Madison Metropolitan Sewerage District

1610 Moorland Road • Madison, WI 53713-3398 • P: (608) 222-1201 • F: (608) 222-2703

# Preliminary Compliance Alternatives Assessment
# Phosphorus Compliance Badger Mill Creek, Outfall 005
# Madison Metropolitan Sewerage District
# June 7, 2022

# Table of Contents


Overview: ... 3
Assessment of Possible Compliance Options: ... 4
Treatment: ... 4
Identification of Treatment Alternatives ... 5
Evaluation of Treatment Alternatives ... 6
Performance Data ... 7
Results ... 8
Discussion ... 11
Recommendations ... 12
Discontinuing Flow to Outfall 005: ... 13
Case study: ... 15
Flow: ... 16
Other Parameters of Interest: ... 21
Phosphorus Compliance by discontinuing flow to Outfall 005: ... 22
Other Considerations: ... 22
THE DISTRICT Risk Assessment for Discontinuing flow to Outfall 005 ... 22
Watershed Alternatives: ... 26
Adaptive Management: ... 26
Discussion: ... 27
Water Quality Trading: ... 29
Variance: ... 32
Site-specific Criterion: ... 33
Summary: ... 33
Additional Figures: ... 34

# Overview:

Badger Mill Creek is an effluent-dominated stream downstream of the Madison Metropolitan Sewerage District's (District) effluent location for Outfall 005 which the District is permitted to discharge up to 3.6 million gallons per day (MGD). The applicable phosphorus water quality criterion for Badger Mill Creek is 0.075 mg/l. Current operations at Nine Springs Wastewater Treatment Plant (NSWWTP) achieve biological phosphorus removal using a modified University of Cape Town activated sludge process. Total phosphorus (TP) enters the plant typically between 5 – 6 mg/L and is reduced to a concentration below 0.30 mg/L, on average, prior to discharge to Badfish Creek (BFC) and Badger Mill Creek (BMC.) Current processes are able to remove 95% of influent phosphorus, but an activated sludge process alone is unable to achieve the final effluent limitation of 0.075 mg/L. In the Yahara watershed, where the majority of the District's effluent is returned (Badfish Creek, Outfall 001), the District is leading the Yahara WINS adaptive management project. This project aims to achieve phosphorus compliance for all participating point source permittees, including the District.

The District has evaluated six basic compliance options as well as logical combinations of these approaches to achieve phosphorus compliance in BMC. These include treatment, discontinuation of flow to outfall 005, watershed alternatives including water quality trading and adaptive management as well as a site-specific criterion and/or variance. The district has narrowed these down to three remaining compliance strategies. Since the district has two discharge locations, one option is for the district to discontinue effluent discharge to Badger Mill Creek, thus eliminating the need for phosphorus compliance at the discharge point. Engaging in a water quality trading program or an adaptive management plan also remain as possible compliance options.

There are challenges and opportunities with each of these strategies. In addition, it is important to remember that the effluent that is discharged to BMC makes up an average of approximately 8% of the total District effluent (> 92% of the District's flow goes to outfall 001, Badfish Creek). The option that includes discontinuing flow to outfall 005 could reduce or eliminate discharge to Outfall 005. Undertaking this option reduces operating costs and energy requirements, provides a valuable pipeline corridor and associated easements for the district and could be straight-forward to implement. However, considering this approach may also require resource assessments and will involve significant stakeholder engagement. Due to the District's discharge location in the upper reach of a rapidly urbanizing watershed, the water quality trading option would be very challenging if the area available for trading were limited. There is more interest and longevity of trades available if the point of standards application is downstream of the confluence of Badger Mill Creek and the Sugar River, including the HUC 12 - 070900040202) (Exhibit B). While adaptive management remains a possibility, the standard challenges associated with adaptive management are compounded in this case by multiple stakeholders and lack of an established Total Maximum Daily Load (TMDL) for phosphorus in the watershed.

# Assessment of Possible Compliance Options:

During this process, we have evaluated and assessed six compliance options. We have undertaken pilot testing of treatment technologies, discussed trading and adaptive management possibilities with municipalities and landowners, worked with the Wisconsin Department of Natural Resources (DNR) to assess a site-specific criterion and variance possibilities and impacts, discussed flow implications with USGS and began to engage a variety of stakeholders. A general overview of each of the six options assessed is included below:

## Treatment:

As described in the Operational Evaluation and Optimization Plan submitted by the District in March 2021 (included as exhibit 28), no operational improvements to the current treatment process would result in a significant enough reduction in effluent TP to meet the new limit. Therefore, a tertiary treatment system would need to be constructed for the approximately 3.6 MGD discharged to BMC.

A literature review of viable tertiary treatment alternatives for TP removal was conducted, as well as research into systems pursued by other treatment facilities in Wisconsin facing similar TP requirements. The information gathered identified five types of treatment technologies capable of removing phosphorus to the low levels required. These are ballasted settling, algae photobioreactors, membrane filtration, cloth media filtration, and sand filtration.

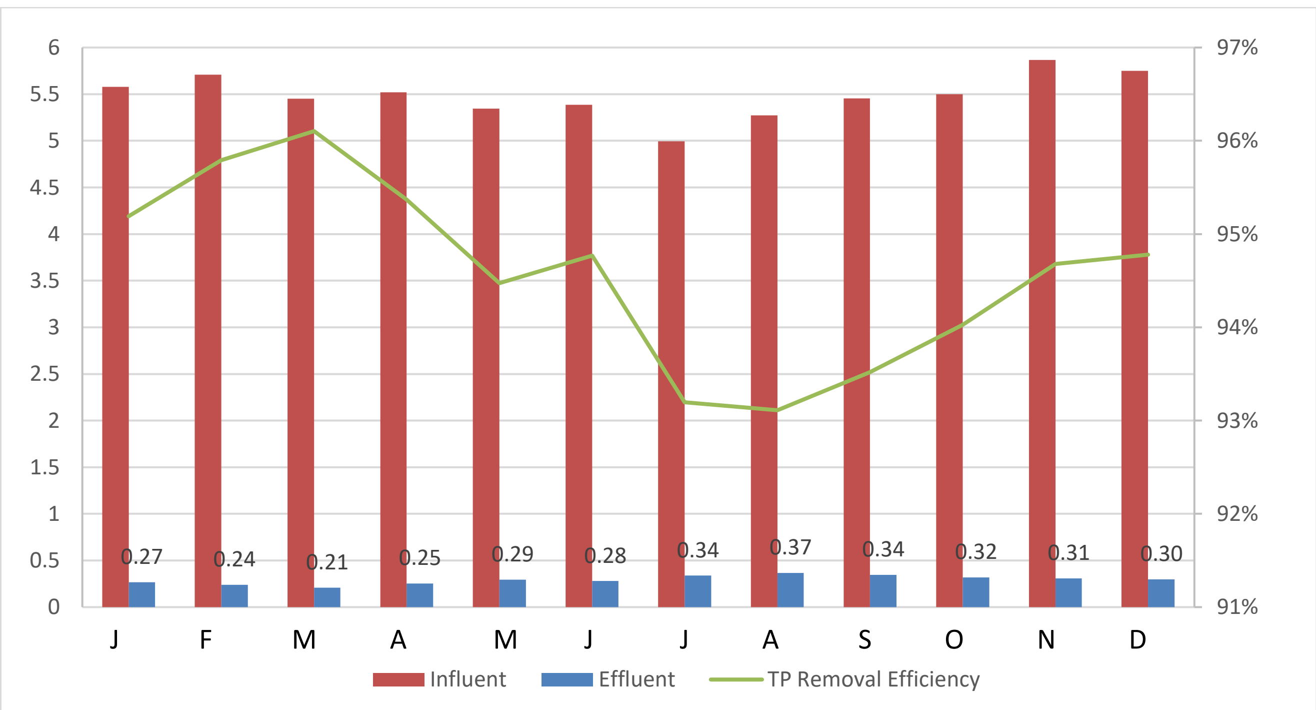



*Figure 1. Average Monthly Total Phosphorus Reduction 2017 - 2021*

## Identification of Treatment Alternatives

At least one representative technology for each of the five viable tertiary treatment alternatives was selected for further investigation and potential piloting. These were:

- Ballasted settling – CoMag from Evoqua Water Technologies and Actiflo from Veolia Water Technologies
- Membrane filtration – ZeeWeed 1500 Ultrafiltration from Suez Water Technologies
- Cloth media filtration – AquaDisk from Aqua-Aerobic Systems
- Algae photobioreactors – CLEARAS Water Recovery
- Sand filtration – BluePro from Nexom

Generally, all treatment options offer similar advantages and disadvantages compared to other compliance methods. The District could achieve phosphorus discharge to BMC which meets the water quality standard through tertiary treatment. This, however, requires the installation of expensive, energy-intensive treatment systems.

To discern the benefits and drawbacks of each individual treatment technology, an initial screening and ranking of the six aforementioned systems was conducted (Figure 2). This ranking also helped to prioritize which systems to pilot and further investigate. The systems were evaluated on the following criteria:

- System complexity and staffing needs
- TP removal efficiency
- Cost (Capital and O&M)
- Chemical requirements
- Footprint
- Energy demand
- Long-term goals (e.g., will it assist with other pollutants aside from TP? Does it offer resource recovery or effluent reuse opportunities?)
- Community impacts (e.g., will it provide a higher level of treatment aside from TP?)
- Risk/Number of installations (e.g., is this a demonstrated technology?)

These considerations were weighted on the basis of perceived importance as it relates to consideration of tertiary treatment as a means to achieve phosphorus compliance. Therefore, ability to remove phosphorus was given the most weight, while considerations involving treatment beyond TP were given less weight. O&M demands fell somewhere in the middle.

| Considerations | % Weight | Actiflo Ballast Settling | BluePro Sand Filter | Clearas Algae ABNR | AquaDisk Cloth Filters | CoMag Ballast Settling | Zeeweed UF Membranes |
|---|---|---|---|---|---|---|---|
| **Staffing/System Complexity** | 11% | 2 | 3 | 2 | 4 | 2 | 3 |
| **P Removal Effeciency** | 17% | 3 | 4 | 5 | 1 | 4 | 3 |
| **Capital Cost** | 11% | 2 | 3 | 2 | 4 | 2 | 1 |
| **O&M Costs** | 11% | 2 | 3 | 3 | 4 | 2 | 2 |
| **Chemical Usage** | 7% | 2 | 3 | 4 | 3 | 2 | 3 |
| **Footprint** | 7% | 3 | 4 | 1 | 4 | 3 | 4 |
| **Energy** | 14% | 3 | 3 | 2 | 4 | 3 | 1 |
| **Long-term Goals** | 7% | 3 | 3 | 4 | 2 | 3 | 4 |
| **Community Impacts** | 4% | 3 | 3 | 4 | 2 | 2 | 4 |
| **# of Installations/Risk** | 11% | 3 | 4 | 1 | 4 | 3 | 3 |
| | 100% | | | | | | |
| | Weighted Score: | 2.6 | 3.4 | 2.8 | 3.2 | 2.7 | 2.6 |
| | **Rank:** | **6** | **1** | **3** | **2** | **4** | **5** |

| Scoring | Scale |
|---|---|
| 5 | Excellent |
| 4 | Good |
| 3 | Average |
| 2 | Fair |
| 1 | Poor |

*Figure 2. Initial Screening of Treatment Technologies*

## Evaluation of Treatment Alternatives

The top four technologies from the initial screening were carried forward to piloting (BluePro, AquaDisk, Clearas, and CoMag), which took place between October 2018 – September 2019. The objectives of piloting were as follows:

1. Demonstrate TP removal efficiency
2. Determine chemical needs
3. Monitor removal efficiencies of currently regulated parameters: BOD, TSS, metals (Cd, Cr, Cu, Pb, Ni, Zn, and Hg), $NH_3$, and chloride
4. Analyze other effluent parameters of interest. Ancillary treatment benefits, such as total nitrogen (TN) removal, would factor into the decision-making process.
5. Estimate basic design parameters
6. Develop an understanding of staffing and maintenance needs.

Each pilot was operated for approximately ten days. Pilots were temporarily installed following final clarification on the west plant of NSWWTP. Effluent from one final clarifier was pumped through the pilot before being discharged to the effluent trough of a second final clarifier. Influent and effluent samples were collected twice daily and analyzed in-house by the District’s lab staff. The vendors and operators of the pilots were encouraged to conduct their own sampling and analysis to inform operational changes and compare data with the District's findings. These results, however, were to be used solely for the vendor's benefit, and do not appear in the performance data presented in this report.

## Performance Data

Figures 3 and 4 summarize the treatment results. It should be noted that during the AquaDisk pilot, the type of cloth media was changed from a 5-micron microfiber to a 2-micron ultrafiber in order to improve treatment. Overall, each technology trialed was able to meet the 0.075 mg/L target as anticipated.

Other effluent parameters of interest (TN, chloride, and mercury) were not significantly removed by the pilots. In the case of chloride, effluent numbers actually increased for most of the pilots. This is likely due to the addition of coagulant chemicals. Results indicate a modest benefit in mercury removal. However, influent mercury concentrations were already below the level of detection for approximately half of the samples. No negative impact was found on the District's other regulated parameters (BOD, TSS, $NH_3$, metals) for any of the systems.

Detailed discussion of pilot results can be found for each treatment system in the next section.

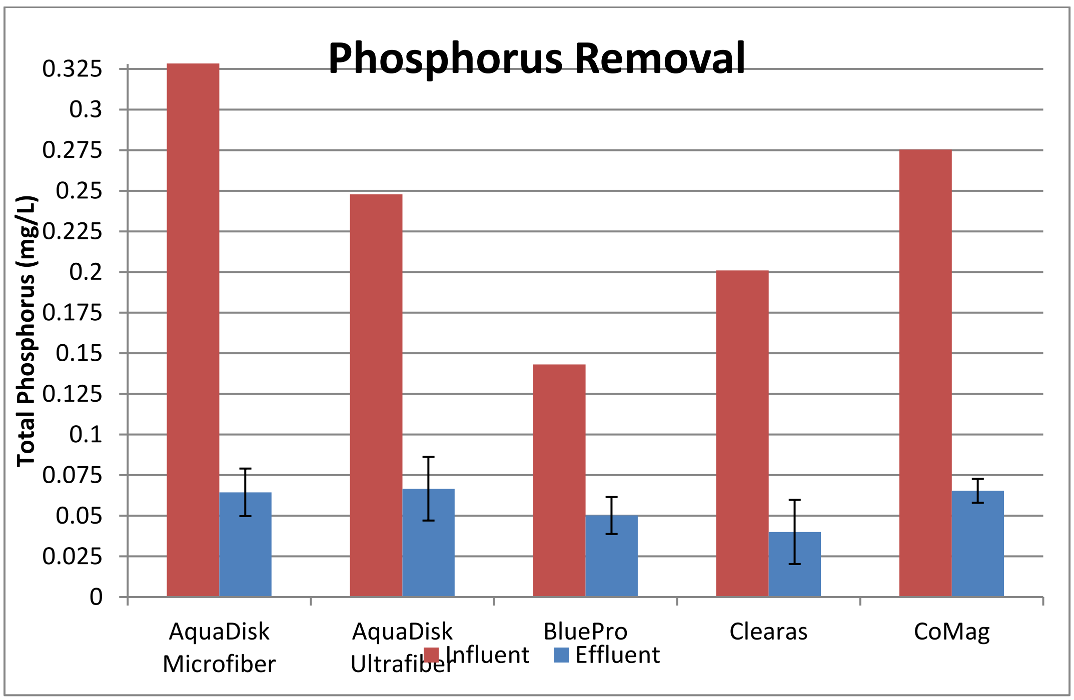



*Figure 3. TP Removal*

| | Total N | Chloride | Mercury |
|---|---|---|---|
| AquaDisk Microfiber | 8.0% | -4.6% | 38.2% |
| AquaDisk Ultrafiber | 4.6% | -5.2% | 35.6% |
| BluePro | 1.1% | -4.1% | 9.3% |
| Clearas | 5.9% | 5.3% | 20.1% |
| CoMag | N/A | N/A | 14.4% |

*Figure 4. Removal Efficiencies of Other Pollutants of Interest*

## Results

Once piloting was complete, an analysis containing both qualitative and quantitative considerations was conducted for each of the treatment technologies.

1. AquaDisk

**Description:** Ferric chloride and polymer are dosed to the incoming flow and mixed in a flocculation tank. As flocs of solids begin to form, the wastewater enters the filter tank, where it flows by gravity into the cloth media disks. Solids are filtered, leaving a mat on the surface of the cloth disks, as treated effluent exits the filter tank. A routine backwashing sequence rotates the disks, while a vacuum-pressured nozzle removes the solids build-up from the surface of the cloth disk.

**Advantages**: Cloth media filtration is a simple, well-established method for tertiary polishing of treated wastewater. Capital costs are low compared to other systems and can be installed in a compact footprint.

**Disadvantages**: Neither the 5-micron microfiber or 2-micron ultrafiber were able to reliably meet the 0.075 mg/L TP target. While each cloth media averaged below the limit for the duration of the pilot, effluent samples regularly exceeded 0.075 mg/L. This system also demands more coagulant and polymer than others.

**Conclusion**: Due to the inability to reliably achieve the desired effluent results, this technology was not pursued once the pilot ended.

2. BluePro

**Description**: The system is described as "reactive filtration", consisting of either a single or dual stage upflow sand filter. Wastewater enters the bottom of the vessel, traveling upwards through the sand as ferric chloride (or other coagulants) are injected into the incoming stream. The sand media is coated in the coagulant, which aids in the reaction and filtration of particulates. An airlift pump sends the captured solids to a washbox, where the sand media is recovered and recycled into the filter vessel.

**Advantages**: The pilot was able to achieve the desired level of treatment with a single stage filter. No polymer was needed. The only chemical required was ferric chloride, which was used at concentrations lower than other technologies piloted. Sand filtration has long been used in water filtration and is a relatively simple process.

**Disadvantages**: While simplicity of the system is a benefit from and O&M perspective, the sand filter does not offer many ancillary benefits beyond TP removal. A second stage could be added if the DIstrict were to receive more stringent effluent limits in the future, but opportunities for resource recovery, effluent reuse, or removal of contaminants of emerging concern (CECs) are limited. As with any technology reliant on chemicals, the threat of fluctuations in chemical costs is also a concern.

**Conclusion**: BluePro met many of the District's requirements and was selected as one of the technologies to investigate further if treatment was selected as the compliance option to pursue.

3. Clearas

**Description:** This system is unique in that it was the only biological systems trialed. Carbon dioxide is added to the incoming wastewater as a carbon source needed for the removal of phosphorus. Wastewater is then mixed with a stream of microalgae, similar to how a conventional biological nutrient removal system uses activated sludge. Instead of aeration tanks, however, the wastewater/algae blend travels through clear glass tubes fitted with LED lights, which serve as the photobioreactors. Following biological treatment, algae is separated and recovered from the effluent using an ultrafiltration membrane. A portion of the recovered algae is returned, while the remaining is wasted from the system. The wasted fraction can be dried and used in a number of commercial applications.

**Advantages:** The Clearas photobioreactors achieved the lowest effluent TP concentrations of the technologies piloted by the District. In addition to a high level of treatment, this system provides a resource recovery opportunity. Recovered algae has the potential to be a high-value, renewable product in the bioplastic, biofuel, or animal agriculture industries. Biological systems are also well-suited for steady, consistent loadings as seen in the BMC outfall.

**Disadvantages:** To date, there are few full-scale installations, all of which are located at small, rural treatment plants. This would be the largest application by a significant margin. The footprint required is approximately an acre. This would also be the most expensive treatment option. Some of the capital and O&M costs would be offset by the sale of the dried algae product. However, to make the installation more economical, the District's current treatment would need to be reduced, allowing more TP to enter the Clearas system. A higher influent TP concentration would yield more algae product but degrade current treatment performance. Another drawback is handling of the algae product. An energy-intensive process is required to dry the material, and once made, the District would need to rely on an outside entity to market and sell the product.

**Conclusion:** Clearas carries a large amount of risk at this time. Likewise, disadvantages such as expense and energy demand make it a less attractive option if the scope of this research is solely TP removal. However, the potential benefits and high level of treatment warrant further investigation into this technology if treatment is selected as the compliance option to pursue

4. CoMag

**Description**: CoMag is a ballasted settling system that uses magnetite to achieve TP removal. Flocculation and mixing tanks are used to dose polymer and coagulant, resulting in floc formation of solids. Also introduced in this step are the magnetite particles. Once the magnetite is incorporated in the floc, the solids quickly settle out in the following clarification step. A magnet is used to recover the magnetite from the solids, which in turn can be recycled to the flocculation tanks.

**Advantages**: The pilot successfully removed TP to the desired concentrations. The rapid clarification process associated with ballasted settling is beneficial when space is limited and tankage is nearing capacity or there is a large peaking factor.

**Disadvantages**: The system is more complex than others piloted and requires the addition of polymer, a coagulant, and magnetite. Additional tankage would need to be constructed for the mixing/flocculation tanks and clarifiers, making this a more expensive option. There are also concerns with fluctuations in chemical costs and magnetite being a more niche product.

**Conclusion:** While CoMag is an effective way to remove TP from effluent, it is better suited for a different application. The BMC outfall is a consistent flow, with very little fluctuations in loading. This excludes the advantages typically associated with a ballasted settling process. Likewise, it would be difficult to incorporate into the existing treatment scheme, requiring new tankage to be constructed.

## Discussion

Of the four treatment technologies piloted, Clearas algae photobioreactor and BluePro sand filter were identified as two viable options if treatment is selected as the phosphorus compliance alternative. Investigation into these technologies included basic design requirements, O&M and consumables, and preliminary capital cost estimates.
Both systems could potentially be located in the area north of the west plant final clarifiers and east of the effluent building (Figure 5). Clearas would fill most of the available area, while BluePro is considerably more compact with room to expand if tertiary treatment for the BFC outfall is required in the future.

*Figure 5. Possible Location for TP Treatment at NSWWTP (Top), Clearas footprint (Left), BluePro footprint (Right)*

Currently, all effluent undergoes the same treatment regardless of whether it is discharged to BMC or BFC. This means a common effluent well can be used to pump to either outfall. If tertiary treatment is selected as the compliance alternative, the portion of effluent pumped to BMC (approximately 8% of daily flows) would need to be separated. This would require heavy construction within the effluent building to partition UV and effluent wells between each outfall. Engineering and costs for this project are not included the following analysis.

Clearas would require the installation of a 140' x 202' greenhouse to contain the glass tube photobioreactors, lighting, membrane filters, algae dewatering system, cleaning system, and other appurtenances. Additional piping, chemical storage, and construction costs would bring the preliminary capital cost estimate up to $15.1 million. Costs for consumables are estimated to be $110,000 for electricity and $60,000 for chemicals annually. Assuming a production of 0.32 tons per day of algal biomass, an annual revenue of $174,500 is projected.

Treatment of BMC phosphorus with BluePro would require the installation of twelve prefabricated filter cones and airlift systems with a total filtration area of 768 $ft^2$. Filter cones would be housed in reinforced concrete cells. Chemical storage, piping, electrical, and construction costs bring the preliminary capital cost estimate up to $7.2 million. Costs for consumables are estimated to be $6,500 for electricity and $29,000 for chemicals annually.

## Recommendations

While treatment could be a viable option with respect to phosphorus compliance for this discharge location, doing so brings many draw backs. It is an expensive alternative and negatively impacts the District's goals of reducing energy consumption and the carbon footprint associated with manufacturing and transportation of chemicals. In addition, these treatment technologies would not be providing significant ancillary benefits to the receiving water such as nitrogen or chloride removal. Based on piloting results and preliminary design and cost estimates, the BluePro sand filter or equivalent treatment system would be the best suited to meet the District's phosphorus compliance goals (should tertiary treatment be selected). Clearas may also be considered, though there is significantly more risk and cost involved with this option. The costs and energy impacts presented in this section only relate to treatment for 8% of the District's effluent. Based on these findings, the District is not intending to pursue treatment as a preferred compliance option for BMC at this time.

## Discontinuing Flow to Outfall 005:

The District currently pumps up to 3.6 MGD of effluent to Badger Mill Creek, which is approximately 8% of the District's effluent. The District began returning effluent to Badger Mill Creek after the City of Verona discontinued operation of their wastewater treatment plant near Bruce Street which discharged effluent to Badger Mill Creek. In 1998, when this diversion began, the District's effluent made up a significant portion of non-flood flows in Badger Mill Creek. In recent years, stream hydrology and the tributary land use have changed. Over the past thirteen years, the district's effluent has remained relatively constant but the flow in the stream has increased, as shown in Figure 6.

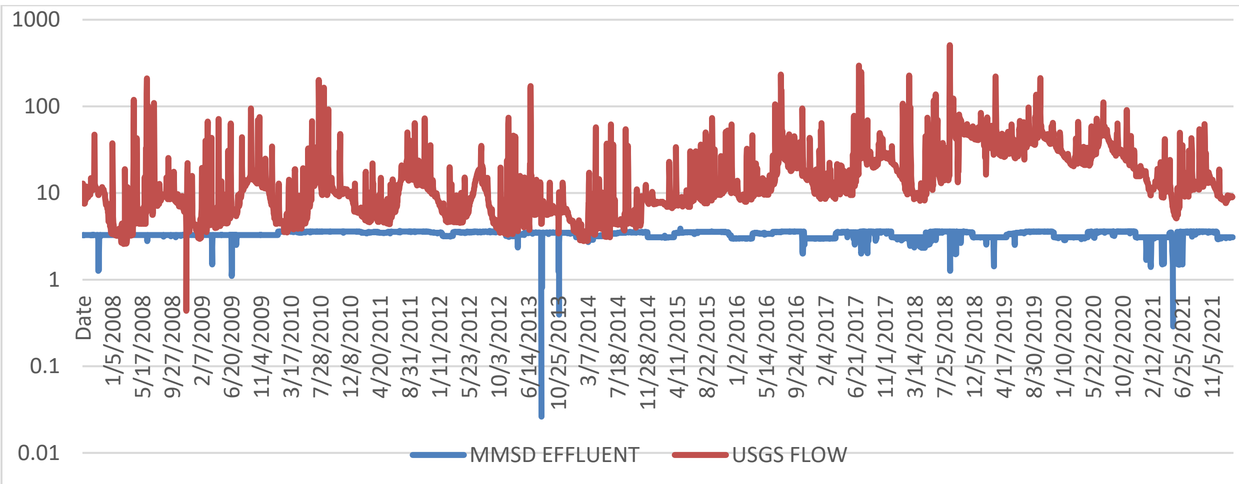
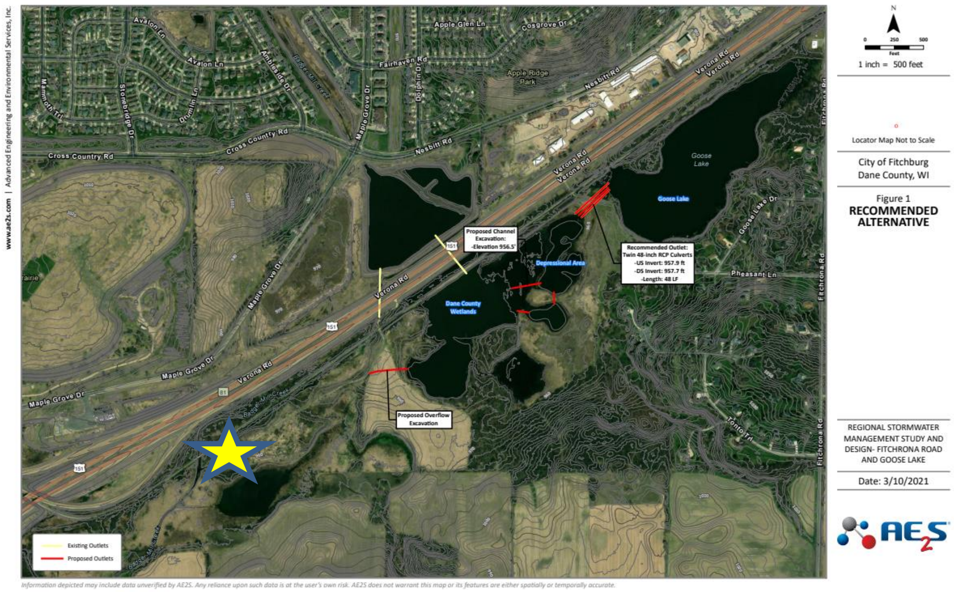



*Figure 6 - **USGS Flow Data for Bruce Street Gage on Badger Mill Creek (MGD) and District Effluent (MGD) – Log based scale***

The DNR stocks trout in Badger Mill Creek and local partners including Trout Unlimited and Dane County recently made habitat improvements to the stream. Upstream of the District's effluent return (aerator), flow coming from north of STH 151 and east from the Goose Lake Area and adjacent wetlands add to the flow in Badger Mill Creek. Immediately downstream of the District's aerator, natural springs add to the baseflow in Badger Mill Creek. Further hydrologic changes are proposed for the watershed, including changing flow routing to alleviate flooding in the Fitchrona Road/Goose Lake area which will change the hydrology and are predicted to increase flood flows to Badger Mill Creek. These are more fully described in the reports and presentations found on the project City of Fitchburg/Town of Verona project website: Fitchrona Road Stormwater Study | Fitchburg, WI - Official Website (fitchburgwi.gov).

The following graphics are from the AE2S Report included with the website above for the project and indicate the flow increases proposed by the recommended Alternative:




City of Fitchburg
Town of Verona
Goose Lake/Fitchrona Road Flood Study
Page 3 of 27


*Figure 2 Preferred Alternative Impacts on 100-year Storm*

Indicates the location of MMSD effluent return to Outfall 005, Badger Mill Creek – for comparison, MMSD's effluent maximum of 3.6 MGD is equal to 6.7 cfs (cubic feet per second)

One phosphorus compliance option is for the District to reduce or discontinue the effluent volume that is pumped to Badger Mill Creek. If this discharge location was discontinued, the district's entire effluent would flow to Badfish Creek (Outfall 001). We recognize that certain permit changes would be required if the current discharge to BMC were diverted to Outfall 001. However, based upon our initial review, these changes would not preclude this as a possible compliance option. The District's variances for mercury and chloride and associated pollutant minimization/source reduction plans are based on overall district operations and are not specific to outfall location. With respect to phosphorus limitations, the Rock River TMDL included the District's entire design flow (50 MGD) at a phosphorus concentration of 1.0 mg/l for baseline. Currently, the district average flows remain around 40 MGD and the phosphorus concentration remains under 0.3 mg/l, which illustrates that this baseline would be inclusive of the District's entire discharge.

## Case study:

There was a recent event that provided a trial for this compliance alternative. Because of construction of the District's Nine Springs Valley Interceptor, a portion of the effluent return line needed to be reconstructed. Construction sequencing for this project required a three-week shut down period for the BMC effluent return line. Incidentally, 2021 was a significantly dry year which provides further insights.

Following discussions and coordination with a DNR biologist, the District started to reduce flows on May 11, 2021 and the return effluent was fully discontinued on May 18, 2021 and pumping did not begin again until June 4, 2021. In retrospect, we are able to assess possible impacts because of the USGS monitoring station at Bruce Street which provides continuous data on parameters such as flow, temperature, conductivity and dissolved oxygen. In addition, the district monitored the stream with photographs to document current conditions.

During our coordination before this shutdown, DNR expressed specific concerns which we worked to overcome. Specifically, DNR was worried about stranding species, so requested that we slowly reduce the flow to allow species a chance to relocate. We accommodated this request. DNR expressed concern with draw down in the fall or winter because of a risk to spawning or egg development for trout. Therefore, we completed this work at the end of May and beginning of June. Below are a series of observations from May and June 2021.

Temperature: One of the District's concerns is temperature as the District maintains alternative effluent limitations for Badger Mill Creek for cooler months. The USGS monitoring station at Bruce Street records temperature of the stream. Figure 7 includes data for May of 2021. In general, the temperatures remain in a standard range. When the District is not discharging, the impact of the significant air temperature drop May 26-27, 2021 is shown to impact temperature in the stream (Figure 8).

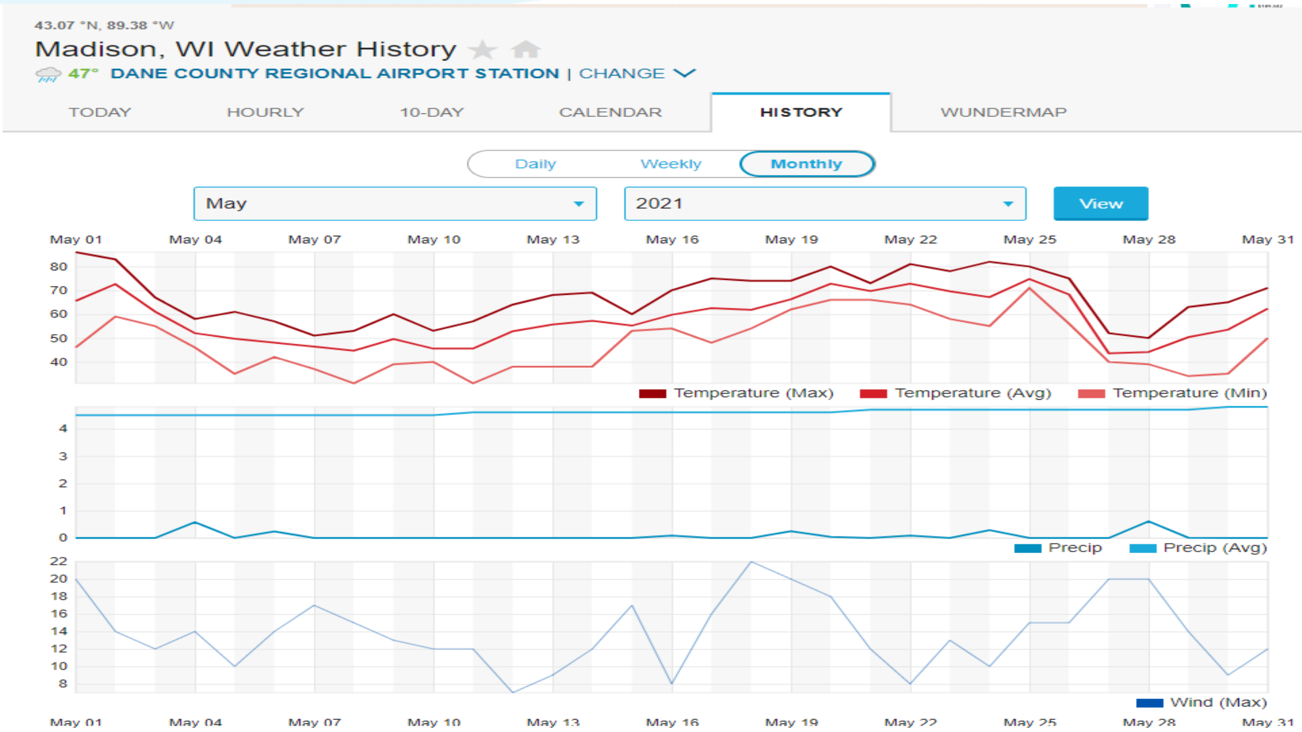



*Figure 7 - Weather from May 1-May 31, 2021, Madison, Wisconsin*

## Flow:

Another interest of the District is flow. Specifically, we are interested in the impact of our effluent on the flow in the stream. Figure 10 illustrates that while in 2008, THE DISTRICT's effluent made up a significant portion of the BMC flow at Bruce Street, over time, that percentage has decreased. Now, even in very dry conditions like 2021, the District's flow rarely reaches 40% of the BMC flow at Bruce Street and in wetter years, it can be less than 10% (Figure 9). The shutdown period was during a dry period in a dry year. The weather data shows two small precipitation events during the shutdown period: May 23 (0.29 in) and May 28 (0.59 in) and an overall May 2021 precipitation of more than 2-inches below normal. The state climatology office graphs (Figure 10) show the relative precipitation in 2021 compared to normal and 2020 as well as 2022 to date.

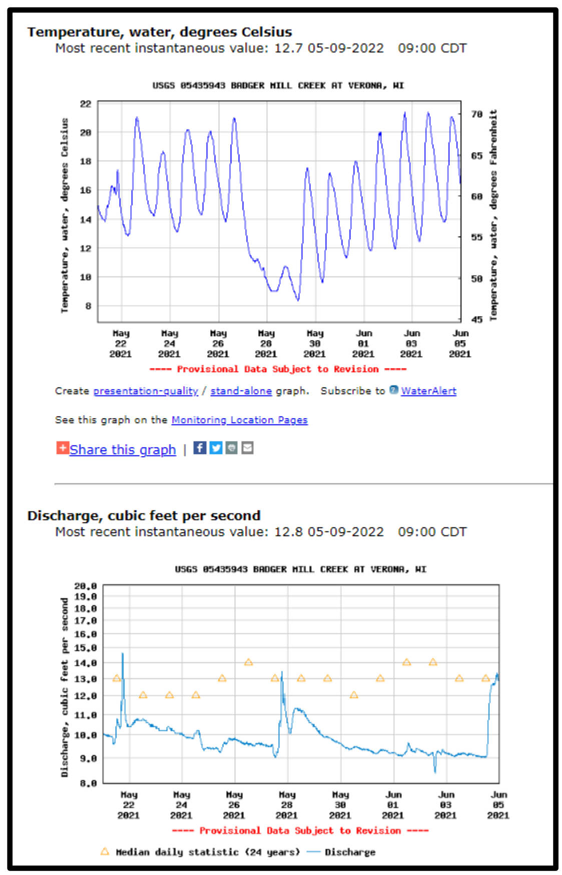



*Figure 8, May and June 2021 Temp/Flow USGS Gage Bruce Street*

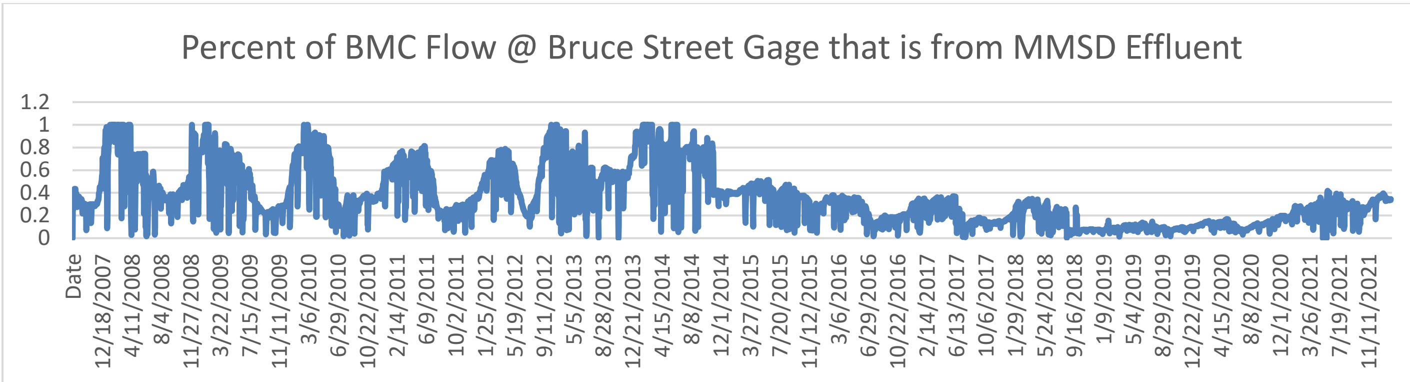
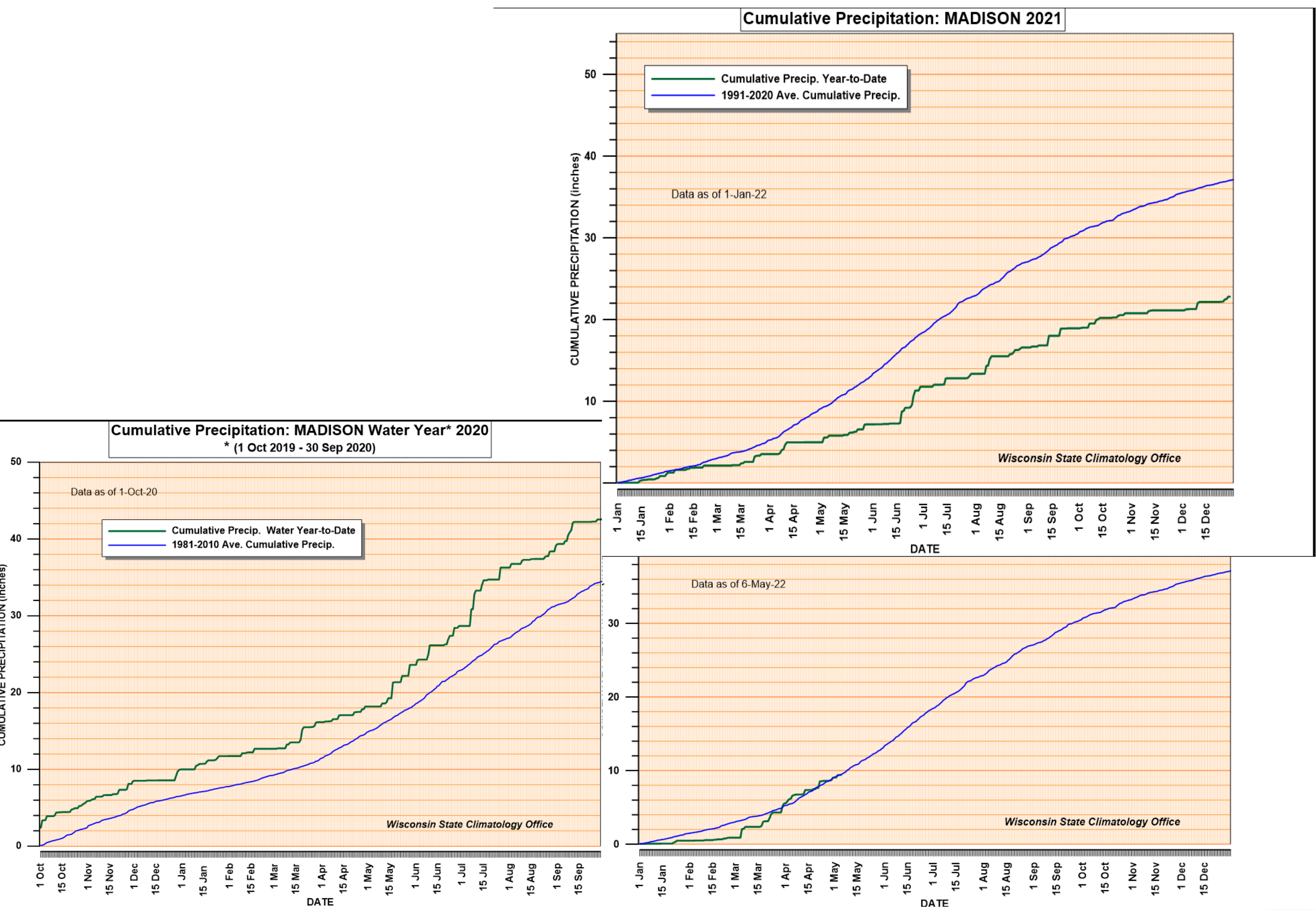



*Figure 9 – Percent of BMC Flow at Bruce Street 2008-2021 that is the District's Effluent*

*Figure 10 Wisconsin State Climatology Office 2021 precipitation with 2020 and 2022 (to date) below*



In 2021, Figure 11 shows the amount of flow that the District made up of the Bruce Street discharge, including the three weeks of shut down where the District contributed no flow to Badger Mill Creek. Even in the significantly dry year of 2021 (overall nearly 7-inches below normal), THE DISTRICT made up a maximum of 40% of the BMC flow at Bruce Street. The actual flow from THE DISTRICT and the gage readings in million gallons per day (MGD) for 2021 are included in Figure 12. The USGS Gage information and photos shown in Figures 13 (during shutdown May 2021) and 14 (normal flow April 2022) show visually what BMC looks like when there was not (Figure 13) and was (Figure 14) District flow at the first roadway crossing of BMC, Old Highway PB. The photo location is approximately 2-miles upstream of the Bruce Street gage and approximately 1/2-mile downstream of where the District's outfall 005 enters BMC.

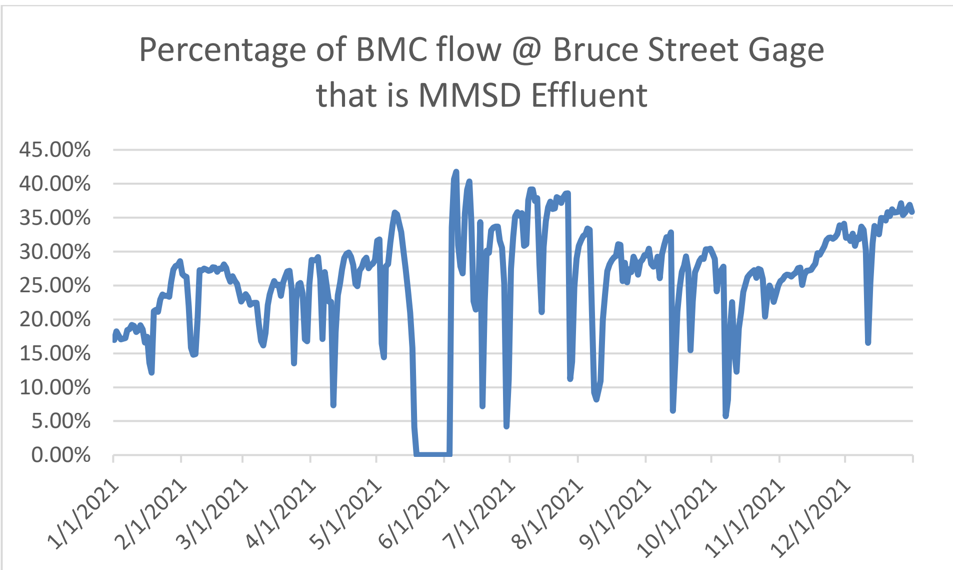



*Figure 91 - Percent of BMC Flow at Bruce Street that is THE DISTRICT Effluent 2021*

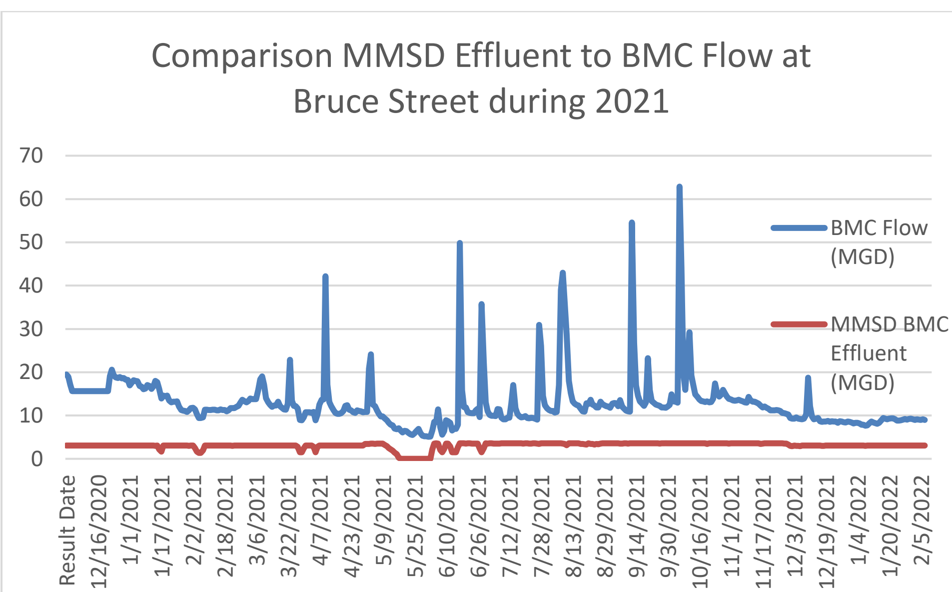



*Figure 102 - Comparison of BMC to Bruce Street Flow*

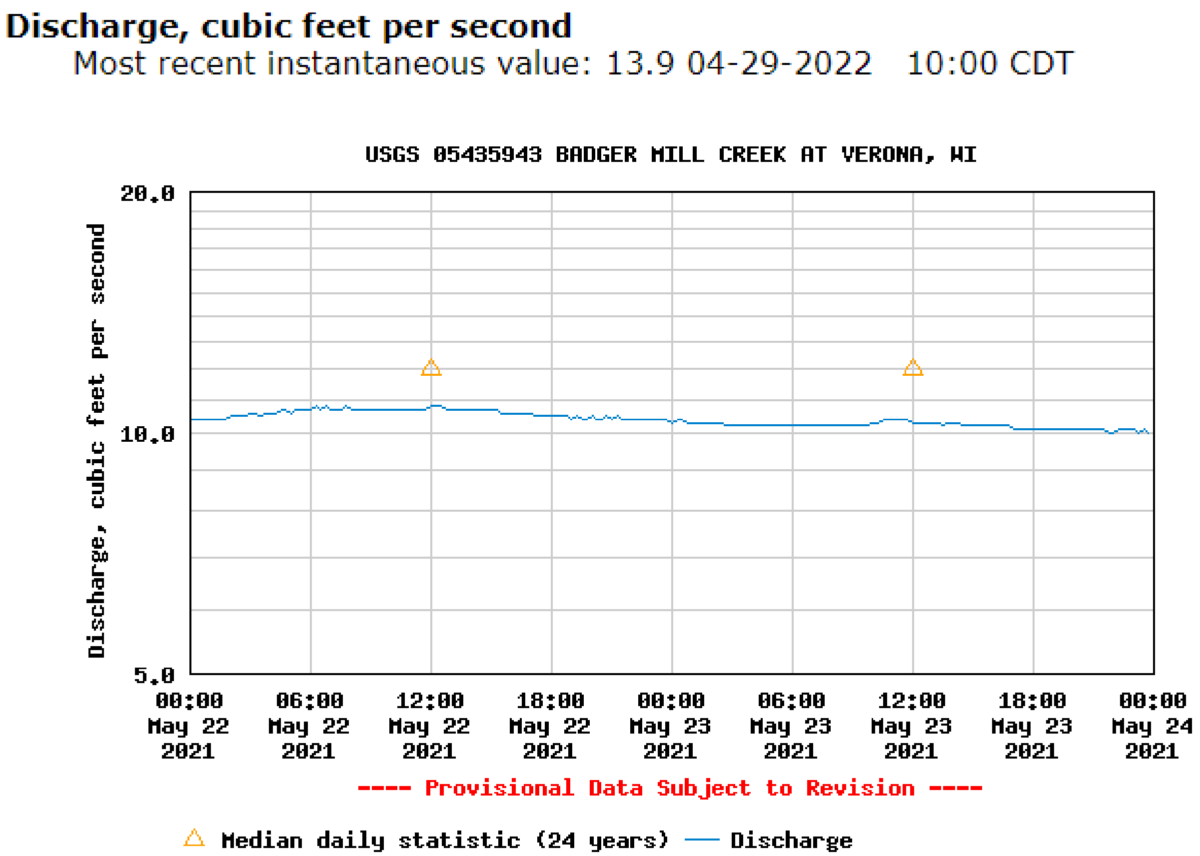



*Figure 13 - Stream at Old PB on May 23, 2021, pumps shut off since May 21 – USGS Gage flow and Photo*

**Discharge, cubic feet per second**
Most recent instantaneous value: 13.9 04-29-2022 10:00 CDT

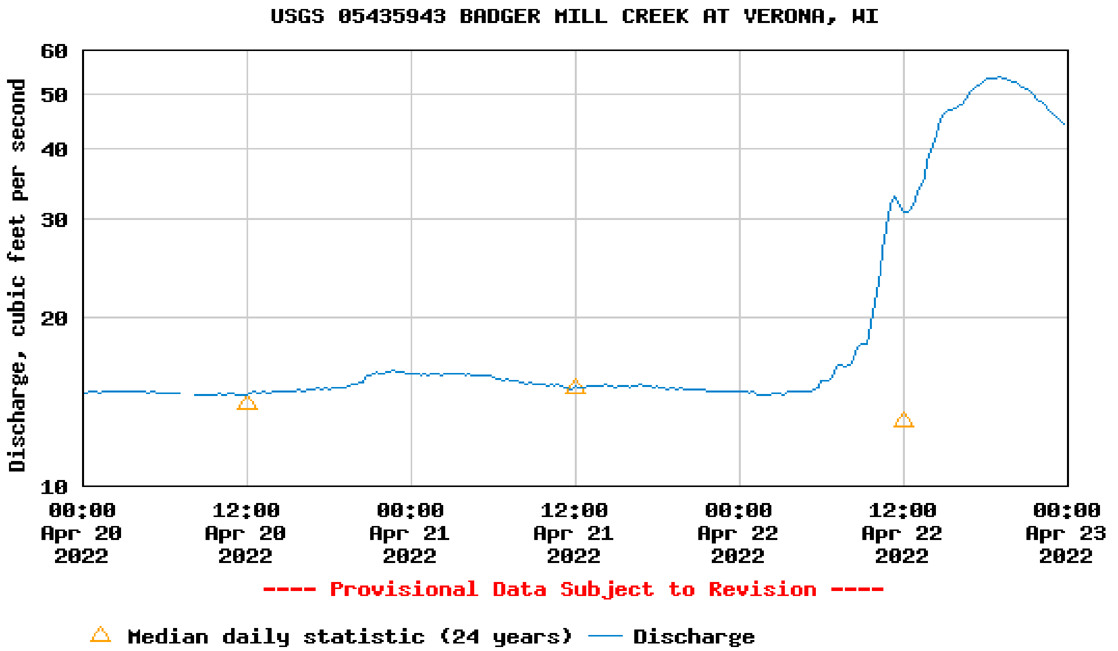
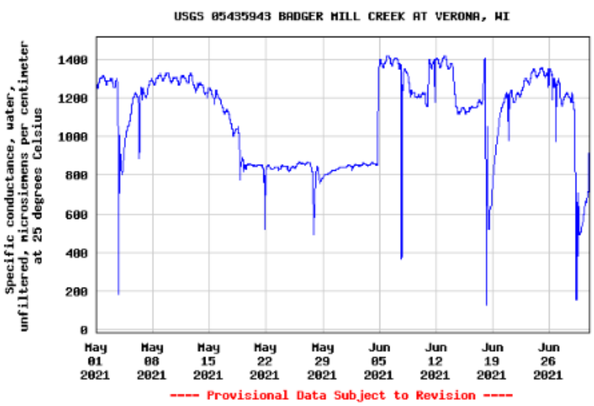



*Figure 11 - BMC at Old PB on April 21, 2022 – USGS Gage flow and Photo, normal the District's operation*

## Other Parameters of Interest:

In addition to the assessment above, USGS tracks conductivity and dissolved oxygen (Figure 15). It is very evident when the District's effluent was discontinued to BMC with the conductivity graph below. The District's effluent contains chloride and we maintain a chloride variance in our WPDES permit. Conductivity includes that chloride contribution. When the District's is not discharging, the chloride and conductivity in BMC are significantly reduced. USGS also maintains dissolved oxygen monitoring for BMC. Assessing the two graphs below, it is clear that during the period of lower conductivity, when the District's is not discharging, the daytime highs for dissolved oxygen are reduced and the nighttime lows appear steady and slightly higher.



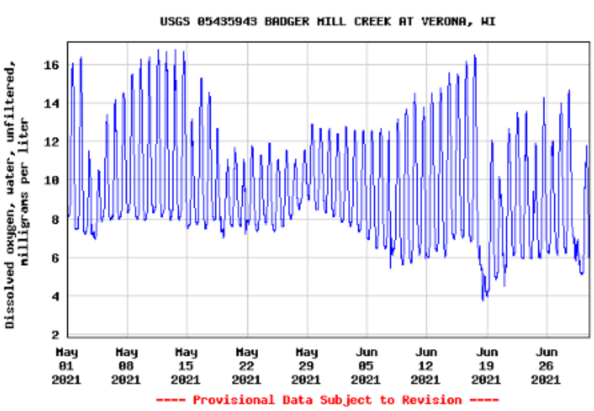

Create presentation-quality / stand-alone graph. Subscribe to WaterAlert

See this graph on the Monitoring Location Pages

Share this graph |

**Dissolved oxygen, water, unfiltered, milligrams per liter**

Most recent instantaneous value: 11.2 05-03-2022 10:00 CDT




Create presentation-quality / stand-alone graph. Subscribe to WaterAlert

*Figure 15 - Badger Mill Creek Conductance and Dissolved Oxygen May/June 2021*

## Phosphorus Compliance by discontinuing flow to Outfall 005:

The majority of the District's effluent (>92%) is discharged to Badfish Creek, the District's Outfall 001. This outfall location is part of the Yahara WINS Adaptive Management project. If flow and associated phosphorus increase in Badfish Creek, the District's contribution to Yahara WINS would increase per the Yahara WINS Intergovernmental Agreement. Based on current effluent flow and phosphorus concentration, if all the Badger Mill Creek flow was diverted to Badfish Creek, approximately 2,100 lbs (exhibits 21 and 22) of phosphorus per year would also be diverted. This would be a relatively small increase to the total pounds that Yahara WINS is addressing (in total Yahara WINS addresses ~96,000 lbs of phosphorus). The Intergovernmental Agreement for an Adaptive Management Plan for the Yahara River Watershed (IGA) includes a mechanism for accounting for increased wastewater treatment plant contributions. Under these requirements, the District would be responsible for paying into Yahara WINS for the added phosphorus reduction required. Using current estimates, this would be approximately $110,000 additionally each year for a 20-year present worth cost of approximately $1.7 million. The Yahara WINS project would need to accomplish reductions to offset the additional pounds of phosphorus.

## Other Considerations:

The District recently completed an Energy Master Plan (Dec. 2021) which indicates that elimination of the Badger Mill Creek pumps would result in a net reduction of energy usage by the District due to the lower energy required for pumping to the BFC outfall compared to the BMC outfall. The difference in specific energy between the BMC pumps and BFC pumps is 610 kWh per million gallons (kWh/MG). This results in an energy savings of 2,010 kWh/day (730,000 kWh per year).

There do not appear to be immediate capital costs associated with implementing this alternative other than Yahara WINS contributions, demolition of the BMC pumps and associated piping and electrical equipment. Demolition costs are anticipated to be minimal if incorporated as part of a larger project to minimize contractor mobilization and overhead costs.

Additionally, once the flow is discontinued, the forcemain, associated corridor and/or easements could be availble for alternative uses for the District (e.g. corridor for a relief forcemain, etc). While the district is intending to continue assessing a discontinuation as a preferred compliance option. A significant next step to assess this option will be to engage with stakeholders. The District is assessing the potential of a professional services contract to engage a facilitator(s) for this process.

## The District's Risk Assessment for Discontinuing flow to Outfall 005

Development and hydrologic change continue to occur in the Badger Mill Creek watershed. The District's effluent provides a constant flow to Badger Mill Creek. During low flow periods, this flow is quickly surpassed with any precipitation or melting. During the shut down period in May of 2021, which occurred during a period of low flows, low flows indicated at the USGS gage at Bruce Street maintained a minimum flow of approximately 9 cfs. The dissolved oxygen appeared stable and possibly reduced in variation with the lows slightly higher and the highs slightly lower. Temperature in the stream appears to correlate closely to the air temperature and the water temperature cools as the air temperature fell into the 30°s F toward the end of the shutdown period. The conductivity was the most pronounced change. Without the District's effluent there is less conductivity in the stream. This correlates directly to the current chloride contribution of the District's effluent.

The artificial stream contribution from the District's effluent provides benefits and risks. The District's effluent provides for a constant input of flow, which also maintains a relatively constant temperature. With this input, there are also challenges including the input of chloride and phosphorus into the watershed and warmer temperatures in some months than are allowed by DNR's thermal requirements.

For THE DISTRICT, there are future considerations with maintaining this discharge location. Our WPDES permit has more restrictive water quality standards for Outfall 005 (Badger Mill Creek) for the following parameters as shown in Figure 16.

| | **001 – BFC** | **005-BMC** |
|---|---|---|
| **CBOD** | 19 mg/l | 7 (May-Oct)<br>16 (Nov-April) |
| **TSS (monthly avg)** | 20 mg/l | 10 mg/l(May-Oct)<br>16 mg/l (Nov-Apr) |
| **Ammonia (total max)** | 17 mg/l | 11mg/l |
| **Thermal** | No limit | Alternative Effluent Limit: Oct, Nov, Jan, Feb |

*Figure 1612 - WPDES permit comparison outfall 001 and 005*

These are generally driven by the current classification of the two discharge locations. There has been on-going discussion regarding classification of Badger Mill Creek. If the stream is reclassified, there will be new effluent limitations calculated which could become more restrictive. Because the District operates one treatment plant which produces one effluent, our operations are based on meeting the more restrictive water quality parameters. While Badfish Creek is classified as Limited Forage Fishery, Badger Mill Creek maintains higher classifications and has been under review for even more stringent requirements. Wisconsin DNR's biologists included in their "An Examination of Fisheries Data for Badger Mill Creek To Determine the Potential for Alternative Effluent Limits for Effluent Discharge" that
"In 2005, the department conducted a comprehensive survey of multiple sites along the creek to determine its status and provide management recommendations. The department concluded that Badger Mill Creek should be considered a "Coldwater B – Class IIx" system from the Lincoln Street footbridge downstream to its confluence with the Sugar River. It also recommended the section upstream of the Lincoln Street footbridge to the effluent discharge

point be considered “Diverse Fish and Aquatic Life – Coolwater” (WDNR, 2005). In 2008, fisheries management designated Badger Mill from its mouth at the Sugar River upstream to the uppermost STH 18/151 crossing as a “Class II” trout water. As noted earlier, the water resources designation has not changed.”

Wisconsin DNR further notes that “Water quality-based effluent limitations are calculated in order to insure that discharges to waters of the state are in compliance with water quality standards. Water quality standards include water quality criteria (such as those in chs. NR 102 [exit DNR], 104 [exit DNR], and 105 [exit DNR], Wis. Adm. Code), use designations or classifications of the state's waters (examples include fish and aquatic life uses, public water supplies, recreational uses, outstanding or exceptional resource waters), and antidegradation provisions to address new or increased discharges to waters of the state. All of these standards are considered together in order to protect Wisconsin’s aquatic life, wildlife and human health from the effects associated with the discharge of toxic (poisonous) and organoleptic (adverse impacts on sensory organs) substances to the state's surface waters.” Changing an effluent dominated stream’s classification will impact the water quality standards and the requirements that dischargers will face. We foresee a future designation of a coldwater trout fishery for Badger Mill Creek. When this happens, we will have significant challenges meeting the permit requirements.

One major change would be that the thermal requirements will become more restrictive – even though DNR biologists have noted that the effluent temperatures do not appear to harm the resource. With our next WPDES permit, we will need to reapply for Alternative Effluent Limitations for the months when our effluent exceeds the current standards. Our effluent is currently warmer than allowed by DNR’s effluent standards for our current classification of Badger Mill Creek. Badfish Creek faces no thermal requirements due to its classification. The District is also operating under a variance for chloride. With two discharge locations, if our effluent exceeds the target value, we end up with two violations, one for each discharge location. In addition, we were recently informed that DNR is looking at reevaluating the chloride water quality standard due to other Midwest states having lower standards. This could make this much more difficult. During our discussions with DNR, they have routinely mentioned the potential of a TMDL for Badger Mill Creek and the Sugar River. If the District is discharging in the watershed when this is completed, the District will have requirements to meet and will have a deadline in which to complete them. DNR has tried to leverage this as an incentive for the District to work with partners now to encourage others to make improvements to their phosphorus discharge. In our current WPDES permit, we are required to submit monitoring data for nitrogen. This includes TKN, Nitrite+Nitrate and total Nitrogen. This is speculated to be leading toward future nitrogen restrictions on effluent.

Not all the potential impacts are to aquatic biological organisms. There are also human recreational uses, including fishing and kayak rentals, that currently engage with BMC. Considering all risks and threats, public perception and interpretation are the most critical. The District needs to engage with stakeholders in order to move a compliance option for Badger Mill Creek forward, especially when considering whether a discontinuation of flow is a possible option. Stakeholders must be heard and their concerns need to be considered. At this point, District staff is evaluating the potential of an outside expert or firm to assist in the development and implementation of our stakeholder engagement approach.

Reference reports:

RESOURCE ASSESSMENT AND DEVELOPMENT ANALYSIS FOR THE UPPER SUGAR RIVER AND BADGER MILL CREEK SOUTHWEST OF VERONA, WI JUNE 2008, By: Montgomery Associates for the City of Verona

*An Examination of Fisheries Data for Badger Mill Creek,*
*To Determine the Potential for Alternative Effluent Limits for Effluent Discharge*
*from the Madison Metropolitan Sewerage District*
*By: Wisconsin DNR, Water District South, February 2017*

## Watershed Alternatives:

Badger Mill Creek is a HUC 12 watershed in the Upper Sugar River Watershed, 070900040201. At the point of the District's discharge, Badger Mill Creek is an effluent dominated stream. Upstream areas contribute stormwater to the creek. This HUC 12 is rapidly urbanizing. The majority of the watershed is included in the urban service area. Land values are high and demand for development is intense. These factors limit the opportunities to utilize watershed approaches in 070900040201 for phosphorus compliance.

While there have been on-going discussions about the health of Badger Mill Creek and its fishery, discussions with the department's biologists have not shown that nutrients are causing impairments to the local fishery. These same discussions have indicated that additional nutrients could impact downstream waters and therefore, approaches that reduce nutrient run-off in the broader watershed area could achieve overall nutrient reduction goals and help achieve point source compliance.

During our preliminary assessment and in meetings with stakeholders, we found potential projects and partners in the Badger Mill Creek HUC 12 (070900040201). Our initial assessment also identified less urban development pressure, longer commitment potential and includes projects that are desired by landowners, agencies and ready to go forward in the adjacent watershed 070900040202 (expanding the watershed to the HUC 10 = 0708000402). One specific project is already being scoped by DNR, Dane County, the Farmers for the Upper Sugar River Watershed and the Upper Sugar River Watershed Association. The location map as well as types of projects and estimated costs are shown in Exhibits 24 and 25. The relative cost and increased desire and longevity of these practices compared to those in the BMC HUC 12, illustrate how significant the point of standards applicability is to the viability of watershed approaches.

## Adaptive Management:

One available watershed compliance option is Adaptive Management. The District's Badger Mill Creek discharge is eligible for adaptive management because:

1. the receiving water exceeds the state water quality criterion,
2. the District would need to install filtration to comply with the water quality standard,
3. non-point sources contribute more than fifty percent of the load to the watershed.

Badger Mill Creek is on Wisconsin DNR's 303d list as impaired for phosphorus, but does not currently have an established phosphorus budget called a total maximum daily load or TMDL. Until a TMDL is established, the only entity in the watershed that is required to make further phosphorus reductions is the District. Stormwater dischargers are required by NR 151 to meet a 20% TSS reduction and eventually a 40% TSS and associated total phosphorus reduction. There are currently five MS4's tributary to Badger Mill Creek: City of Madison, City of Fitchburg, City of Verona, Town of Middleton, and Town of Verona. During this alternatives assessment, we met with the Cities of Fitchburg, Verona and Madison, the Town of Verona and groups like the Upper Sugar River Watershed Association (USRWA). There are potential projects and some interest in partnering but without a driver, like a TMDL or permit requirements, the discussions have focused on examples of how the District could help pay for these entities' desired projects. DNR has noted that an adaptive management project could help put in place practices to eliminate the need for a future TMDL. However, as of yet, we have not found success in advancing this line of reasoning with potential partners.

The success of an adaptive management program requires meeting in-stream water quality criterion for phosphorus. Existing water quality data indicates that Badger Mill Creek does not meet the applicable water quality criterion upstream of the District's outfall location and the Sugar River does not appear to meet the applicable water quality criterion downstream of the confluence with Badger Mill Creek. This indicates that there are additional sources of phosphorus which an adaptive management plan could work to reduce. While the variety of phosphorus reducing practices increases as the watershed is expanded, the number of pounds of reduction required to achieve water quality compliance and the complexity of the project increases as an adaptive management project increases in scale.

Figure 17 illustrates the Badger Mill Creek Watershed acreages, land use types and modeled pounds needed to achieve adaptive management compliance with various scale adaptive management projects. In general, as the project compliance point moves downstream, the approximately number of pounds of phosphorus that would need to be reduced increases.

## Discussion:

Adaptive management requires meeting in-stream water quality standards. This would mean that for 6-month averaging periods, the stream would need to remain below 0.075 mg/l. For the District, this could occur at the location where our effluent meets Badger Mill Creek or at a series of locations downstream from there. Based on the instream water quality measurements, the number of pounds that would need to be offset would increase as the tributary area increases. To determine how many pounds would need to be reduced to achieve the water quality standard, we assessed our stream monitoring data. This data includes grab samples taken at points along Badger Mill Creek and the Sugar River as shown on Figure 18. Our WPDES permit requires that the six-month averaging periods. DNR states that the six-month average concentration and mass limits are applicable to the periods of May 1st through October 31st and November 1st through April 30th each year. Therefore, we have assessed our data based on those time periods. Figure 17 includes the instream total phosphorus for four points on Badger Mill Creek (Location map is included as the Upper Sugar River Watershed on Exhibit 23) from the past five years of the District's stream sampling. Figure 18 includes average flow from USGS's gaging stations for the Bruce Street and Sugar River at Hwy 69 gages.

| | BM7 (Bruce St) | | BM-9 (Hwy 69 & BMC) | | SR-7 (Hwy 69 & SUGAR) | | BM-5 (most upstream) |
|---|---|---|---|---|---|---|---|
| May-October | 0.20 | | 0.19 | | 0.15 | | 0.25 |
| Nov-April | 0.12 | | 0.14 | | 0.09 | | 0.18 |

*Figure 17 - BMC instream Total Phosphorus Concentrations for 6-month averaging periods*

| Flow at Bruce Street Average over May-October | Flow at Bruce Street Average November – April. | Flow at Sugar River Hwy 69 May to October | Flow at Sugar River Hwy 69 November – April (Exhibit 27) |
|---|---|---|---|
| **31.0 MGD** | **24.1 MGD** | 91.7 CFS = **59.2 MGD** | 79.5 CFS = **51.4 MGD** |

*Figure 18 – USGS Flow at various points along BMC by 6-month averaging period*

| Location & Avg Period | Flow (MGD) | Phosphorus Conc | WQS | Pounds to offset per half year |
|---|---|---|---|---|
| Bruce Street May-Oct | 31.0 | .20 | .075 | 5940.38 |
| Bruce Street Nov-Apr | 24.3 | .12 | .075 | 1676.34 |
| Sugar River @69 May-Oct | 59.2 | .25 | .075 | 15881.88 |
| Sugar river @69 Nov-Apr | 51.4 | .18 | .075 | 8273.60 |

*Figure 19 - Pounds to be Offset based on Averaging Period and Location*

Figure 19 uses this data to calculate the approximate pounds needed to be offset at different adaptive management compliance points. Based on these calculations, for adaptive management to work in the watershed upstream of Bruce Street, approximately (5940+1676) 7617 pounds per year would need to be reduced by the end of the Adaptive Management period (which by statute is 20-years). If the Adaptive Management plan is expanded to include the watershed upstream of STH 69 on the Sugar River, the total pounds we would need to achieve would be around 24,155 pounds per year. The district is discharging approximately 2100 pounds per year more phosphorus than would be allocated to our discharge.

Putting this in perspective of the size of the watershed, the majority of the watershed's shared urban acres are within the Badger Mill Creek watershed. An adaptive management program that incorporates the entire Badger Mill Creek watershed would be cost prohibitive for the District to do alone as significant urban treatment practices will be required to meet the required phosphorus reductions. Moving downstream and incorporating the Upper Sugar River as well as Badger Mill Creek will add both significant additional pounds of phosphorus as well as additional non-urbanized acres with the potential desire for watershed improvement. The attached plan and projects, Exhibits 24 and 25, show existing energy and planning in the adjacent watershed 070900040202 that would possibly lead to significant landscape changes, water quality improvements and create synergy for additional improvements.

While adaptive management remains a possibility, it also includes significant challenges. The driver of District phosphorus compliance alone has not been the needed catalyst to advance the broad partnership required to implement a successful adaptive management plan in this area. Since our discharge is to Badger Mill Creek, we have been guided to believe we could work only in the Badger Mill Creek HUC 12 alone (070900040201). A target area in that upstream watershed (070900040202) or broadening the area to encompass the HUC 10 watershed may make this compliance option more practical and help to improve overall water quality. The approximate pounds that The District needs to offset are approximately 2100 pounds per year. The number of pounds estimated to need to be reduced to meet water quality standards in the combined Sugar River and Badger Mill Creek is estimated to be nearly 25,000 pounds. Based on these broad discrepancies, the District would consider working in the Upper Sugar River as an Action or Target Area but working in the overall area with the end goal of meeting instream water quality does not appear to be in the District's best interest. Without a TMDL or a timeline to comply with the DNR's NR 151 standards, the District anticipates that it would be challenging to establish a viable adaptive management plan for permit compliance. Thus, while the District continues to evaluate Adaptive Management possibilities, it is not the District's currently preferred compliance option.

### Water Quality Trading:

The excess phosphorus load to Badger Mill Creek could be offset through a water quality trading program. The Wisconsin Department of Natural Resources (WDNR) guidance for implementing a water quality trading program 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, approximately 2,100 lbs/yr, Exhibits 21 and 22) to come up with a total phosphorus load reduction that must be accomplished. Using the WDNR guidance document, we have estimated that a minimum trade ratio in the range of 1.0-3.0 could be applied to the District's required load reduction, with a higher trade ratio possible. Based on an effluent flow rate of 3.6 mgd, the amount of phosphorus that would have to be offset through trades would be in the range of 2100-6300 lbs/year depending on the trade ratio. The amount of flow going to Badger Mill Creek is directly related to the amount of phosphorus offset required. If the effluent flow discharged to Badger Mill Creek was reduced by 50%, the amount of phosphorus required to offset by trades would also be reduced by 50% (1000-3,150 lbs/yr).

One challenge for implementing water quality trading is the capacity of the watershed to accomplish the necessary phosphorus offsets. If the point of compliance is placed in a location that limits trading to the Badger Mill Creek HUC 12 watershed (070900040201) that becomes more challenging. For example, there appear to be less than 6,000 acres of non-urban land uses upstream of the confluence of Badger Mill Creek and the Sugar River and development pressures continue to reduce this number. If this location is the point of compliance, a significant number of these acres would need to be placed under improved practices in order to accomplish the needed phosphorus reduction. In addition, those practices would need to remain in place in order for the district to continue to achieve compliance based on these trades.

We have consulted with agricultural producers in the watersheds. While we have found that there are some viable trading opportunities with agricultural producers and/or owners in the BMC watershed, but because of the significant development pressure, these do not appear to be guaranteed for over ten years. If the District continues to discharge to Badger Mill Creek and uses water quality trading as our compliance option, we will need assurance that our trades will remain into the future. Dane County has one trade that could be possible on a longer-term basis, but that is currently restricted to their 12-acre parcel which limits the available number of pounds. To move forward with trading as a compliance option, the district would need more assurance and longevity. With the continuing growth of the urban service area and urbanization of the watershed, the BMC watershed area (HUC 070900040201) introduces significant future risk as relying on long-term continuation of those trades is not certain.

There is also an opportunity for urban based practices to be funded under a trading program. However, urban phosphorus reduction practices are generally more expensive and not as efficient as agricultural practices at addressing phosphorus on a cost per pound basis. On the other hand, urban projects that fall into the category of point-to-point trades could achieve a trade ratio closer to 1:1, reducing the number of pounds of required offset.

During this analysis, we have assessed a point-to-point trading option with the City of Madison (Figure 20) that could involve active or passive treatment of stormwater to remove additional phosphorus. Preliminary estimates indicate that this major project could provide up to 1600 pounds of phosphorus reduction per year (about 1300 pounds at a 1.2:1 ratio), yet the 20-year present worth cost is estimated to be over $10 million (Figure 21), and that assumes that in this very urban area, that all dredged sediments are clean enough to be land applied. If dredged sediments need to be taken to a special landfill or treated, the cost could increase significantly.

Historically, stormwater ponds are designed for flood control and/or total suspended solids removal. Some phosphorus is removed in stormwater ponds, but unless there is an intentional design, this is generally minimal. One specific trading opportunity for the District in the Badger Mill Creek watershed is with the city of Madison's stormwater pond near Nesbitt Road, which is north of STH 151 and upstream of our discharge location. In order to be redesigned to increase the phosphorus removal, this pond would need to have its southwest cell (Figure 26) dredged approximately four feet to allow sufficient storage depth. According to the city's stormwater designers, this pond is not ideally situated to use a passive treatment system, like iron filings, because those would need to be able to dry out and not remain saturated.


*Figure 13 - Nesbitt Pond and its Southwest Cell Size*

| | |
|---|---|
| Annual TP Removal Above Existing (lbs) | 1600 |
| Dredging and Disposal Costs | $3,000,000 |
| Capital Costs | $1,500,000 |
| Annual O&M Costs | $326,300 ($4,850,100 PW at 3%) |
| Engineering and incidentals | $1,125,000 |
| Total Cost Opinion | $10,500,000 |

*Figure 14 - Construction Cost Opinion to enhance Nesbitt Pond's phosphorus removal*

Adding additional phosphorus removal capability to this pond will include adding a flocculating system, such as alum treatment, and a way to capture and sequester the phosphorus laden floc (what settles out). The city of Madison has tentatively engaged with similar phosphorus treatment systems and is gaining experience, yet, these are not common and can be misunderstood in the community. If THE DISTRICT is looking at pursuing a trade that includes adding phosphorus treatment at the city's pond, the city would like the District to take the lead. The city would like the District to reach out to the Alder and if there is the ability to go ahead, the city would like the DIstrict to enter into a memorandum of understanding (MOU) with the city to pursue consulting services to undertake a preliminary design study. If the findings of that study lead to a desire to pursue construction, the city would like the District to work with them to amend the MOU to include construction and management agreement which would work to divide the total suspended solids (TSS) and TP credits from existing conditions and the future treatment system and for THE DISTRICT to have the right to enter and operate that system on city property.

These are very serious considerations. The city currently is not required to remove additional total suspended solids or total phosphorus from this pond. If a treatment system is designed for their stormwater pond, the District would be asked to own and operate that system on city property. In addition, if adding this treatment system to the pond could remove 1600 pounds of phosphorus each year, we understand that at least that amount of phosphorus is entering Badger Mill Creek above our discharge location and there are no requirements for any entity other than the District to reduce phosphorus discharges to the stream. There are other potential urban trades, but these appear to carry similar burdens.

The point of compliance will be an important aspect in determining the viability of water quality trading. Water quality trading becomes more viable if the point of compliance is determined to be downstream of Badger Mill Creek's confluence with the Sugar River (ie: includes the entire HUC 10 0709000402 shown on Exhibit 23). As noted above, there are interested participants and trading potential with longer time horizons in the adjacent watershed. While the District is intending to continue to pursue water quality trading as a preferred compliance option at this time, it is interesting to note that the cost of urban trades are similar to the cost for treatment for wastewater phosphorus removal. Since the district could undertake the phosphorus treatment without the engagement of partners and the pounds removed would be reliable, if the trading area is restricted to the Badger Mill Creek watershed, the district would need to reconsider treatment to remove phosphorus at the treatment plant. The increased burden to rate-payers for major investments that impact only 8% of our effluent will need to be seriously considered as well.

## Variance:

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. The District has been unsuccessful in receiving economic variances in the past, and the facts around granting the District variances under one of the six criteria have not changed. Based on the learnings gathered during the District's recent experience with a chloride variance, a variance does not appear to be a probable compliance solution. The other type of variance option called multi-discharger variance is not applicable in Dane County and therefore not available to the District. The District is not intending to pursue a variance as a preferred compliance option at this time.

## Site-specific Criterion:

Wisconsin Administrative Code, NR 102.06 (7)  allows for the development of site-specific criteria for phosphorus. This is a process where site-specific data and analysis using scientifically defensible methods and sound scientific rationale demonstrate that a different criterion is protective of the designated use of the specific surface water segment or waterbody.

During the District's last permit term reissuance, DNR staff compiled and evaluated multiple years of fish monitoring information in the context of considering Alternative Effluent Limitations for thermal requirements (DNR's "Examination of Fisheries Data for Badger Mill Creek, February 2017"). In this evaluation, DNR concluded that: "The effluent discharge from the District to Badger Mill Creek has caused no appreciable harm to the resource based on the fact that 1) it has not appreciably altered the fish community from its historic state in the absence of effluent; 2) a balanced indigenous community remains which includes the presence of native or introduced important species, mottled sculpin and brown trout, respectively, and 3) the resource is in a healthy state based on the appropriately applied IBI." In addition, at the request of the DNR, the district recently conducted sampling for benthic algae and diatoms to provide additional data to aid in the initial site-specific criteria evaluation.

The district is aware that there is a downstream criterion for phosphorus of 0.10 mg/l on the Sugar River which DNR has indicated will limit the site-specific criterion for phosphorus in the watershed. This means that any site-specific criterion for phosphorus in the watershed would likely not exceed 0.10 mg/l, but would likely remain between the current criterion of 0.075 mg/l and 0.10 mg/l. This information has led the District to conclude that a site-specific criteria closer to the current effluent concentration is not possible, even if the biology were to support it. These values (0.1 and 0.075 mg/l) are very close to each other and therefore either of these values would require similar treatment processes and similar number of pounds to offset via trading. The District is not intending to rely on a site-specific criteria as a preferred compliance option at this time.

# Summary:

Based on the findings of this assessment, water quality trading and adaptive management may be potential compliance options with a broader definition of the applicable watershed. Confining watershed approaches to areas upstream of the District's outfall appear to require mainly urban stormwater phopshorus projects. These raise a variety of challenges, including jurisdiction and ownership. In addition, they raise the cost of the project to the level of treating effluent to remove phsophorus, which would make us rethink that assessment. In addition, while discontinuing flow to Badger Mill Creek remains a possibility, if this is the direction that the District wants to pursue, a strategic communications strategy will be necessary to engage with stakeholders, including DNR, to futher assess it.

## Additional Figures:

| Month | Influent Avg. Flow (MGD) | Influent Avg. TP Concentration (mg/L) | Influent TP Mass (lb/day) | Effluent Avg. Flow (MGD) | Effluent Avg. TP Concentration (mg/L) | Effluent TP Mass (lb/day) | Target TP Concentration (mg/l) | Effluent TP Mass (lb/day) |
|---|---|---|---|---|---|---|---|---|
| Jan | 41.13 | 5.33 | 1828.15 | 3.07 | 0.26 | 6.75 | .075 | 6.75 |
| Feb | 41.15 | 5.37 | 1842.24 | 3.09 | 0.20 | 5.24 | .075 | 5.24 |
| Mar | 43.93 | 4.77 | 1750.11 | 3.09 | 0.20 | 5.27 | .075 | 5.27 |
| Apr | 40.71 | 5.11 | 1732.57 | 3.08 | 0.24 | 6.07 | .075 | 6.07 |
| May | 43.17 | 4.96 | 1773.97 | 3.44 | 0.29 | 8.33 | .075 | 8.33 |
| Jun | 45.32 | 4.91 | 1854.02 | 3.57 | 0.26 | 7.60 | .075 | 7.60 |
| Jul | 47.38 | 4.34 | 1712.64 | 3.59 | 0.34 | 10.22 | .075 | 10.22 |
| Aug | 42.00 | 5.02 | 1756.09 | 3.55 | 0.31 | 9.18 | .075 | 9.18 |
| Sep | 41.89 | 5.15 | 1800.42 | 3.58 | 0.29 | 8.79 | .075 | 8.79 |
| Oct | 39.90 | 5.74 | 1907.77 | 3.59 | 0.26 | 7.79 | .075 | 7.79 |
| Nov | 38.62 | 5.83 | 1879.94 | 3.58 | 0.26 | 7.68 | .075 | 7.68 |
| Dec | 37.14 | 5.66 | 1754.79 | 3.09 | 0.37 | 9.63 | .075 | 9.63 |
| Avg | 41.86 | 5.18 | 1799.39 | 3.36 | 0.27 | 7.71 | .075 | 7.71 |

*Figure 15 - Baseline 2020 THE DISTRICT phosphorus Influent and Discharge Data for Outfall 005*

| Month | Effluent Avg. Flow (MGD) | Effluent Avg. TP Concent ration (mg/L) | Effluent TP Mass (lb/day) | Effluent TP WQS @0.075 (mg/L) | Effluent TP Mass (lb/day) | Effluent TP Mass (lb/month) |
|---|---|---|---|---|---|---|
| Jan | 3.07 | 0.26 | 6.75 | 1.92 | 4.83 | 149.72 |
| Feb | 3.09 | 0.2 | 5.24 | 1.93 | 3.31 | 92.60 |
| Mar | 3.09 | 0.2 | 5.27 | 1.93 | 3.34 | 103.45 |
| Apr | 3.08 | 0.24 | 6.07 | 1.93 | 4.14 | 124.30 |
| May | 3.44 | 0.29 | 8.33 | 2.15 | 6.18 | 191.53 |
| Jun | 3.57 | 0.26 | 7.6 | 2.23 | 5.37 | 161.01 |
| Jul | 3.59 | 0.34 | 10.22 | 2.25 | 7.97 | 247.21 |
| Aug | 3.55 | 0.31 | 9.18 | 2.22 | 6.96 | 215.74 |
| Sep | 3.58 | 0.29 | 8.79 | 2.24 | 6.55 | 196.52 |
| Oct | 3.59 | 0.26 | 7.79 | 2.25 | 5.54 | 171.88 |
| Nov | 3.58 | 0.26 | 7.68 | 2.24 | 5.44 | 163.22 |
| Dec | 3.09 | 0.37 | 9.63 | 1.93 | 7.70 | 238.61 |
| Avg - yearly | 3.36 | 0.27 | 7.71 | 2.10 | 5.61 | 171.32 |
| | | | | | Approx. yearly total | 2055.8 lbs |

*Figure 16 - Approximate Yearly Pounds to Offset*

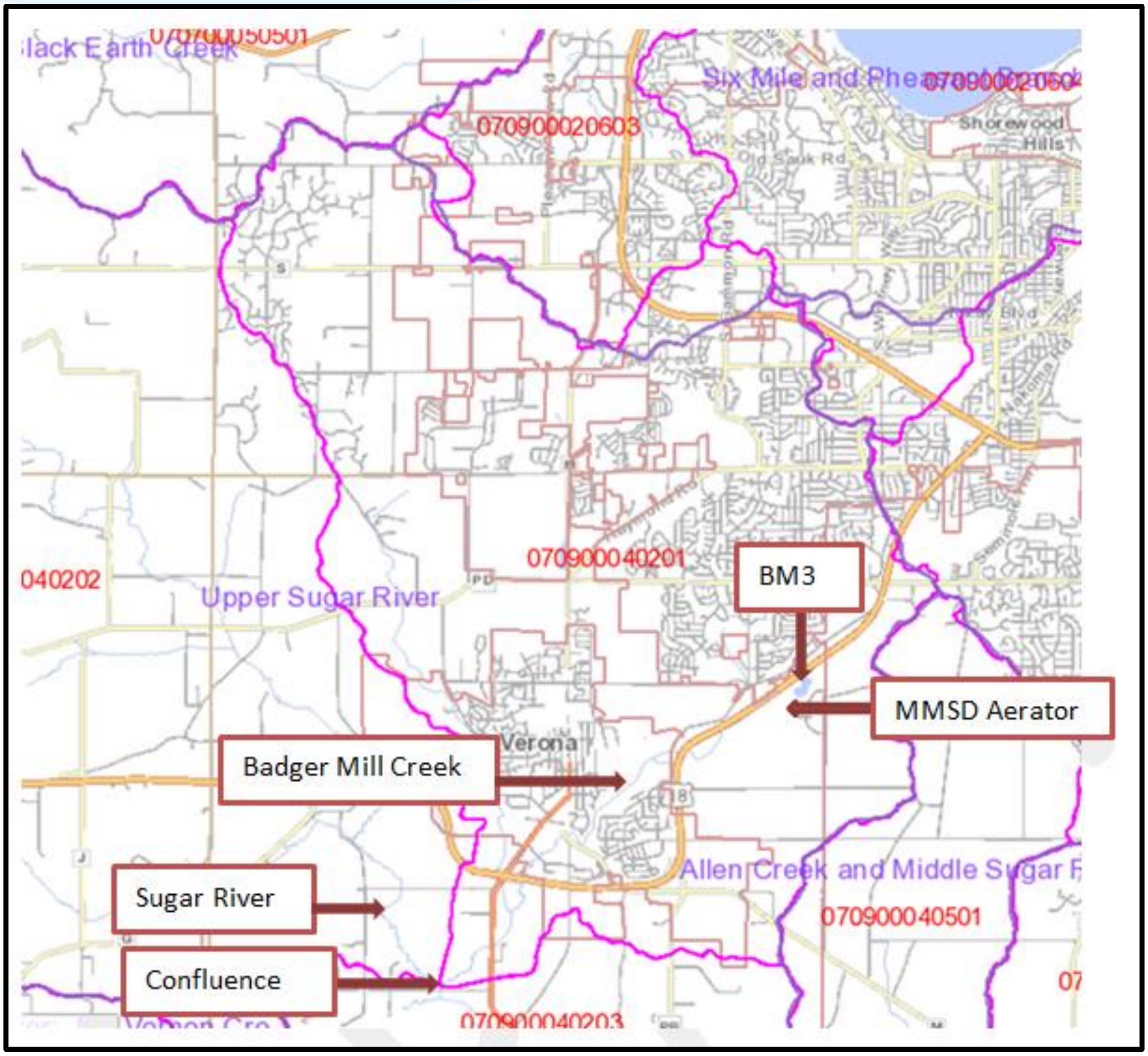



*Figure 23 - Location Map for HUC 12s, THE DISTRICT Aerator (Outfall 005)*

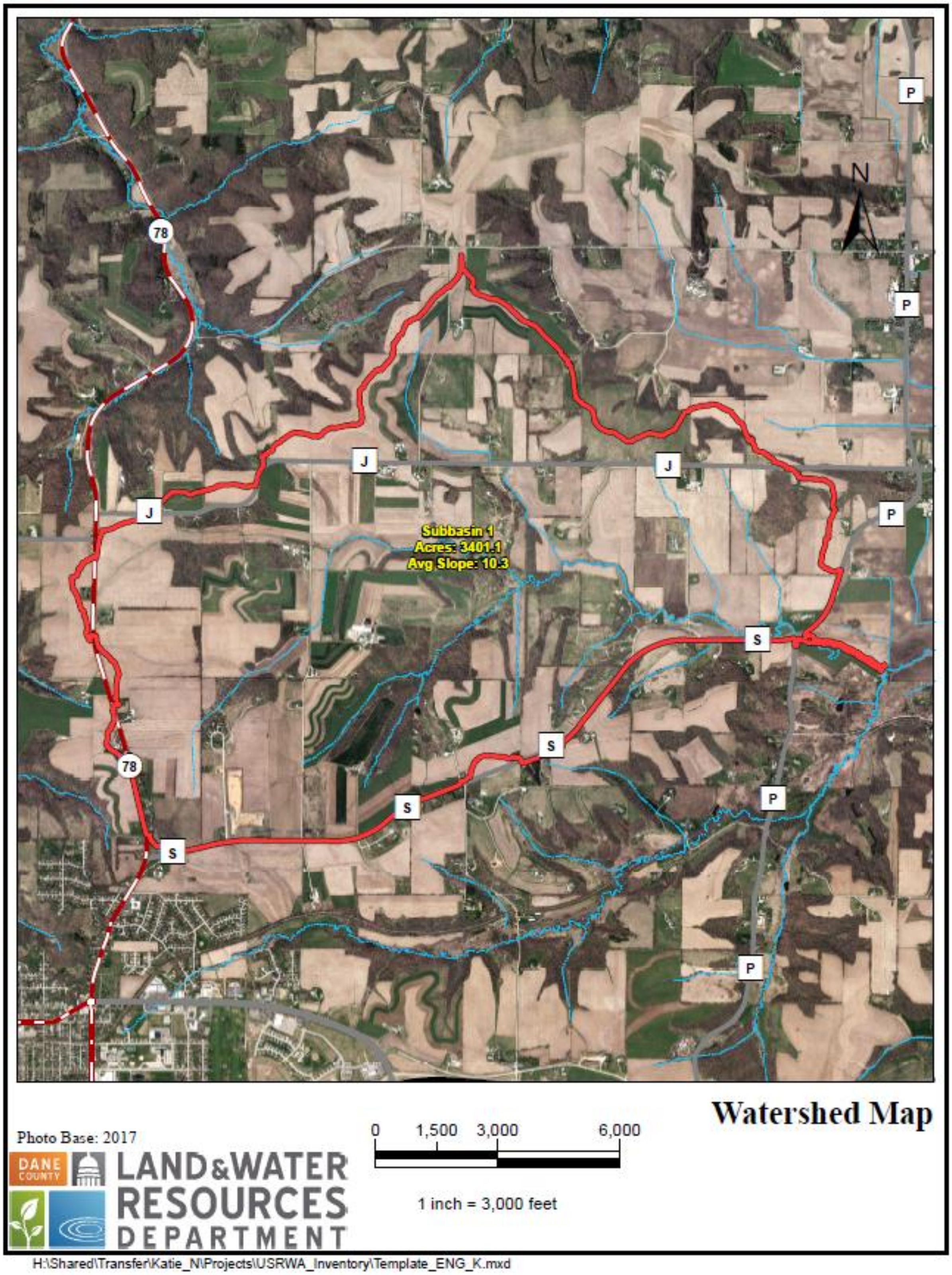



*Figure 24 - Location Map for Upper Sugar River Watershed Improvements*

| Practice/Program | Acres | Cost ($) per acre | Total Cost ($) | Notes |
|---|---|---|---|---|
| 329- Residue Mgmt-No-Till/Str | 262.0 | $89 | $23,315 | All farmable acres. Could cover cost of no till drill. |
| 340- Cover Crops | 844.6 | $367 | $309,983 | All acres with at least one year cover crops could be planted but currently are not in the nutrient management plan. |
| 342- Critical Area Planting | 8 | $550 | $4,400 | 13 potential locations. |
| 412- Grassed Waterways | 8 | $4,750 | $38,000 | 13 potential locations with 4 being very small. |
| **Practice/Program** | **Acres** | **Cost ($) per acre** | **Total Cost ($)** | **Notes** |
| 484- Mulching | 8 | $1,500 | $12,000 | 13 potential locations. |
| 590- Nutrient Management | 260.1 | $53 | $13,784 | All acres in agricultural land use not currently in an NMP.* |
| 638- Water and Sediment Control Basin | | | $12,500 | 1 WASCOB on * land east of his farmstead |
| Conservation Cover Program | Potential acres | $150 | | Possibly for Various Producers |
| LDMI toolbar | | | ~$80,000 | Cost for LDMI toolbar (including hoses), flow meter, and corresponding sensors, and GPS mapping and equipment |
| TDR “Prime”** | 1,901.5 | | | Based on appraisals and other information. 104 landowners. |
| TDR “Prime if Drained”*** | 56.7 | | | Based on appraisals and other information. 12 landowners. |
| | | | | |
| **Total** | | | **$413,982.45** | |

*Figure 25 - Project estimate for Upper Sugar River Watershed Improvements*

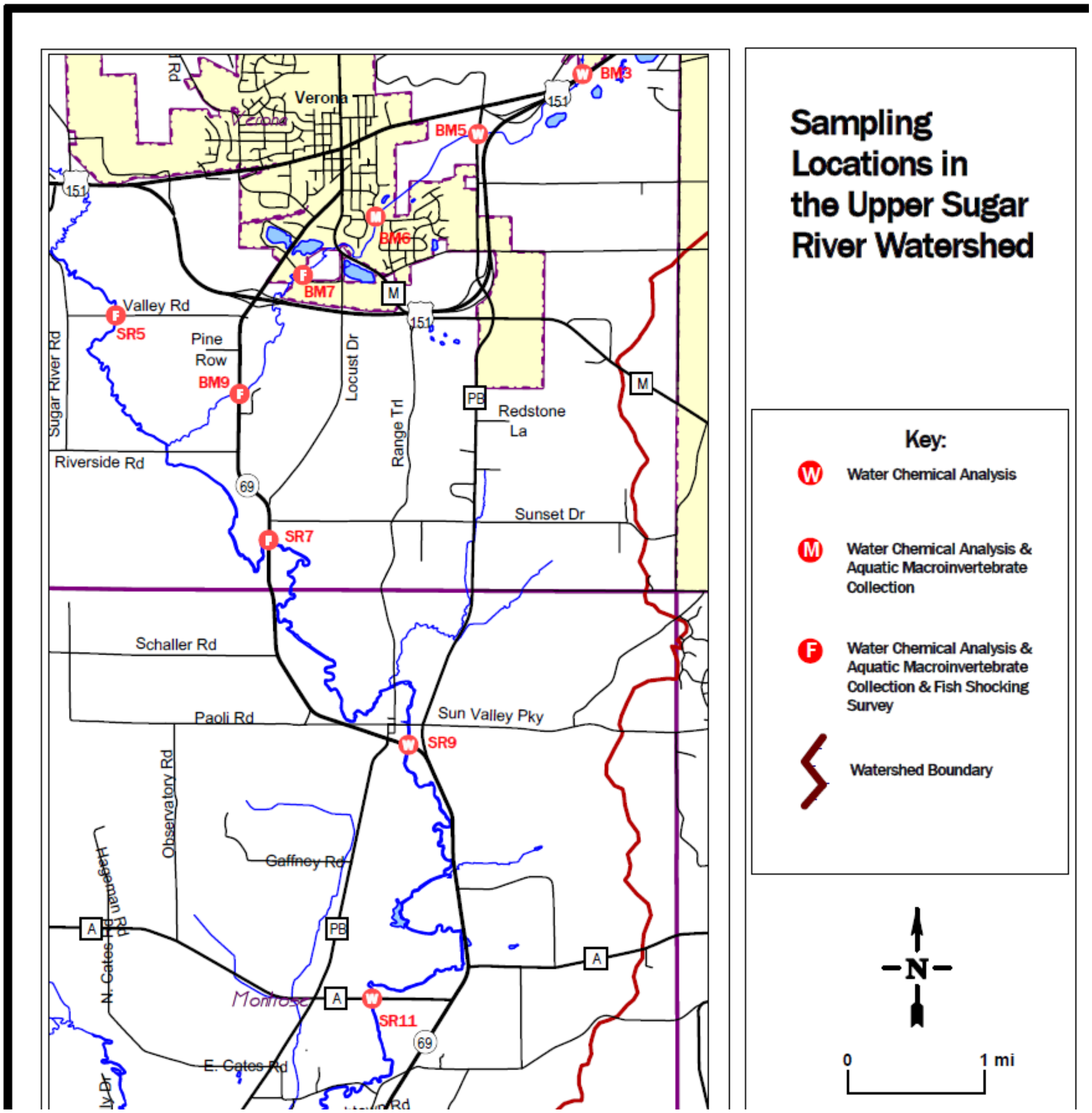


Figure 26 - THE DISTRICT Water Quality Monitoring Location Map BMC & Sugar River

## USGS Surface-Water Monthly Statistics for Wisconsin

The statistics generated from this site are based on approved daily-mean data and may not match those published by the USGS in official publications. The user is responsible for assessment and use of statistics from this site. For more details on why the statistics may not match, click here.

USGS 05435950 SUGAR RIVER NEAR VERONA, WI

Available data for this site Time-series: Monthly statistics GO

| | Output formats |
|---|---|
| Dane County, Wisconsin<br>Hydrologic Unit Code 07090004<br>Latitude 42°56'57", Longitude 89°32'39" NAD83<br>Drainage area 82.7 square miles<br>Gage datum 906.09 feet above NAVD88 | HTML table of all data<br>Tab-separated data<br>Reselect output format |

| 00060, Discharge, cubic feet per second, | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| YEAR | Monthly mean in ft3/s (Calculation Period: 2009-05-01 -> 2021-09-30) | | | | | | | | | | | |
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| 2009 | | | | | 109.5 | 102.9 | 76.5 | 66.8 | 60.8 | 86.3 | 67.3 | 65.7 |
| 2010 | 66 | 55 | 95.5 | 99.6 | 88.3 | 121.6 | 119.2 | 116.5 | 87.8 | 70.3 | 63.3 | 68.8 |
| 2011 | 65.9 | 85.2 | 113.6 | 106.1 | 81.6 | 75.8 | 58.3 | 46.1 | 52.3 | 45.2 | 66.9 | 59.5 |
| 2012 | 45.7 | 49.1 | 62.8 | 57.4 | 58.6 | 46.7 | 39.1 | 32.5 | 30.2 | 41.4 | 42.5 | 37.6 |
| 2013 | 56.4 | 58.8 | 111.8 | 157.6 | 90.2 | 132.5 | 87.7 | 60.1 | 49.4 | 45.6 | 50.1 | 30.2 |
| 2014 | 24.3 | 25.7 | 65.5 | 80 | 60.7 | 87.4 | 83.3 | 57.3 | 80.1 | 48.6 | 46.3 | 53 |
| 2015 | 42.8 | 34.1 | 52.6 | 62.4 | 64.6 | 58.3 | 57.2 | 46.5 | 64.7 | 57 | 90.3 | 105.8 |
| 2016 | 70.8 | 78 | 91.5 | 72.5 | 54.1 | 87.8 | 121.8 | 73.5 | 67.6 | 82.2 | 70.9 | 65.6 |
| 2017 | 111.2 | 90.4 | 93.9 | 105.9 | 93.7 | 93.4 | 254.7 | 114.1 | 75 | 83.5 | 67.6 | 56.4 |
| 2018 | 67.9 | 160.7 | 61.8 | 66.8 | 144.1 | 209.5 | 113.6 | 305.6 | 186.9 | 227.4 | 132.5 | 104.2 |
| 2019 | 109 | 114 | 250.1 | 110.6 | 133 | 107.8 | 134.4 | 120.4 | 153.6 | 203.6 | 134.3 | 111.7 |
| 2020 | 90.6 | 82.8 | 145.5 | 101.6 | 115.2 | 113.3 | 126.6 | 77.7 | 87.3 | 85.1 | 73.9 | 63.3 |
| 2021 | 57.6 | 51.7 | 85.3 | 73 | 59.4 | 53.7 | 47.9 | 46.7 | 44.7 | | | |
| Mean of monthly Discharge | 67 | 74 | 102 | 91 | 89 | 99 | 102 | 90 | 80 | 90 | 75 | 68 |
| ** No Incomplete data have been used for statistical calculation | | | | | | | | | | | | |

*Figure 17 - Summary Statistics from USGS at Sugar River Hwy 69*

**FIGURE 28 – Phosphorus Optimization Report, March 2021**

**PHOSPHORUS OPTIMIZATION REPORT WORKSHEET**
**Facility Name:** Madison Metropolitan Sewerage District
**WPDES Permit #:** WI-0024597-09-0
**PART 1—BACKGROUND INFORMATION**
**(A) Briefly describe wastewater treatment facility processes and operations and the means of treating phosphorus, including any chemicals used. Attach a flow schematic which shows the point(s) of chemical addition for TP control. Include both liquid and solids treatment trains.**
Wastewater is conveyed to THE DISTRICT's Nine Springs Wastewater Treatment Plant via 18 District-owned pumping stations, averaging approximately 42 MGD of influent. Preliminary treatment consists of fine screening followed by grit vortex tanks to remove debris and other inorganic material, which is subsequently landfilled. Primary liquid-solids separation is accomplished using settling tanks. Sludge from this process is thickened with gravity thickener tanks. Secondary treatment follows primary settling, achieving biological phosphorus removal. Aeration tanks are arranged in a modified University of Cape Town configuration, which reduces total phosphorus from approximately 5 mg/L to 0.3 mg/L following secondary settling. Treated effluent is disinfected using UV on a seasonal basis before being discharged to Badger Mill Creek (4 MGD) and Badfish Creek (38 MGD). Solids handling occurs in the following order; thickening of waste activated sludge (WAS) with gravity belt thickeners (GBT), acid-phase anaerobic digestion of WAS combined with thickened primary sludge, then digestion at mesophilic temperatures with about 15% of solids continuing to thermophilic digestion for the intermittent production of a centrifuged thickened Class A cake. The remaining 85% of digested sludge is thickened via GBT to approximately 5% total solids for land application as a Class B liquid. Phosphorus-rich filtrate from both the WAS and digested sludge GBTs (and centrate from Class A cake production when operating) are conveyed to an Ostara process, where nutrients are recovered in the form of struvite. Effluent from struvite harvesting is recycled through the liquid treatment stream.

| **(B) Baseline Year:** 2020 **Month** | **Influent Avg. Flow (MGD)** | **Influent Avg. TP Concentration (mg/L)** | **Influent TP Mass (lb/day)** | **Effluent Avg. Flow (MGD)** | **Effluent Avg. TP Concentration (mg/L)** | **Effluent TP Mass (lb/day)** |
|---|---|---|---|---|---|---|
| **Jan** | 41.13 | 5.33 | 1828.15 | 3.07 | 0.26 | 6.75 |
| **Feb** | 41.15 | 5.37 | 1842.24 | 3.09 | 0.20 | 5.24 |
| **Mar** | 43.93 | 4.77 | 1750.11 | 3.09 | 0.20 | 5.27 |
| **Apr** | 40.71 | 5.11 | 1732.57 | 3.08 | 0.24 | 6.07 |
| **May** | 43.17 | 4.96 | 1773.97 | 3.44 | 0.29 | 8.33 |
| **Jun** | 45.32 | 4.91 | 1854.02 | 3.57 | 0.26 | 7.60 |
| **Jul** | 47.38 | 4.34 | 1712.64 | 3.59 | 0.34 | 10.22 |
| **Aug** | 42.00 | 5.02 | 1756.09 | 3.55 | 0.31 | 9.18 |
| **Sep** | 41.89 | 5.15 | 1800.42 | 3.58 | 0.29 | 8.79 |
| **Oct** | 39.90 | 5.74 | 1907.77 | 3.59 | 0.26 | 7.79 |
| **Nov** | 38.62 | 5.83 | 1879.94 | 3.58 | 0.26 | 7.68 |
| **Dec** | 37.14 | 5.66 | 1754.79 | 3.09 | 0.37 | 9.63 |
| **Avg** | 41.86 | 5.18 | 1799.39 | 3.36 | 0.27 | 7.71 |

| (C) Possible Contributors: For municipalities, list all possible industries, other commercial buildings and hauled in wastes that could be introducing phosphorus into the collection system Name Source | Type of Process | Already Contacted? | If so, possible cont |
|---|---|---|---|
| Graber Manufacturing Inc. | Metal Finishing | Yes | Yes |
| Electronic Theatre Controls | Metal Finishing | Yes | Yes |
| Latitude Corp. | Metal Finishing | Yes | Yes |
| Bock Water Heaters | Metal Finishing | Yes | Yes |

**Water supply: What are the phosphorus levels within your water supply? Does the water utility add phosphorus for corrosion control or iron and manganese sequestration?**
Only one of the District's customer communities adds phosphorus to their water supply. The city of Fitchburg manages iron and manganese in their North System by targeting a 2 mg/L dose of polyphosphate. Water usage in this system is approximately 1.5 MGD. Assuming the entirety of this flow is conveyed to NSWWTP, total phosphorus from Fitchburg's water supply accounts for less than 0.5% of daily loading. Since the city of Fitchburg uses an appropriate, recommended polyphosphate dose, and is not a significant contributor to influent phosphorus loading, benefit from further optimization work would be negligible.

## PART 2—OPTIMIZATION ACTION PLANS

**List the items that will be addressed to reduce the phosphorus in the effluent and provide a schedule for accomplishing each item. Note that all items must be completed by no later than 3 years after the date of permit reissuance. For each optimization action fill out a separate plan sheet.**

**1. Optimization Action: (example: Address Phosphorus from Industries)**
Continued optimization of Ostara struvite harvesting process to reduce phosphorus in side stream flow.
**Briefly describe optimization action plan: (example: determine contributors of phosphorus throughout the sewer area and work with them to reduce the incoming phosphorus. Parts of the plan include meeting with the industries, etc.)**
When the Ostara struvite harvesting process went into service in 2016, removal of total phosphorus from sludge dewatering filtrate was less than 40%. The District and Ostara have worked together to trial a number of equipment modifications and process optimizations to improve phosphorus capture. Through this work, total phosphorus removal is now approximately 65% with over 80% orthophosphate recovered from sludge dewatering filtrate. District staff continues to participate in monthly meetings with Ostara to further this progress. While it is advantageous to both parties to increase struvite production, improvement to phosphorus removal will likely have minimal impact to biological treatment and subsequent effluent loading to Badger Mill Creek. The unrecovered phosphorus in the Ostara effluent stream only increases plant influent concentration by approximately 0.2 mg/L at current removal efficiency. Potential to meet the new permit limit is not significantly improved even if complete phosphorus removal via Ostara process was possible.

| Anticipated Time Frame for Optimization Action | Date Start | Date Complete |
|---|---|---|

| | | |
|---|---|---|
| **Plan: Main Item to Complete** | | |
| Optimize struvite harvesting process | 2016 | Ongoing |

**Overall Optimization Action Plan Time Frame:** Ongoing
**Overall Completion Date:** Ongoing
**Outcome hoping for:**
Identify sources of hauled waste that have the potential to inhibit THE DISTRICT's phosphorus removal processes.
**Anticipated reduction and/or comments:**
While the District will continue to monitor and evaluate hauled waste acceptance, current septage receiving rates are not a significant source of phosphorus. Due to the relatively small volume of hauled waste, significant reduction or even complete elimination of septage receiving would have a negligible impact on effluent phosphorus loading to Badger Mill Creek.

**PART 3—OPTIMIZATION APPROVAL**
**Facility Name:** Madison Metropolitan Sewerage District **WPDES Permit #:** WI-0024597-09-0
**Name and Contact Information of Person Preparing Report:**
**Name:** Drew Suesse **E-mail Address:** Drews@madsewer.org
**Telephone #:** 608.222.1201 ext. 226
**OPTIMIZATION ACTION PLANS**
**Please provide a summary of the proposed action items and projected completion dates. The completion dates should be developed to enable the incorporation of the action items into the Preliminary Facilities Plan that is required in the WPDES Permit Phosphorus Compliance Schedule.**
**Action Item Proposed Date of Completion**
Optimize struvite harvesting process Ongoing
Continued monitoring of industrial waste streams Ongoing
Continued monitoring of hauled waste Ongoing

PRINT | CLEAR ALL | SAVE AS

# S.A.M.
## Sustainable Action Map

Leadership Required
Manageable Risks
Value Delivered

**Name:** BMC Divert to Badfish Creek **Decision:**

| | Healthy Environment | Strong Community | | Vital Economy |
|---|---|---|---|---|
| | **Natural:** *How does it impact environmental health?* | **Individual:** *How does it directly impact the well-being of people?* | **Community:** *How does it impact relationships, effective government, social justice, and overall livability?* | **Economy:** *How does it impact the local economy and at what long and short term costs?* |
| **S:** | BMC more ecological natural southern Wisconsin stream - not artificial through pumping from Nine Springs. WOuldn't have to reapply for AEL for BMC in next permit. Stream wouldn't be warmer in winter. | less cost to rate payers (energy, maintenance & phosphorus compliance) no treated effluent in BMC or Sugar River | BMC no longer tied to MMSD (BMC quality not based on effluent dominated stream, MMSD not part of a future TMDL) | One MMSD discharge point decreases O&M (pipeline and pump maintenance, future expenditures), pumping, energy costs (?), permitting work - permit restrictions |
| **W:** | potential disruption in low flow for BMC Interbasin wastewater transfer. reduced opportunity for beneficial reuse of effluent Stream wouldn't be cooler in Summer. | Water story goes untold in Verona/Sugar River. Perhaps less (reliable) flow in BMC | Discontinuation of the golf course irrigation project. Less opportunities for reuse of effluent from that route. | resiliency? |
| **O:** | Diversion of treated effluent from BMC reduces chloride, phosphorus,...temperature in the winter. Potential reuse of pipeline or corridor from existing BMC return line. | Rate payer money allocated to other challenges | Expand relationship with BFC? Friends of BFC? Neighbors? | More rate payer money to be allocated to other priority projects. Staff time allocated to other priority projects. Ability to reuse main or easement for relief force main - saving time and money. |
| **T:** | Diversion of treated effluent raises stream temperature in the summer. Possible reduction in baseflow - interbasin transfer to Yahara. | Lack of future effluent discharge location. | Future discharge location in Sugar River basin would be very challenging to achieve if we give up this location. | If Yahara WINS doesn't work out, we would need to achieve compliance for more effluent. |

**SWOT: S=Strengths W=Weaknesses O=Opportunities T=Threats**

Madison Metropolitan Sewerage District

*Figure 29 - Strategic Action Map discontinue Outfall 005*

PRINT CLEAR ALL SAVE AS

# S.A.M.

## Sustainable Action Map

Leadership Required
Manageable Risks
Value Delivered

**Name:** BMC Trading **Decision:**

| Healthy Environment | Strong Community | | Vital Economy |
|---|---|---|---|
| **Natural:** *How does it impact environmental health?* | **Individual:** *How does it directly impact the well-being of people?* | **Community:** *How does it impact relationships, effective government, social justice, and overall livability?* | **Economy:** *How does it impact the local economy and at what long and short term costs?* |
| **S:** Auxilliary projects in the watershed could improve ecosystem, environment and provide on-going phosphorus reductions. Improving Non-developed land may be able to remain that way, providing on-going benefits for water quantity and quality | **S:** Continued contribution to baseflow of BMC Potential improvement for recreation. | **S:** Consistency of BMC improves Verona's natural resource - BMC. Potential improvement in tourism, recreation, etc. | **S:** Possible cost savings due partnerships. Ecological improvement increases value of resource. |
| **W:** Effluent still in BMC | **W:** maintaining effluent in BMC makes us party to future TMDL and we will face Nitrogen and other requirements which could increase rates. | **W:** Reliability of trade? inability to use the FM or corridor for relief | **W:** Significant development in the region reduces viable trades and potentially increases cost per pound. |
| **O:** Ability to partner on some great projects. Maybe make things happen that wouldn't have without us. Keep effluent in BMC. Continue to tell the water cycle story in the Sugar River. | **O:** potential less cost trade could be permanent | **O:** Potential to make some great projects happen with additional partnership from MMSD. Visibility of reclaimed water helps protect water (district messaging.) | **O:** Partnerships with projects and partners strengthen our Reduces uncertainty? |
| **T:** Effluent still in BMC - future regulation. New forcemain construction ? | **T:** | **T:** Cost to rate payers for future investments in the watershed or if trade ceases to function. | **T:** Trades must continue to achieve compliance. Development pressure and land values are challenges. |

**SWOT: S=Strengths W=Weaknesses O=Opportunities T=Threats**

Madison Metropolitan Sewerage District

*Figure 30- Strategic Action Map Water Quality Trading*

PRINT CLEAR ALL SAVE AS

# S.A.M.

## Sustainable Action Map

**Name:** Treatment Alternative for BMC Low TP Limit **Decision:**

Leadership Required ✓
Manageable Risks
Value Delivered

| | Healthy Environment | Strong Community | | Vital Economy |
|---|---|---|---|---|
| | **Natural:** *How does it impact environmental health?* (Manageable Risks ✓) | **Individual:** *How does it directly impact the well-being of people?* (Manageable Risks ✓) | **Community:** *How does it impact relationships, effective government, social justice, and overall livability?* (Leadership Required ✓) | **Economy:** *How does it impact the local economy and at what long and short term costs?* (Leadership Required ✓) |
| **S:** | -Technology exists to meet TP limits as defined by DNR<br>-Reduction of nutrients to Sugar, Rock River watersheds<br>-Continues to meet District's goal of high quality effluent | -BMC is a popular location for recreational water activities. Treatment maintains high quality effluent for this purpose. | -Continues to supply flow to BMC that had been diverted w/ closure of Verona WWTP. Agreement w/ Verona in 90's.<br>-Maintains BMC as a permitted outfall for the District. Re-permitting for BMC would be unlikely if treatment is not pursued and flow is discontinued. | -Large construction project that would employ engineers, construction workers, skilled labor, etc.<br>-highly treated effluent used by business as an alternative to groundwater could be a cheaper source (lower cost of water to businesses). |
| **W:** | -Increased energy consumption. Treatment and pumping is estimated to be 1,099,000 kWh/yr (depending on treatment option) | -Added complexity and maintenance requirements for District staff to operate treatment alternatives - process/equipment would be new to staff | -Conflicts with District's goal (and many communities' goal) of reducing energy consumption and reliance on fossil fuel derived chemicals<br>-Increased solids production will need to be handled by Metrogro | -High capital and O&M costs (~ $15M in treatment equipment, ~ $130k/yr in chemicals, ~$31k/yr treatment energy, ~$63k/yr in pumping energy)<br>-Increased solids handling costs |
| **O:** | -Potential improvement for aquatic species in BMC through reduction of algal growth<br>-Small step towards advanced tertiary treatment for all NSWWTP flow (if required in the future)<br>-Sustainability option for water reuse in the area from groundwater recharge to direct potable reuse and everything inbetween conserving water resources | -Educational/showcase opportunity of high level of treatment - Wastewater transformed to popular kayaking/fishing/etc. destination<br>-Sustainability option for water reuse in the area from groundwater recharge to direct potable reuse and everything inbetween. | -DNR has interest in maintaining aquatic biology<br>-Customer communities' interest in recreational stream<br>-Further partnerships/coordination with these groups<br>-Sustainability option for water reuse in the area from groundwater recharge to direct potable reuse and everything inbetween<br>-Increased solids production is more opportunity for an alternative reuse product that decrease the reliance on mined fertilizer | -Some treatment options provide resource recovery opportunities - added revenue source through sale of algal biomass |
| **T:** | -No significant reduction in other key effluent parameters aside from TP.<br>-Would need additional treatment/plant modification for future BMC low level limits (e.g. TN, chlorides)<br>-BMC limits currently dictate level of treatment | -Improves water quality health through reduction of phosphorus, but does not treat for CECs. Future concerns of pharmaceuticals and PCPs, microplastics, etc., exist if primary goal of maintaining BMC discharge is for public recreation and aquatic biology | -Conflicting goals and community interests<br>-Questions of environmental justice - who's benefiting vs. who's being burdened (expensive, energy intensive treatment to maintain recreational stream in wealthier, white community) | -Fluctuations in chemical costs<br>-Uncertainty of resource recovery markets (depending on treatment alternative)<br>-Rate payers' concerns: expensive option to maintain voluntary outfall that only accounts for 10% of NSWWTP flow |

**SWOT: S=Strengths W=Weaknesses O=Opportunities T=Threats**

Madison Metropolitan Sewerage District

*Figure 31 - Strategic Action Map - Treatment*

| | Blue PRO<br>Sand Filtration | CLEARAS<br>Algal Photobioreactor | CoMag<br>Ballasted Settling | AquaDisk<br>Cloth Media Filtration |
|---|---|---|---|---|
| Strength | • Consistent treatment below TP limit (0.05 mg/L average<br>• Well-known, established technology<br>• Relatively small footprint | • Best TP removal (avg eff TP: 0.04 mg/L)<br>• Algae resource recovery<br>• Steady, consistent discharge to BMC is well suited for this technology | • Recoverable ballast material<br>• Achieved TP removal target (0.065 mg/L avg) | • Simple, well established technology<br>• Compact footprint<br>• Low capital cost |
| Weakness | • Requires alum or ferric addition, though less than other alternatives and no polymer required to meet effluent TP goal<br>• Limited "auxiliary" benefits beyond TP removal | • Very large footprint (~1 acre). Would be the largest installation of this process by far.<br>• Energy intensive process for algae solids handling (Large dryers or cold storage building)<br>• Need to make our current treatment worse for more favorable algae growth conditions (more nutrients sent to tertiary treatment results in higher algae yield, and is more economical) | • Demands a significant amount of polymer and ferric<br>• More complex system from an O&M perspective<br>• High capital costs – additional tankage required | • Did not reliable achieve TP removal target. Ranged from 0.05 – 0.09 mg/L<br>• Demands a significant amount of polymer and ferric |
| Opportunity | • Single or dual stage option if further treatment is required in future (single stage unit achieved <0.075 mg/L target during pilot) | • Similar technologies exist. Not as established, but have smaller footprints and less chemical requirements<br>• Revenue from algae sales<br>• Bleeding edge technology | • Good technology if we had extra tankage available or if we had excessive I/I and large peaking factor | • Aqua continuing to develop new cloth media. MMSD pilot tested two. Potential for better TP removal in future. |
| Threat | • Fluctuations in chemical cost<br>• Increased solids handling due to chemical sludge | • Uncertainty of algae market<br>• Biological system is more susceptible to plant upsets<br>• Partnership with Clearas. Would rely on them to purchase and market algae<br>• Unknown how product may be regulated (EPA Part 503?)<br>• Very few full-scale installations. Currently none at our size. Most projects in design are < 1 MGD | • Fluctuations in chemical and ballast costs<br>• More specialized parts and equipment than other alternatives<br>• Increased solids handling due to chemical sludge | • Risk of violating permit due to minimal treatment<br>• Chemical cost fluctuations<br>• Would not provide sufficient treatment if faced with more stringent limits in the future<br>• Increased solids handling due to chemical sludge |

*Figure 18 - SWOT Analysis Treatment Options*