memo

Project Name |	Settlers Glen Iron Enhanced Sand Filter	**Date** |	4/4/2018
To / Contact info |	BCWD Board of Managers		
Cc / Contact info |	Karen Kill, District Administrator		
From / Contact info |	Ryan Fleming, PE		
Regarding |	2017 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 four seasons. This was 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

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 (influent) and in the downstream discharge pipe leaving the bottom of the filter (effluent). In 2017 there were six sampling events at the inlet and outlet of the filter. During two of the sampling events (5/17/2018 and 5/22/2018) the concentrations of both influent and effluent were very close to the analysis reporting limit of 0.05 mg/l (+/-40%). According to the laboratory, there is greater variability when the results are close to this limit but because they are within the allowable error, the results are still considered valid. Compared to past years, the average observed influent concentration was approximately 45 percent lower with the maximum concentration 16 percent lower. 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	0.067	**0.155**	0.268
Outlet	0.031	**0.059**	0.079

Water flow rate 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. The volume of flow 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 2017. Approximately 32.4 inches of precipitation fell in 2017 (Minneapolis St. Paul Airport, 2017), which is 8.6 inches less than in 2016.

Based on the modeling and monitored results, the neighborhood volume of runoff made up approximately 13 percent of the total volume through the filter with 87 percent being pumped from the stream.

The volume discharged from the filter was approximately 31 percent of the combined runoff from Morgan Avenue and the pumped water[1]. This volume is significantly less than calculated for 2016. The discrepancy is likely a result of following:

1. Infiltration occurs 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 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. During field visits, it was observed that the filtration rate through the filter may be less than previous years due to clogging of the surface. This can result in a higher ratio of water being directed to the 2nd cell and infiltrated than discharged to the monitoring location.
2. Discharge water is bypassing the flow monitoring equipment. The Washington Conservation District (WCD) field notes indicate high velocity from the pipe. It is possible that flowing water bypasses the sensor during these times. They field checked the equipment installation periodically throughout the year and therefore it is no believed to be a significant contributing factor to the discrepancy.

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	4.0	1.7
Pumped from Stream	28.0	11.8
Total	**32.0**	**13.5**
Discharged from Filter	9.8	1.6
Total Removed	**24.1**	**11.9 (88.3%)**

[1] Assumes 100% of winter runoff is discharged through the filter (flow is not monitored during this time).

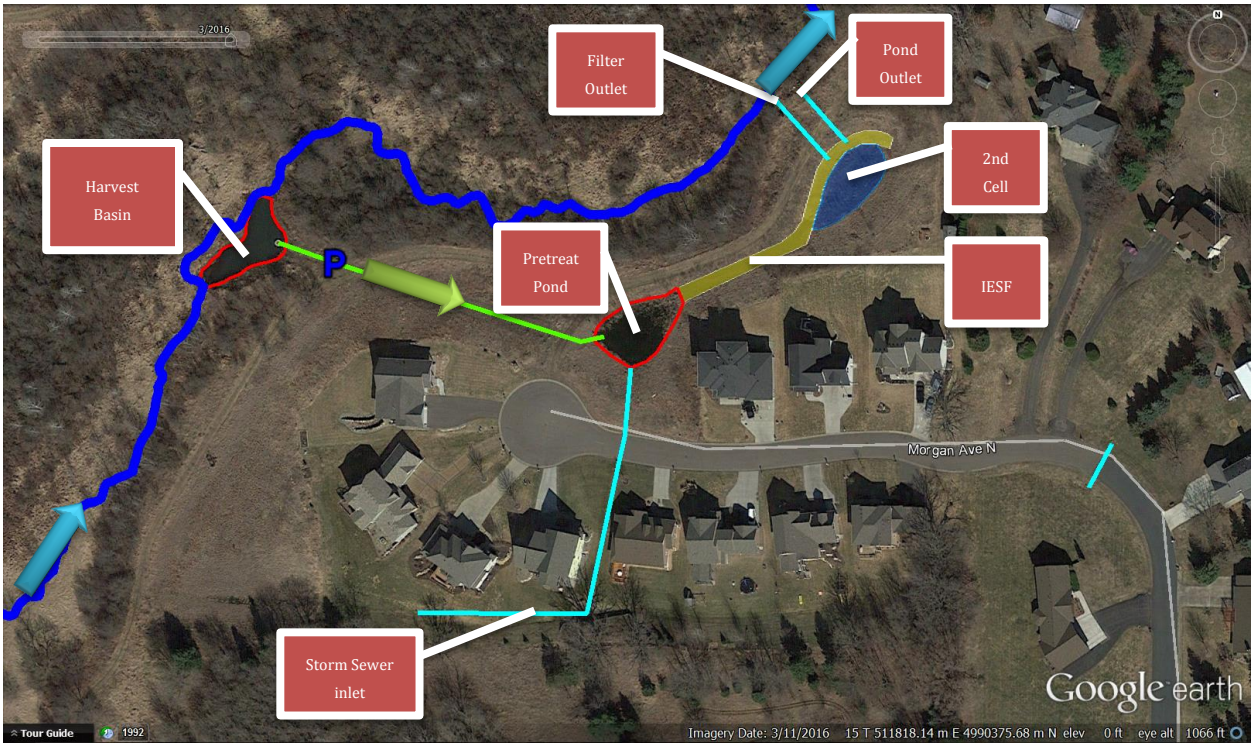

Figure 1: IESF Project Layout

Conclusions

The total phosphorus removal for 2017 was lower than past years due to a number of factors.

1. A lower influent phosphorus concentration yields fewer pounds of phosphorus for the filter to treat. The removal efficiency for the filter is generally lower when there is very low influent concentration as observed in 2017.
2. The rainfall intensity measured at the BCWD weather station was lower than past years, with all storms less than 1.5 inches per hour. The creek does not respond as "flashy" during low intensity rainfall and therefore the pump remains at lower speeds throughout the events. This, combined with less rainfall overall, contributed to less volume through the filter.
3. The pump, which supplies the majority of flow to the filter, was decommissioned from mid-August to November due to damage caused by muskrats. According to the BCWD weather station, 8.7 inches of rain fell during this period, or approximately 27 percent of the annual precipitation. Had the pump been online, additional volume would have been conveyed through the filter.

The removal performance of the filter remained consistent with the previous three 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 sampled effluent concentrations were below this standard during four of the six sampling events, suggesting that the phosphorus binding capacity is sufficient to continue operating at the observed removal efficiency.

Recommendations

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. The winter of 2017 was the first that the system was left operational so that it can pump during melt events. Since November, there have been 19 pumping events and the system will be available to early treat spring runoff. The WCD conducted sampling during one of the pumping events so that the winter phosphorus concentration and the pollutant load can be reviewed. Based on the 2017 project observations, the following is recommended and portions within EOR's scope of services will be presented in a subsequent work plan for 2018.

1. The filter surface should be aerated annually to break up the upper portion and encourage movement of water into, rather than across, the filter.
2. Sediment observed in the harvest basin should be surveyed to determine the volume of accumulation and gauge the timing of when the basin will need maintenance.
3. Vegetation management to control invasive species on all areas that were disturbed by the project should be conducted throughout the year.
4. Flow monitoring and sampling should continue while including monthly grab samples when the automated equipment is not installed. This will help in assessing the winter phosphorus load and cold weather performance of the filter.
5. The WCD should review the outlet sampling setting to confirm that the weir has not loosened which could result in flow getting beneath the sensor as well as to make sure the sensor placement is optimized to most accurately represent the discharge quantity.