description of tasks

Wenck understands that the BCWMC also wishes to monitor the effectiveness of the Schaper Pond Diversion Project. Effectiveness monitoring will be completed according to the same methods used in the 2011 Schaper Pond Feasibility Study which included monitoring of two major inlets to the pond and the pond outlet. For this study, flow was monitored continually between May and August and a total of six storm events were collected between June and August. Storm event samples were analyzed for total phosphorus, dissolved phosphorus, total suspended solids, volatile suspended solids, and particle size distribution. Equipment at each sampling location included an auto sampler, level sensor, and area velocity meter. Below is a list of 2017 monitoring tasks Wenck will perform to repeat the 2011 monitoring and measure the effectiveness of the Schaper Pond project:

- Install and maintain monitoring equipment three locations. Monitoring equipment for each site will include an ISCO auto sampler, level sensor, area velocity meter, batteries to power the equipment, and equipment Job Box to house the equipment.
- Water quality sampling of six storm events at each location between June and August.
- Final report summarizing the results of the sampling, annual flow and pollutant load estimates, and a discussion of the effectiveness of the project. Wenck will present results of the report/project at a regular BCWMC meeting.

Cost Estimate

Description	Labor Cost	Lab Cost	Equipment & Mileage	Total Cost
Task 1 Install and Maintain Equipment	$3,038	--	$15,000	$18,038
Task 2 Storm Event Sampling	$3,472	$2,772	$86	$6,330
Task 3 Final Report and Presentation	$6,786	--	--	$6,786
Total	$13,296	$2,772	$15,086	**$31,154**

List of Subcontractors and Laboratories

Wenck will use Pace Analytical Services, Inc. for laboratory analysis of all water quality samples.

Deliverables and Timeline

- Install monitoring equipment (May 2017)
- Flow monitoring and storm event sampling (May through September 2017)
- Final report submitted to BCWMC and presentation of results at a BCWMC meeting (November 2017)

Information needed from BCWMC

- Raw data from 2011 feasibility study monitoring
- Assistance from BCWMC to notify land owners and/or obtain necessary permits to install monitoring equipment (if applicable)

Joe Bischoff will serve as Wenck's project manager and will be assisted by Jeff Strom, Joel Toso, Brian Beck and Tom Langer for most of the monitoring and modeling tasks. Mr. Bill James will work as a subconsultant on this project, performing all sediment laboratory analysis. Joel Toso will provide engineering assistance, technical review, and senior modeling expertise. Ed Matthiesen will also provide engineering assistance, technical review, and QA/QC. Summary paragraphs are provided below for critical team members; detailed resumes are available at your request.

JOE BISCHOFF, Project Manager - ***Aquatic Ecologist/Certified Lake Manager***

Mr. Bischoff has over 18 years of experience in the fields of water resources and lake and reservoir management. He has served as project manager and technical lead for numerous multidisciplinary projects in lake and watershed restoration throughout the State of Minnesota. His project and technical experience includes the following: sediment chemistry and internal load management, shallow lake management, wetland and stream ecology and restoration, water quality planning and analysis, water quality modeling, watershed assessment, and Total Maximum Daily Loads (TMDLs). Mr. Bischoff recently developed alum dosing options for the Rice Creek Watershed District for Bald Eagle Lake and Golden Lake, including options to maximize water quality benefits while minimizing costs.

BILL JAMES – ***Aquatic Biologist, University of Wisconsin-Stout***

Mr. James is a research aquatic biologist with the University of Wisconsin-Stout and the sole owner of Aquatic Restoration and Research, LLC. He has been working with Wenck on lake studies since 2006. Mr. James is an expert in lake management and restoration applications with experience developing and improving alum dosage techniques. Mr. James was recently recognized by the North American Lake Management Society with the "Best Paper" award for his submission on alum dosing techniques for Half Moon Lake in Wisconsin. He has also designed and implemented numerous management plans to control phosphorus, reduce algal blooms, and increase light habitat for native submersed aquatic plants.

JOEL TOSO – ***Senior Engineer and Modeler***

Dr. Toso is a civil engineer with more than 30 years of experience specialized in water resources engineering and hydraulics. His specialties include hydrologic and hydraulic modeling, surface water management plans, best management practice design, dams, reservoirs, spillways, stilling basins, river engineering, stream restoration, sediment transport, and wetland hydrology. Specific expertise related to the project includes two-dimensional flow modeling, thermal plume modeling, thermal mixing models, and advection-dispersion modeling. In addition to consulting work, Dr. Toso has taught Applied Hydrology and Hydraulics at the University of Minnesota for more than 18 years.

ED MATTHIESEN, PE, Principal - *Water Resources Engineer*

Mr. Matthiesen has 30 years of extensive experience in water resources and environmental engineering. His water resources experience includes being the District Engineer for three Twin Cities area watershed districts and four Joint Powers Associations, writing municipal comprehensive stormwater plans, outlet structure and storm sewer design, conducting evaporation studies, aquifer analysis, water quality protection plans, developing computer hydrologic and hydraulic models, and design and construction of lift stations. He also has experience in biological sampling techniques, virus isolation in surface runoff, and chemical modeling of leachate.

JEFF STROM – *Water Resource Scientist*

Mr. Strom is a water resource scientist with eight years of consulting work experience in the areas of water quality monitoring, water quality modeling, hydrologic modeling, lake management and Geographic Information Systems (GIS). Prior to arriving at Wenck, Mr. Strom worked as a graduate research assistant at the University of Minnesota Duluth researching biogeochemcial cycling and thermal stratification in Lake Superior using one and two dimensional models. Mr. Strom currently oversees the Watershed Outlet Monitoring Program (WOMP) station on Bassett Creek and has worked with the BCWMC on this effort since 2013.

BRIAN BECK – *Water Quality Specialist*

Mr. Beck has over three years of consulting experience working on water quality data analysis, water quality modeling, sulfate geochemistry, data processing and analysis, technical report writing, and water quality monitoring. Since arriving at Wenck, he has worked as a hydrologic and water quality modeler to develop and write TMDLs for turbidity, bacteria, and nutrients in impaired water bodies. Prior to working at Wenck, Mr. Beck worked as a Research Assistant at the University of Minnesota Duluth on projects related to sulfur geochemistry and mercury fate/transport. Mr. Beck has worked has worked with the BCWMC since 2013 on their WOMP station.

TOM LANGER - *Aquatic Ecologist*

Tom has over five years of experience as an aquatic ecologist working on aquatic monitoring projects assessing ecosystem health and environmental- biotic community linkages within deep lake, shallow lake, wetland, river, and stream ecosystems of the Upper Midwest. Specialties include environmental-community assessments, water quality monitoring, aquatic taxa identification, habitat assessments/determinations, biological sampling, statistics and modeling.

Lake and Stream Monitoring in Shingle Creek and West Mississippi Watersheds

Wenck staff has been the District Engineer for the Shingle Creek Watershed Management Commission (SCWMC) and West Mississippi Watershed Management Commission (WMWMC) for over 30 years. During this time Wenck has performed various monitoring tasks, including: routine lake water quality sampling, intensive lake monitoring for TMDL studies and 5-year TMDL reviews, point intercept macrophyte surveys, lake and stream fish sampling and surveys, macroinvertebrate sampling, routine stream water quality sampling, flow monitoring, outfall water quality and flow monitoring, wetland and stormwater pond flow and water quality monitoring, and various other specialized monitoring tasks for grant projects. Each year, Wenck authors the SCWMC and WMWMC Annual Monitoring Report which presents results and analysis of the routine lake and stream monitoring along with other monitoring tasks performed that year. A link to the 2015 monitoring reports is provided below.
Link to report:
http://www.shinglecreek.org/uploads/5/7/7/6/57762663/2015_annual_wq_report.pdf
Reference: Tina Carstens, SCWMC, 651-792-7960

Lake and Stream Monitoring in Clearwater River Watershed

Wenck has been the District Engineer for the Clearwater River Watershed District (CRWD) for over 25 years performing numerous projects on shallow and deep lakes. Wenck has worked with the CRWD since 2006 to complete routine lake and stream monitoring, macrophyte surveys, fish and macroinvertebrate sampling/surveys, rough fish management and removal, TMDL studies, and implementation project design on several impaired lakes. Each year, Wenck authors the CRWD Annual Monitoring Report which presents all of the District's routine lake and stream monitoring data as well as results of targeted monitoring projects, grant projects and other special projects/studies. A link to previous monitoring reports is provided below.
Link to reports: http://www.crwd.org/water_quality_monitoring_reports.html
Reference: Merle Anderson, CRWD, 507-736-2413.

Black Dog Lake Modeling

Wenck Associates studied the effect of a proposed Minnesota River phosphorus reduction facility on the Black Dog Lake discharge temperatures. Black Dog Lake is used by Xcel Energy for cooling of the power facility located adjacent to the lake. The discharge is regulated by a National Pollutant Discharge Elimination System (NPDES) permit. During low river flow periods in summer the permitted temperature difference between

upstream river water and Black Dog Lake discharge is 9 degrees F. Any proposed new river treatment facilities at Black Dog must maintain the capability of meeting NPDES permit requirements.

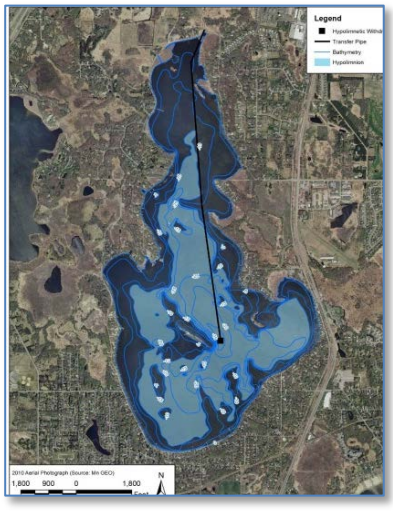
The effect of the proposed facility was modeling using the HEC-RAS hydraulic model. This model is a one-dimensional flow model; it assumes the flow is fully mixed vertically and laterally, a condition that is typically met in Black Dog Lake. The primary feature of the model used in this investigation is its river water quality capability with an advection-dispersion module using heat energy sources and sinks to estimate temperatures. The model was calibrated with existing flow and temperature data provided by Xcel. The calibrated model was then used to estimate the relative temperature variations at the Cedar outfall under existing and proposed conditions for selected historical normal and extreme weather periods.
Reference: John Chelstrom, Xcel Energy, (952) 895-4268

Crystal Lake Internal Load Control Feasibility Study City of Robbinsdale, Minnesota

Wenck Associates, Inc. was commissioned by the City of Robbinsdale, Minnesota to conduct a feasibility study to control internal nutrient loading in Crystal Lake. The purpose of the feasibility study was to evaluate both cost and effectiveness of four internal nutrient load control techniques for lakes including sediment sealing with aluminum sulfate (alum), hypolimnetic withdrawal, hypolimnetic aeration/oxygenation, and artificial circulation.

Wenck Associates, Inc. worked closely with City staff to evaluate each option for required infrastructure, effectiveness of the treatment, costs including capital cost and operational cost, and required permits. The analyses included preliminary alum dosing for cost purposes, sizing of pumps and aerators for hypolimnetic aeration or oxygenation, and potential odor controls. In the end, Wenck and the City of Robbinsdale developed an innovative hybrid approach that offers treatment of both the internal nutrient loading as well as watershed loading from one of the largest contributing subwatersheds.
Reference: Richard McCoy, City of Robbinsdale, 763-531-1260

Bald Eagle Lake Internal Load Reduction Feasibility Study



After completing a TMDL, Wenck and its partner, Bill James, were hired by the Rice Creek Watershed District to develop an implementation plan including internal phosphorus release control for Bald Eagle Lake in Ramsey County. Bald Eagle Lake is a highly-used recreation lake that is known to be a high-quality bass and muskie recreational fishery. A major focus of the implementation plan was to assess the effectiveness, cost and feasibility of internal load management techniques including alum, artificial circulation, hypolimnetic withdrawal, and hypolimnetic aeration. Wenck collected cores from numerous stations throughout the lake to apply the Rydin and Welch (1999) approach for estimating the alum dose needed to inactivate sediment phosphorus release. Several scenarios with varying levels of effectiveness and ranging in cost from $0.5 M to $1M were presented to the District, which is currently pursuing funding to complete the alum treatment in 2013.
Reference: Matt Kocian, Rice Creek Watershed District, 763-398-3075

Golden Lake Internal Load Reduction Feasibility Study

Wenck was hired by the Rice Creek Watershed District to assess internal phosphorus release control options for Golden Lake. Golden Lake is a eutrophic, shallow lake, located in Circle Pines, MN. Several internal phosphorus load management techniques including alum, dredging, hypolimnetic withdrawal, and hypolimnetic aeration were assessed to determine the cost effectiveness and viability of each internal load reduction option. Each scenario cost and internal load reduction was compared in a technical memorandum, which demonstrated that an alum application was the cost effective management option on a phosphorus per pound basis.

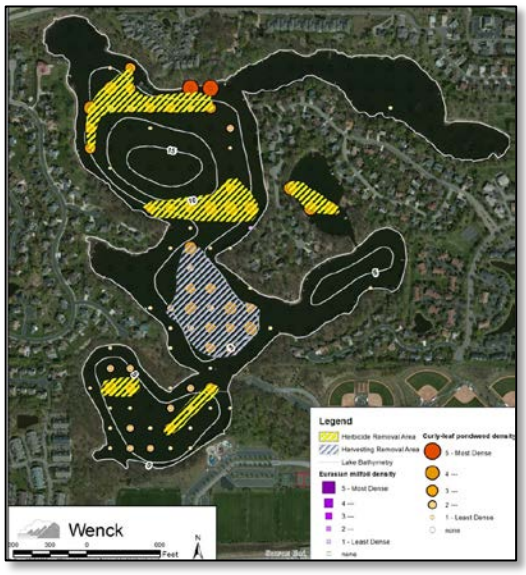
Reference: Matt Kocian, Rice Creek Watershed District, 763-398-3075

Aquatic Plant Monitoring and Management Plans for Lily, McKusick, and Long Lakes – City of Stillwater

Wenck performed point intercept vegetation surveys and used results to develop aquatic vegetation management plans for Lily, Long and McKusick Lakes in Stillwater, Minnesota. Aquatic invasive species were present in all lakes and required analysis on cost effective approaches to manage current infestations along with methods to prevent contamination of adjacent lakes. As part of the plan stakeholder input was gathered to optimize implementation strategies due to limited City resources. The result of active stakeholder input upfront resulted in streamline adoption of the plan by the City.

Reference: Shawn Sanders, City of Stillwater, 651-430-8835

Aquatic Vegetation Management Plan for Mitchell and Red Rock Lake and Lake Lucy - Riley Purgatory Bluff Creek Watershed District



Wenck developed aquatic plant management plans for Mitchell Lake, Red Rock Lake, and Lake Lucy in Eden Prairie, Minnesota. These studies addressed effective long-term management of aquatic plants, especially invasive species within each lake. Prior to this study, the District and City managed invasive species through the use of mechanical harvesters. This project developed a comprehensive plan that focused on long-term management to improve water quality while improving and promoting navigation, recreation, and the overall health of the lake. Wenck worked with the District to conduct a series of stakeholder meetings to identify goals and objectives, outline the available plant management techniques, and develop an approach to meet the identified goals for each lake.

Reference: Claire Bleser, Riley Purgatory Bluff Creek Watershed District, 952-607-6512.

Lake Jennie Aquatic Vegetation Survey

Wenck conducted point-intercept surveys on Lake Jennie in Meeker County. Wenck conducted an early summer survey focused on mapping the extent of curly-leaf pondweed in the lake and a late summer survey to document the extent of other vegetation species in the lake following the senescence of curly-leaf pondweed. Wenck also collected data using a Lowrance HDS sonar and CiBiobase software to create high resolution bathymetry and vegetation density maps.

Reference: Randy Newman, Lake Jennie Improvement Association, 507-276-3735

Lake Riley Chain of Lakes Internal Load Management- Riley Purgatory Bluff Creek Watershed District

Wenck developed an internal phosphorus load reduction plan for the Lake Riley chain of lakes (LRC) with the Riley Purgatory Bluff Creek Watershed District (RPBCWD). The LRC includes Riley Lake, Lake Susan, and Rice Marsh Lake. Carp management in the LRC was highly successful and resulted in substantial improvements in upstream lakes but muted results in Lake Riley. Furthermore, internal loading from upstream lakes (Susan and Rice Marsh Lake) further exacerbate phosphorus loading in the LRC. In an effort to improve the submersed plant community and water clarity in Lake Riley, RPBCWD hired Wenck to assess internal phosphorus loading control using aluminum sulfate (Alum). Sediment cores were collected from Lake Riley, Lake Susan, and Rice Marsh Lake to assess the impact of internal loading on water quality. Aluminum dosage was estimated as the concentration required to inactivate >90% of the redox-P in the upper sediment. Wenck is currently completing an alum treatment on Lake Riley.

Reference: Claire Bleser, Riley Purgatory Bluff Creek Watershed District, 952-607-6512.

Barr Engineering. 2015. 2014 Lake Water Quality Study: Sweeney and Twin Lake. Prepared for Bassett Creek Watershed Management Commission.

Braun Intertec Corporation. 2010. Effects of Whole-Lake Aeration Sweeney Lake Golden Valley, Minnesota. Prepared for Hidden Lakes Residents.

James, W.F. 2007. Internal Phosphorus Loading and Sediment Characteristics: Sweeney Lake, Minnesota. ACOE-ERDC Report.

James, W.F. and J. M. Bischoff. 2015. Relationships between redox-sensitive phosphorus concentrations in sediment and the aluminum:phosphorus binding ratio. Lake Reserve Manage. 31 (4): 339-346.