

Project Name | Settlers Glen Iron Enhanced Sand Filter**Date** | 3/24/17**To / Contact info** | BCWD Board of Managers**Cc / Contact info** | Karen Kill, District Administrator**From / Contact info** | Ryan Fleming, PE**Regarding** | 2016 Project Performance

Background

The purpose of this memorandum is to provide an end-of-season update on the project performance focusing on phosphorus removal. The Settlers Glen Iron Enhanced Sand Filter (IESF) has been in operation for three seasons. This is the first application of its kind using stream stage to control a pump that charges the filter (Stormwater Pump-and-Treat). Given the experimental nature of the project, the District has implemented a monitoring program to assess the removal performance for a variety of pollutants.

Update

In June of 2016 the following equipment was installed in order to optimize the amount of flow entering the filter as well as to reduce the amount of time needed for staff in the field.

- Variable Frequency Drive (VFD) Controller Module – Allows the pump speed to fluctuate based on the water elevation in the pump well. Therefore, higher flow resulting from runoff into the stream will result in an increase in pump speed and volume being treated. Likewise, the pump has the ability to slow down for low flow events, thereby allowing the pump to continue through the set maximum run time of 24-hours without prematurely shutting off due to the water level dropping below the minimum depth set point. It is calculated that this modification increased the volume to the filter by 15 to 20 percent in 2016.
- PumpView™ Remote Controller Access – The user(s) can monitor and program the pump via web access throughout the season which results in fewer staff time hours traveling to and from the site to collect data or change settings. It also aid in communication among staff regarding operation, monitoring and sampling coordination. The estimated cost savings for routine operation and monitoring due to this technology is between \$1,000 and \$2,000 per year.
- Inline Magnetic Flow Meter – Allows for accurate (+/-0.25%) measurement of pumped volume as it fluctuates during high and low flow events. Besides providing a very high level of accuracy, this flow meter also replaces a portion of the monitoring equipment that previously had to be installed, maintained, and removed each year. It also gives users the ability to review pumped volume in real-time or summarize at any point in the season.

There are two sources of water entering the IESF:

1. Cul-de-sac neighborhood runoff (7 acre drainage area, Year-round runoff)
2. Pumped from tributary (1,200 acre drainage area, March-December periodic, precipitation driven pumping events)

The water from these two sources mixes in a small, permanently inundated pretreatment pond prior to entering the IESF. Water quality sampling is conducted at the upstream end of the filter and in the downstream discharge pipe. In 2016 there were six sampling events at the inlet and outlet of the filter. The monitoring results were reviewed and those deemed not representative of the actual conditions were removed from the performance analysis. For example, the August 11, 2016 discharge sampling was at a time when the outfall pipe was inundated by the stream exceeding its banks and influencing the sampled concentration. Table 1 includes the range and average sample concentrations that were observed.

Table 1: Observed Phosphorus Concentrations

Location	Minimum [mg/l]	Average [mg/l]	Maximum [mg/l]
Inlet	0.125	0.283	0.320
Outlet	0.034	0.043	0.116

Water quantity is monitoring at the pump station and at the outlet of the filter. By comparing the volume of flow and phosphorus concentration into the filter with what leaves the filter, the phosphorus load and removal in pounds can be estimated. Volume of flow into from Morgan Avenue was not able to be measured due to back flow of the pond into the catch basin structure. Therefore, the District's calibrated hydrologic and hydraulic model was used to estimate the volume of runoff from the contributing drainage area for 2016. Approximately 41 inches of precipitation fell in 2016 (Minneapolis St. Paul Airport, 2016). The neighborhood volume of runoff made up approximately 20 percent of the total volume through the filter with 80 percent being pumped from the stream.

The volume discharged from the filter was approximately 82 percent of the combined runoff from Morgan Avenue and the pumped water. This discrepancy is due to infiltration in the 2nd cell of the stormwater pond. Water begins to pond in this cell when the inflow rate exceeds the filtration rate through the sand. The rate of filtration reduces as the sand reaches saturation. The water elevation in the 2nd cell did not reach the normal pond outlet elevation; therefore the entire volume is infiltrated that does not discharge to the stream. Table 2 provides a phosphorus load and removal summary for the system.

Table 2: 2016 Total Volume and Phosphorus Load Summary

Flow Source	Volume [Acre-Feet]	Phosphorus [Pounds]
Morgan Avenue	8.8	6.8
Pumped from Stream	36.4	28.0
Total	<u>45.2</u>	<u>34.8</u>
Discharged from Filter ¹	37.3	4.4
Total Removed	<u>7.9</u>	<u>30.4 (87%)</u>

Conclusions

The removal performance of the filter remained consistent with the previous two seasons. The Minnesota Stormwater Manual Suggests that total phosphorus at the outlet of an iron-sand filter that consistently exceeds 0.06 to 0.07 milligrams per liter may be used as an indicator that the phosphorus binding capacity of the iron-enhanced sand bed has been consumed. The discharge concentration remained below this standard, suggesting that the phosphorus binding capacity is sufficient to continue operating at the observed removal efficiency.

With the consistently high treatment efficiency observed, staff will aim to extend the duration of operation as long as feasible in order to maximize the number of pumping events throughout the year. This year, the pump was brought online on March 3, 2017; the earliest occurrence since the project has been in operation.

¹ Monitoring equipment was installed from 4/28/2016 to 11/1/2016. Annual discharge from the filter outlet assumes the same ratio as that which was monitored.