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TECHNICAL MEMORANDUM

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DATE: July 22, 2014

SUBJECT: Wetland 639W Wetland Export Reduction Project
Evaluation Report

Background

In 1999 the Shingle Creek WMC modeled the watershed draining to Upper Twin Lake, and conducted some limited monitoring of the primary inputs into the lake to help calibrate that model. It was noted that the measured concentration and associated load from the subwatershed draining through Wetland 639W was far higher than the model predicted. The Commission suspected that Wetland 639W, rather than being a sink for total phosphorus was acting as a source. Follow up monitoring in 2002 at the inlet and outlet of the wetland confirmed that the discharge load was far greater than the inflow load. (See Tables 1 and 2.)

In 2008 the Commission received a Section 319 grant from the MPCA to conduct additional monitoring, perform a diagnostic study, and complete a feasibility report detailing options for reducing phosphorus export from the wetland. Analysis of the monitoring data and observation of conditions in Wetland 639W suggested that the likely reason phosphorus is released from the wetland is the de-saturation of the central basin during the summer by the dense cattails that dominate the basin. When groundwater is drawn down, the desaturated soil becomes aerobic, and mineralizes faster than it would were it saturated. Thus, instead of tying up organic phosphorus in slowly decomposing peat, the phosphorus is transformed into an inorganic form that is bound with iron as ferric phosphate. When the soil becomes flooded again, the ferric iron is reduced to more soluble ferrous compounds that are released into the water column and discharged in outflow. The vegetation and soil also become friable, and as stormwater sheet flows across the wetland, the organic material and mineralized soil particles are mobilized and conveyed downstream to Upper Twin Lake.

That feasibility study concluded that the most viable and effective means of mitigating this phosphorus discharge would be to construct a controlled outlet structure to store runoff in the wetland, keeping the

soil saturated for longer periods. Because the wetland borders residential areas, an overflow structure and channel would also be necessary to minimize potential for flooding from larger rain and snowmelt events.

Wetland 639W Wetland Export Reduction Project Results

This project, Wetland 639W Nutrient Export Reduction, constructed the two new outlet structures and the overflow channel (Figure 1). In addition to the overflow channel, two emergency relief valves were installed in the primary outlet structure. These are exepected to operate only in very wet conditions or in the early spring when there is a large snowpack to melt. The relief valves discharge water from a pool at the downstream end of the wetland. Phosphorus is released from the sediments into the water stored in the pool, so when the relief valves are opened they release nutrient-enriched flow.

Prior to construction and for two years post-construction flow and water quality were monitored at the wetland inflow and outflow as well as in the overflow channel and in a channel downstream of the relief valves. The data in Tables 1 to 4 and Figures 2, 3 and 4 below show that the amount of total phosphorus exported from the wetland depends on the volume of water exported, and whether that discharge is made via the overflow channel or the relief valves. Preconstruction, 2002 was an average precipitation year and 2008 was a dry year. During the monitoring period in 2002, 786 acre-feet of runoff flowed into the wetland at 63rd Avenue N, and 970 acre-feet flowed out. Some of that additional flow was the discharge of water stored in thewetland, some was groundwater, and some was from some small areas of overland flow direct to the wetland. The calculated montioring period TP load coming into the wetland was 263 pounds, while an estimated 725 pounds was discharged to the wetland. During the dry preconstruction year 2008, 277 acre-feet flowed into the wetland, but only 32 acre-feet flowed out. The outlet channel was dry most of the season, as vegetation in the wetland likely evapotranspired most of the runoff discharged into it. As a result, the discharge load was very low, estimated at 24 pounds.

Post construction, flow into the wetland is intended to be contained as much as possible in the wetland, both to slow soil mineralization and to limit the outflow of nutrient-rich discharge. In post-construction 2012, the outflow (108 acre-feet) was less than the inflow (257 acre-feet) and the discharge load (74 pounds) was less than the load into the wetland (217 pounds). However, this was not the case in 2013, when the outflow volume was still less than the inflow volume, but the outflow TP load (134 pounds) was greater than the inflow load (71 pounds). The difference resulted from how the overflow channel and relief valves were operated in those two years.

The project was initially designed to discharge mainly from the overflow channel, which is on the upper west end of the wetland and where there is less sediment release of dissolved phosphorus. However, a quirk of topography in the wetland - a slight but significant ridge in the center of the wetland – meant that runoff stored in the east side of the wetland was unable to access the overflow outlet. Water tended to pool on the lower east side, flooding a trail and an adjacent ballfield. The relief valves installed in the outlet structure are intended to relieve that flooding. Heavy spring rains in 2013 filled the wetland storage, and the relief valves were operated to reduce the subsequent flooding. Figure 3 shows the significant difference in volume discharged from the two outlets between 2012 and 2013. In 2013 the majority of the outflow from the wetland was released through the valves. The average TP concentration in outflow through the channel was 289 µg/L, while the concentration of outflow from the valves averaged 545 µg/L. This explains the increase in TP load discharged in 2013.

To minimize the discharge of high TP concentration outflow, a channel extension was completed at the end of 2013 to provide a flowpath across the higher ground to allow pooled storage to flow west to the overflow outlet. This should reduce the amount of time that the relief valves need to be operational, and should further reduce the TP load discharged from Wetland 639W. Even with the relief valves operating, the mass of TP discharged from the wetland during the monitoring period in 2013 was 134 pounds, compared to 725 pounds preconstruction in 2002.

Figure 1. Wetland 639W outlet modification components.

Table 1. Inflow load and concentration to Wetland 639W at 63rd Avenue North for various monitoring periods.

		Precipitation		Flow		Total Phosphorus		Ortho Phosphorus	
Year	Monitoring Period	Monitoring period (inches)	Annual (inches)	Acre-ft	Runoff (inches)	TP (ug/L)	Load (lbs)	OP (ug/L)	Load (lbs)
1999									
2002	5/3 to 10/25	21.27	33.47	786	9.77	123	263	72	154
2008	5/20 to 11/19	10.73	27.10	277	3.44	184	139	103	78
2012	3/28 to 11/16	24.69	30.21	257	3.19	311	217	77	54
2013	4/4 to 10/23	30.92	35.90	127	1.58	207	71	103	36

Note: Concentrations are flow-weighted means.

Table 2. Outflow load and concentration from Wetland 639W for various monitoring periods.

		Precipitation		Flow		Total Phosphorus		Ortho Phosphorus (ug/L)	
Year	Monitoring Period	Monitoring period (inches)	Annual (inches)	Acre-ft	Runoff (inches)	TP (µg/L)	Load (lbs)	OP (µg/L)	Load (lbs)
1999	?	?	27.34	908	7.32	481	1189	?	?
2002	5/4 to 10/25	21.27	33.47	970	7.82	275	725	148	390
2008	5/20 to 9/11	10.73	27.10	32	0.26	271	24	76	7
2012	4/20 to 11/16	22.52	30.21	108	0.87	252	74	142	42
2013	4/4 to 8/28	26.1	35.90	106	0.85	465	134	153	44

Note: Concentrations are flow-weighted means.

Table 3. Outflow load and concentration in the Wetland 639W overflow channel.

	Flow		Total Phosphorus		Ortho Phosphorus	
Year	Acre-ft	Runoff (inches)	TP (µg/L)	Load (lbs)	OP (µg/L)	Load (lbs)
2012	79	?	252	54	142	30
2013	33	?	289	26	110	10

Note: Concentrations are flow-weighted means.

Table 4. Outflow load and concentration discharged from the wetland 639W relief valves.

	Flow		Total Phosphorus		Ortho Phosphorus	
Year	Acre-ft	Runoff (inches)	TP (µg/L)	Load (lbs)	OP (µg/L)	Load (lbs)
2012	29	?	252*	20	142*	11
2013	73	?	545	108	173	34

Note: Concentrations are flow-weighted means.
*No concentration data available, assumed the concentration measured in the overflow channel.

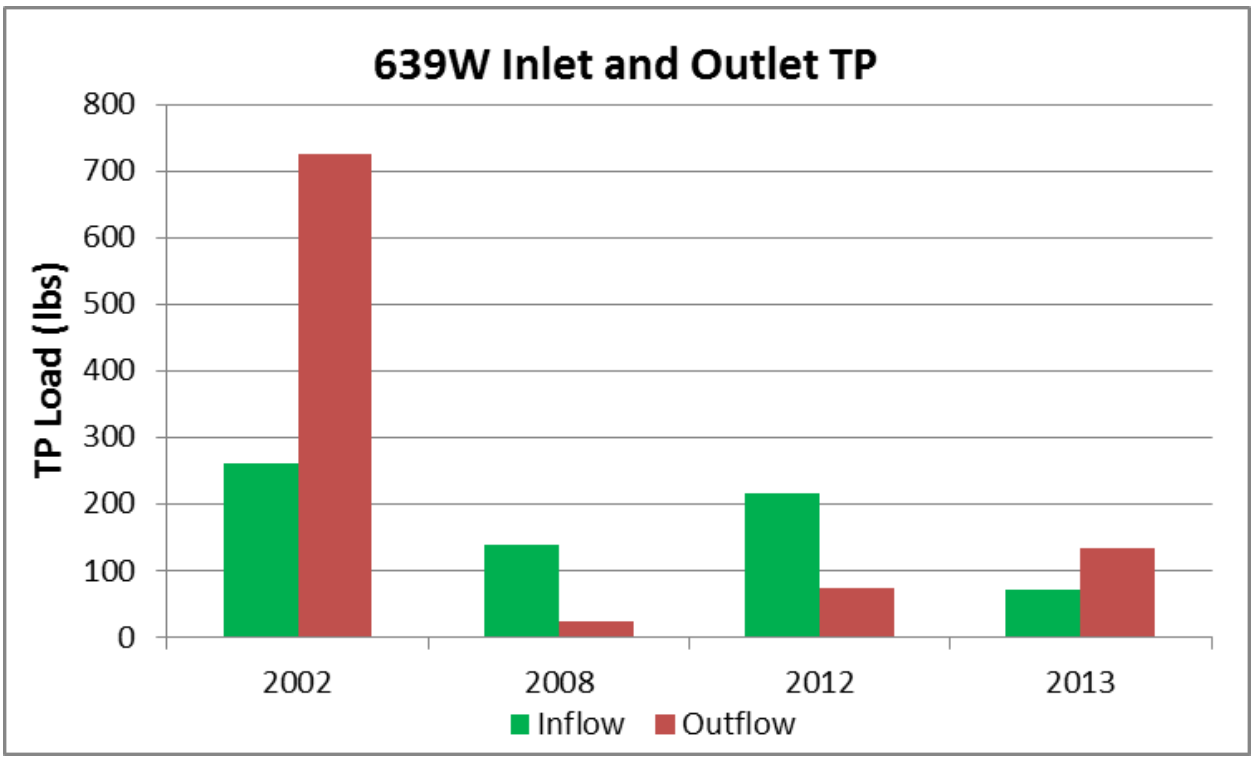

Figure 2. Monitoring season Wetland 639W inflow and outflow TP load.

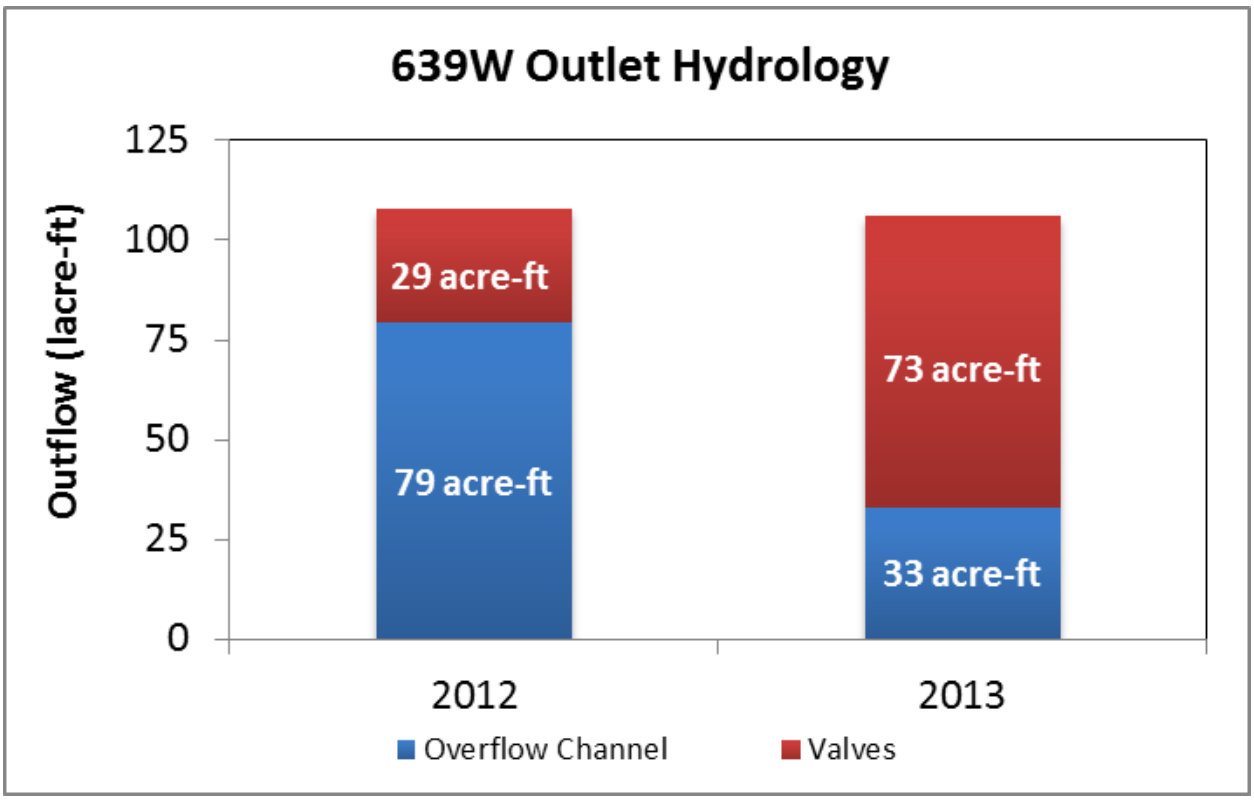

Figure 3. Monitoring season Wetland 639W outlet hydrology.

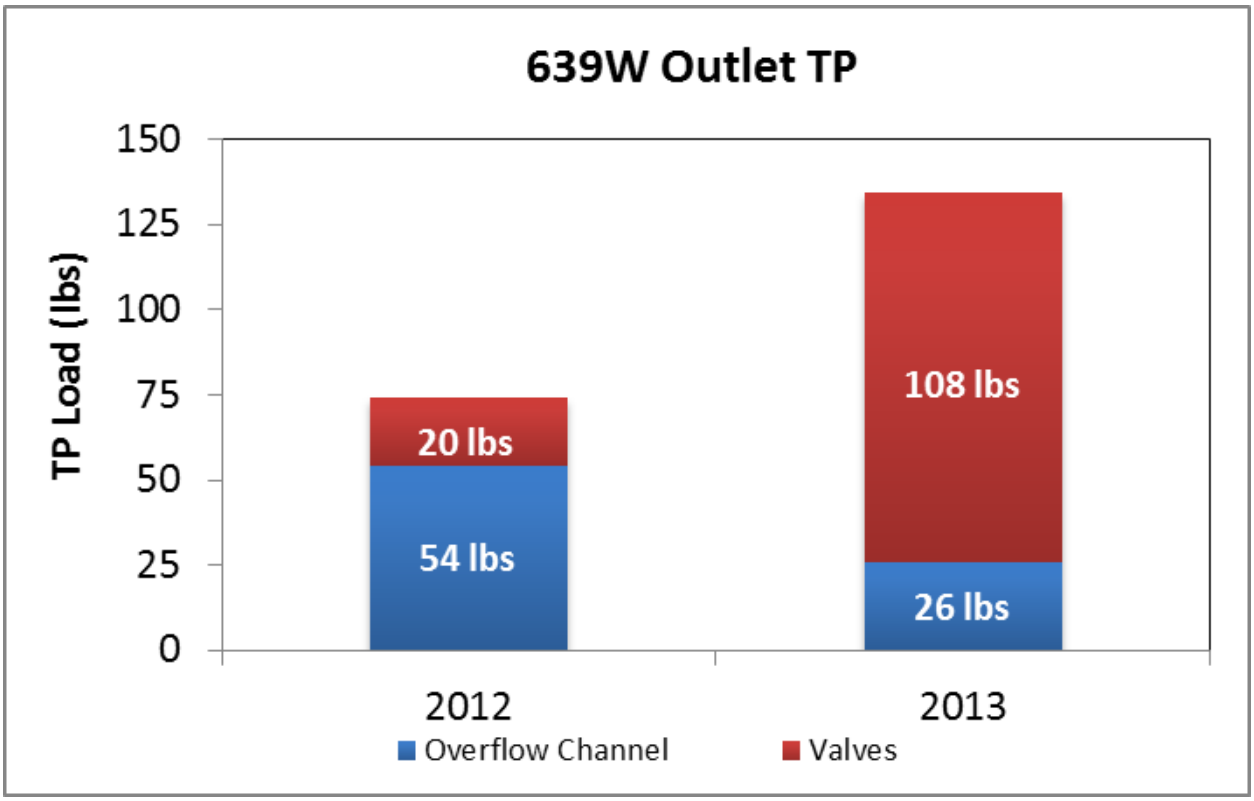

Figure 4. Monitoring season Wetland 639W TP load.