memo

Project Name |	Settlers Glen Iron Enhanced Sand Filter	**Date** |	3/2/16
To / Contact info |	BCWD Board of Managers		
Cc / Contact info |	Karen Kill, District Administrator		
From / Contact info |	Ryan Fleming, PE		
Regarding |	2015 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 two seasons. This is the first application of its kind using stream stage to control a pump that charges the filter. Given the experimental nature of the project, the District has implemented a monitoring program to assess the removal performance for a variety of pollutants.

A mid-season performance review was conducted in September 2015. At that time, it was estimated that the filter had removed 18.4 pounds of phosphorus however the sampling data had not undergone final QA/QC by the laboratory or the Washington Conservation District. The lab results have been finalized, including samples collected from the cul-de-sac runoff, not previously analyzed in September.

Update

Water quality sampling is conducted upstream and downstream of the IESF. There is also runoff entering the filter from the Morgan Avenue cul-de-sac that mixes in the pond between the two monitoring points (7 acre drainage area, 11 residential lots). In 2015 there were nine sampling events at the inlet, eight events at the outlet, and three samples analyzed from street runoff in the cul-du-sac. The event of 5/27/2015 was removed from this summary as it remains uncertain whether the inlet and outlet samples were switched. The outlet results for 7/6/2015 were removed due to stream tailwater mixing with the filter discharge, therefore not representative of filtered discharge. Table 1 includes the range and average sample concentrations that were observed.

Table 1: Observed Phosphorus Concentrations

Location (No. Samples)	Minimum [mg/l]	Average [mg/l]	Maximum [mg/l]
Stream Pumped (8)	0.062	**0.233**	0.390
Morgan Ave (3)	0.136	**0.259**	0.378
IESF Outlet (6)	0.031	**0.038**[1]	0.049

[1] 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.

Water quantity monitoring is conducted at the same locations upstream and downstream of the IESF. 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 2015. Approximately 36 inches of precipitation fell in 2015 (Minneapolis St. Paul Airport, 2015). The neighborhood volume of runoff made up approximately 20% of the total volume through the filter with 80% being pumped from the stream.

The volume discharged from the filter was approximately 50 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 has not yet come close to the normal pond outlet elevation; therefore the entire volume is infiltrated that does not discharge from beneath the filter. Table 2 provides a phosphorus load and removal summary for the system.

Table 2: 2015 Total Volume and Phosphorus Load Summary

Flow Source	Volume [Acre-Feet]	Phosphorus [Pounds]
Morgan Avenue	8.6	6.1
Pumped from Stream	32.8	22.2
Total	**41.4**	**28.3**
Discharged from Filter[2]	20.7	2.1
Total Removed	**20.7 (50%)**	**26.1 (92%)**

Conclusions

The removal performance of the filter remained consistent throughout 2014 and 2015. The total phosphorus removed in 2015 falls below the projected 33 pounds estimated in the mid-season update. This was primarily due to three factors, (1) exercising caution with the pump speed to avoid drawing down the stream too quickly during low flow, (2) downtime due to debris clogging the pump intake, and (3) shutting the pump down earlier than planned to protect new sod placed to at the outlet area.

A site visit in late February found that the outlet area remains stabilized with vegetation already growing (this area receives groundwater seeping from the embankment throughout the year). The 2016 pump commissioning is anticipated in early March with the pump optimization upgrades,

[2] Monitoring equipment was installed from 4/20/2015 to 10/15/2015. Annual discharge from the filter outlet assumes the same ratio as that which was monitored.

approved at the January 13, 2016 Board Meeting, installation in April. The pump upgrades will allow the pump to operate at different speeds such that the stream will not be drawn down too quickly, eliminating factor (1) above.

Performance Factors – There are a number of factors that impact the overall performance of the system as outlined below.

- Influent Concentration – Very low influent concentration results in poorer removal efficiency of the filter (it's more difficult to make clean water cleaner). The influent phosphorus concentrations have ranged from very low to that which is typically found in suburban runoff. The filter has consistently exhibited removal efficiencies in the high 80 to 90 percent for the higher range of sampled concentrations. This is consistent with and sometimes exceeds the removal expectations assumed in the Minnesota Stormwater Manual.
- Snowmelt Runoff – The spring snowmelt can be the single largest water and pollutant loading event in the year (MPCA, 2004). Neighborhood runoff is always routed through the IESF, however pumping from the stream will depend on the time that the system is commissioned. The system was commissioned as early as possible in March but the winter months were all below the normal amount of precipitation by a total of 3.4 inches. The winter snowmelt event was essentially non-existent for 2015 with relatively low pollutant loading to be treated by the IESF. With snow cover below the historical median in Washington County, 2016 looks to be similar to 2015 in this regard (MNDNR, 2016).
- Pump Duration and Speed – The pump program was initialized to run for a maximum duration of 18 hours at the lowest speed setting to avoid overwhelming the filter and to allow the erosion control blanket to "bed in" to the sand surface. Based on observed filter performance following short drying durations (26-30 hours), the pump speed and duration was increased to direct more volume into the filter in the fall of 2015 and will continue to be ramped up to 24 hours in 2016.

Works Cited

MNDNR. (2016). *HydroClim Minnesota*. Retrieved from http://www.dnr.state.mn.us/hydroclim/index.html

MPCA, E. &. (2004). *The Minnesota Stormwater Manual Issue Paper "B": Precipitation Frequency Analysis and Use.* St. Paul, MN: MPCA.