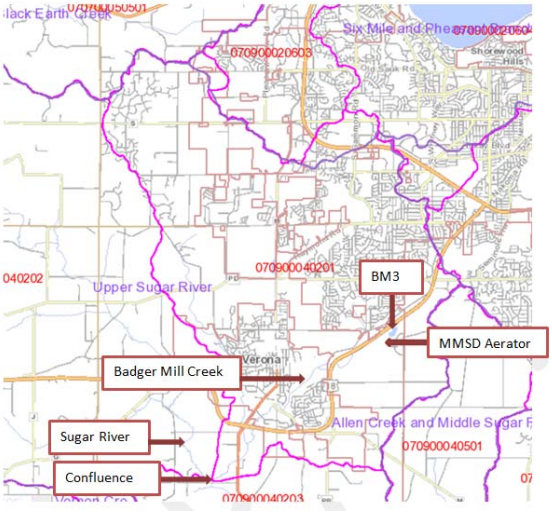
Badger Mill Creek Phosphorus Compliance



Project Purpose:

Badger Mill Creek is an effluent dominated stream downstream of MMSD's aerator (see Map). The applicable phosphorus water quality criterion for Badger Mill Creek is 0.075 mg/l. The Nine Springs Wastewater treatment plant produces a high quality effluent with respect to phosphorus but the effluent phosphorus concentration currently exceeds the 0.075 mg/l phosphorus criterion.

Based on the total phosphorus concentration (mg/l), Badger Mill Creek does not meet the applicable water quality criterion upstream of MMSD's aerator and the Sugar River does not appear to meet the applicable water quality criterion downstream of the confluence with Badger Mill Creek.

It is expected that when the District's WPDES discharge permit is reissued (currently projected to be reissued in 2019), it will contain a water-quality based effluent limit (WQBEL) for Badger Mill Creek of 0.075 mg/l. The permit will also contain a compliance schedule for addressing phosphorus and meeting the WQBEL. It is expected that the reissued permit will include a nine year compliance schedule. The compliance schedule allows time for dischargers to evaluate potential compliance options, develop a plan for compliance and implement a compliance solution.

The project purpose is to evaluate, plan for and implement the final compliance solution.

Project Proposer/Champion: Martin Griffin

Departments: Ecosystems, Engineering, and Operations

Project Involvement: The project will be undertaken by the Ecosystem Services Department, the Engineering Department and the Operations Groups. Depending on which phase of the project we are in depends on which Department will take the lead for that particular phase. The project manager will be Kathy Lake, Pollution Prevention Program Manager. Her contacts will be Alan Grooms, Operations Manager, and a project engineer as determined.

Project History and Status: In 2017, a scoping and evaluation document was created to help guide the process. This document outlined a summary of potential options to meet phosphorus criteria compliance. During 2018 and 2019, we are continuing to reach out to partners to get a sense of level of interest and involvement to gain a better sense of how to incorporate any of the watershed options outlined in the evaluation document. Also during 2019 piloting of low P removal technologies will begin at the plant to better provide specifics on one of the potential options to meet compliance.

Description: There are six basic compliance options as well as logical combinations of approaches for addressing phosphorus discharges to Badger Mill Creek.

Compliance Options

Option 1: Diversion of Flow to Badfish Creek: The District currently returns 3.6 MGD of effluent to Badger Mill Creek, which offsets wastewater that is pumped out of the Sugar River Basin to the Nine Springs Plant for treatment. The District could completely eliminate or significantly reduce the effluent volume that is returned to the Sugar River Basin through a discharge to Badger Mill Creek. Whatever amount of flow is diverted away from Badger Mill Creek, must be discharged to Badfish Creek.

*Note: A built in assumption with this option is that sufficient capacity exists for offsetting the resulting impact decreasing the flow to Badger Mill Creek has on increasing the flow to Badfish Creek. For example, if all of the Badger Mill Creek flow was diverted to Badfish Creek, approximately 2,500 lbs of phosphorus per year would also be diverted. This would be a relatively small increase to the total pounds that Yahara WINS is going after (~96,000 lbs) but the District would be responsible for paying for the added phosphorus reduction needed (~$50/lb (Yahara WINS cost per pound) *2500 lbs/yr = $125,000/year).*

Option 2: Water Quality Trading: The excess phosphorus load to Badger Mill Creek could potentially be offset through a water quality trading program. The Wisconsin

Department of Natural Resources has developed guidance for implementing a water quality trading program. That guidance includes the application of a trade ratio to account for a variety of uncertainties associated with trading. The trade ratio is a multiplier that is applied to initial phosphorus load reduction (in our case, ~2,500 lbs/yr) to come up with a total phosphorus load that must be addressed. Using the current WDNR guidance document, we have estimated that a minimum trade ratio in the range of 2.5 to 3.0 is likely, with a higher trade ratio possible. Assuming that no flow is diverted to Badfish Creek, the amount of phosphorus that would have to be offset through trades would be in the range of 6,250-7,500 lbs/year. If the effluent flow discharged to Badger Mill Creek was reduced by 50%, the phosphorus loads would also be reduced by 50% (3,125-3,750 lbs/yr). The pounds of phosphorus addressed through trading could also be reduced (or perhaps eliminated entirely) if a site specific criterion for phosphorus is developed that is higher than the current applicable criterion of 0.075 mg/l.

***Option 3: Site Specific Phosphorus Criterion for Badger Mill Creek*:** NR 102.06 (7) allows for the development of site specific criteria for phosphorus where site-specific data and analysis using scientifically defensible methods and sound scientific rationale demonstrate a different criterion is protective of the designated use of the specific surface water segment or waterbody. DNR is currently codifying the site-specific criteria development process, which will include codifying the specific factors to be considered when developing site specific criteria.

Option 4: Variance to Current Water Quality Criterion: Wisconsin DNR states that facility-specific variances to water quality standards, referred to as variances, must be approved by both DNR and USEPA. Variances may be given on a facility-specific basis for the length of a Wisconsin Pollutant Discharge Elimination System (WPDES) permit term. A variance requires working toward water quality criteria and requires reissuance each permit term

A variance may allow extra time for a facility to come into compliance with a water quality standard based on one or more of the six factors listed in s. 283.15(4), Wis. Stats, only three of which have been determined to be factors that could be used to apply for a variance

Option 5: Watershed Adaptive Management: NR 217 allows for watershed adaptive management as another compliance option. To qualify for Adaptive Management, certain criteria need to be met. First, watersheds must have more than 50% non-point sources of phosphorus at their discharge location. Based on Wisconsin DNR's PRESTO model, only 22% of the phosphorus in Badger Mill Creek at the discharge location is estimated from nonpoint sources. However, other qualification criteria appear to be met (i.e. MMSD would need filtration to meet the phosphorus limit and the stream currently exceeds the phosphorus criteria.).

For adaptive management to work in the Badger Mill Creek watershed, all sources of phosphorus will need to be engaged. Unlike the Yahara watershed, there is no Total Maximum Daily Load (TMDL) for phosphorus or TSS in the Badger Mill Creek/Sugar River watershed, which would provide a regulatory incentive to bring MS4s (i.e. municipalities like City of Verona, City of Madison and Town of Middleton) and agriculture to the table in an adaptive management project. In the absence of a TMDL, the TSS reduction requirements in NR 151 (40% TSS control) could incentivize MS4 participation in an adaptive management project, as there is a relationship between TSS control and phosphorus control. However, 2011 Wisconsin Act 32 prohibits WDNR from enforcing against the 40% TSS requirement effectively eliminating the regulatory hook to encourage meeting the TSS standard. Regardless, all three MS4s appear to currently already meet or exceed 40% TSS control. MMSD is the only permitted entity with a discharge to Badger Mill Creek so there are no other wastewater dischargers to engage.

Option 6: Treatment: The cost to treat MMSD's effluent to meet phosphorus water quality standards was estimated in the 2012 CH2MHill report. The report indicates a cost range from $71-124 million to treat MMSD's entire effluent (Badfish and Badger Mill Creek), depending on the target effluent concentration. The District's 50-year master planning effort evaluated the cost of treating a portion of the District's effluent to a higher level, followed by blending and return of the blended effluent to the Sugar River Basin. That plan also evaluated a satellite facility in the Sugar River Basin that would produce a higher quality effluent with respect to phosphorus and nitrogen. Treatment technologies are advancing and are currently being evaluated as part of the planning process for their potential application to the Badger Mill Creek outfall. In addition, partial treatment options will be considered along with water quality trading, reducing discharge volume and/or site-specific criterion.

Key Risks and Issues

Option 1: Diversion of Flow to Badfish Creek:
The District's annexation of the old Verona Wastewater Treatment Plant was conditioned on returning effluent to the Sugar River Basin to offset the reductions to base flow resulting from groundwater pumping and diversion of wastewater from the basin to the Nine Springs Wastewater Treatment Plant for treatment. Diversion of all effluent flow would likely have a deleterious effect on the fishery in Badger Mill Creek. However, partial diversion of flow may still allow for a viable fishery and may increase the likelihood that the District could use water quality trading or adaptive management as the long term compliance strategy for Badger Mill Creek.

Option 2: Water Quality Trading
A concern related to water quality trading is whether there is sufficient capacity to accomplish the necessary phosphorus offsets. This is particularly a concern if trading is

limited to the Badger Mill Creek watershed and there is no diversion of flow from Badger Mill Creek to Badfish Creek. In the current badger Mill creek watershed, For example, there are only 6,300 acres of agricultural land upstream of the confluence of Badger Mill Creek and the Sugar River. A significant number of acres would need to be placed under improved practices in order to accomplish the needed phosphorus reduction.
It should be noted that recent developments at the state and federal level related to increasing the flexibility of the water quality trading program criteria could allow for a larger watershed area to be considered and significantly increase the number of agricultural acres available for placement of practices increasing the possibility of getting significant pounds reductions through trading.

Urban practices could also be funded under a trading program, opening up much larger acreage, but urban phosphorus reduction practices are generally expensive and not as effective at addressing phosphorus. As part of this evaluation, the City of Madison is evaluating the potential for chemical phosphorus treatment at their Nesbitt Pond which is immediately upstream of our discharge. As indicated earlier, the viability of water quality trading increases when the pounds of phosphorus that need to be addressed decreases. These pounds could be reduced by flow diversion, development of site specific criterion, or a combination of these two factors.

Option 3: Site Specific Phosphorus Criterion for Badger Mill Creek
Preliminary discussions with DNR indicate that stream biology will be a factor in determining whether a receiving water is eligible for development of a site specific criteria. We are hopeful that Badger Mill Creek will be eligible for development of a site specific criteria for phosphorus. It is not known at this time what the actual criterion would be, but it would not be unreasonable to expect that it could approach or even be similar to current effluent quality.

Option 4: Variance to Current Water Quality Criterion
A variance requires working toward water quality criteria and requires reissuance each permit term. Under NR 104, Wisconsin DNR lists certain water bodies as Limited Forage Fish (LFF) or Limited Aquatic Life (LAL) waterways (Variance Waters). The effluent channel for Badfish Creek is listed as LFF while Badger Mill Creek's lowest designation is LAL. Modifying this listing may impact where the phosphorus criteria would be applied and warrants further investigation.

Option 5: Watershed Adaptive Management
Before undertaking an adaptive management project, the treatment plant would need to qualify. At the current discharge location, this is unlikely.

To qualify for Adaptive Management watersheds must have more than 50% non-point sources of phosphorus at their discharge location. Based on Wisconsin DNR's PRESTO

model, only 22% of the phosphorus in Badger Mill Creek at the discharge location is estimated from nonpoint sources. Wisconsin DNR notes that this interpretation of the watershed relative to discharge location can be discussed with the Basin Engineer. If the District wanted to pursue Adaptive Management, undertaking a path similar to NEW Water, Green Bay's wastewater utility could be evaluated further. NEW Water, has been granted an Action Area to perform Adaptive Management which is not the watershed that encompasses their discharge.

The success of an adaptive management program requires meeting in stream water quality for phosphorus as evidenced by water quality monitoring. An adaptive management project in the Badger Mill Creek watershed would not be impossible to implement (if MMSD can meet the qualification criteria), but in the absence of a regulatory driver (like a TMDL), there does not appear to be sufficient incentive for other partners to come to the table in an adaptive management project, especially if they were expected to bear some of the cost.

While required to do so, or not, municipalities (Verona/Madison) and groups like the Upper Sugar River Watershed Association (USRWA) are interested in aspects of this type of partnership, which is being explored further but given the above factors, it is not currently the recommended approach for Badger Mill Creek since the onus of meeting in-stream numeric water quality criteria would fall squarely on the District. Water quality trading appears to be a more viable option than Adaptive Management in the Badger Mill Creek.

Option 6: Treatment

The District also has regulatory requirements related to chloride and mercury, which it is attempting to address through implementation of pollution prevention/source reduction measures. The mercury effort is mature and has been very successful while the chloride program is still evolving. The District evaluated treatment options for meeting future chloride limits including treating a portion of effluent to a higher quality and then blending with the remaining effluent. This study also found treatment to be cost prohibitory

In addition, treatment options for phosphorus that could also remove other parameters such as chlorides, nitrogen, mercury and certain pharmaceuticals, however, since only a portion of the effluent would be treated to remove phosphorus; it is unclear if treating to remove phosphorus would be a cost-effective or feasible approach to also removing an adequate amount of chlorides.

Treatment for phosphorus removal continues to evolve. Piloting the removal technologies for phosphorus will start in 2019 and further piloting (if needed) and evaluation will continue into 2020 as critical step in this assessment of treatment as a long term strategy. An additional synergy related to treatment is that producing a high

quality effluent could expand future options for beneficially reusing effluent (e.g. groundwater recharge, cooling tower) and help meet other potential regulatory discharge limits related to Chlorides, Nitrogen or other parameters.

Economic Analysis

The cost to treat MMSD's effluent to meet phosphorus water quality standards was estimated in the CH2MHill report. The report indicates a cost range from $71-124 million to treat MMSD's entire effluent, depending on the target effluent concentration. The District's 50-year master planning effort evaluated the cost of treating a portion of the District's effluent to a higher level, followed by blending and return of the blended effluent to the Sugar River Basin. That plan also evaluated a satellite facility in the Sugar River Basin that would produce a higher quality effluent with respect to phosphorus and nitrogen.

Project Schedule and Fiscal Year Allocation

In 2018 we started specific conversations with potential partners to identify planned and potential watershed projects and how those projects could be used in a water quality trading scenario with the District. These are continuing in 2019 and being refined to result in specific projects to be used in evaluation of compliance options.
In 2018 we also were able to run a 4 week low P removal pilot test using the Evoqua CoMag system. The full Pilot testing plan/schedule will continue through 2019 with the testing of 4 additional treatment technologies: Aquadisk cloth filter, Nexom BluePRO sand filter, Clearas photo-bioreactor, and Suez ZeeWeed membrane filtration.
In addition a public engagement plan will be completed in 2019 to be used in the societal impact analysis as part of the quadruple bottom line analysis planned for 2020.

For the 2020 phase of the project we will:

- Evaluate the 2019 pilot test data and set up a longer term pilot test of the best option. This will allow us to better refine performance and cost estimates based on a variety of flows and provide data to be used in final evaluation of how a low P removal technology as a compliance option fits in with other compliance options that are being evaluated.
- Undertake (with the use of a consultant) a quadruple bottom line analysis (economic, environmental, social, and operational) on the current discharge of 3.6 MGD comparing that volume to other discharge volumes. [The environmental component will involve an environmental flow study evaluating impacts to various aquatic biota. The societal component will involve the public engagement plan and meeting with various stakeholders to understand interests around stream flows. The operational component will involve assessment of operation changes and impacts related to changing current discharge amounts]. This information will be used to provide the District a way to evaluate and decide what discharge volume is the target and also allow us to fine tune

the economics and feasibility of the low P treatment options related to the discharge volume options that are being considered.

- Continue to evaluate other alternative compliance options (listed above) and prepare preliminary compliance alternative plan

For the 2021 phase of the project we will:

- Conduct final compliance feasibility studies related to:
  - Final trading options outlining projects and entities where trading can occur to meet phosphorus reduction goals taking into account different watershed sizes
  - Adaptive management options when considering different watershed sizes
- Work with a consultant to conduct a Triple bottom line analysis on final trading plan and adaptive management plan for comparison to other compliance options explored and analyzed
- Prepare the final compliance alternative plan

The goal of these evaluations from 2019-2021 would be to continue to provide information and data in order determine the recommended options or combination of options for final compliance. The final recommended project plan could be a combination of water quality trading, reducing the volume of effluent returned to Badger Mill Creek, and/or treatment options

For 2022 – 2023 phase of the project will begin the design work related to the final treatment option chosen. It will also begin the design of a trading brokerage system/program with the help of a consultant and also potential operational design changes if altering the BMC diversion is part of the final compliance option. Previous tertiary treatment options for chloride were predicted to be around 15 million dollars in construction costs on the high end. The design costs for this project used the 15 million dollar amount and factored in approximately 5-7% of construction cost as design costs. This could change based on the final treatment options chosen

Project Schedule:

	Start Date	Completion Date
Study &Planning:	2019	2021
Design	2022	2023
Bid Date	2025	TBD
Construction	TBD	TBD

Fiscal Year Allocation (2019$):

Study + Public engagement plan; and short term initial Treatment Options Pilot - 2019	Study and analysis of discharge options+ long term follow up Treatment Options Pilot - 2020	Economic analysis of how other compliance options fit in with low P treatment options - 2021	Design of final low P treatment option - 2022 - 2023	2024
$300,000	$300,000	$200,000	$750,000 - $950,000	