technical memo

Project Name |	Clean Water Fund: Water Harvest and Reuse	**Date** |	07/05/2019
To / Contact info |	BCWD Board of Managers		
Cc / Contact info |	Karen Kill, District Administrator		
From / Contact info |	Brett H. Emmons, PE		
Regarding |	Oak Glen Golf Course Stormwater Reuse Feasibility Study (DRAFT)		

Background

The EOR report "Lake McKusick Wetland – Assessment of Wetland and Surface Water Connections to Brown's Creek" dated September 10, 2018 identified the wetland as a significant source of thermal loading and phosphorus loading to the creek. It also demonstrated that using water from the wetland to irrigate Oak Glen Golf Club (OGGC) could have dual benefits of:

1. **Reducing the thermal load and phosphorus load to Brown's Creek**
2. **Reducing the need to pump groundwater for irrigation (& support creek baseflow)**

The BCWD applied for and received a grant from the state of MN to implement a project to reduce pollution to Brown's Creek and downstream TMDL listed St. Croix river by utilizing reuse on the Oak Glen Golf Course. Brown's Creek Watershed District (BCWD) is currently in discussion with the Oak Glen Golf Club (OGGC) regarding ways to reduce the OGGC's groundwater withdrawal for irrigation, and at the same time, reduce runoff, pollutants, and thermal loading that can impact downstream waterbodies, such as Brown's Creek and ultimately the St. Croix River. This memo summarizes the findings so that OGGC and BCWD are able to evaluate the cost effectiveness of installing reuse infrastructure and altering the irrigation system.

Part of the September 2018 analysis found that the diversion weir (preventing flows from reaching McKusick wetland and thus Brown's Creek except at high lake levels) had been compromised and by-passed. In the fall of 2018, the diversion breach was repaired, reducing, although not eliminating, excess water from the diversion reaching Brown's Creek. In early 2019, a further analysis of options is discussed in the memo "Water Reuse and Management Options for the Diversion Drainage/McKusick Wetland System" dated May 7, 2019. The initial grant application included a simple diversion from McKusick wetland to the irrigation pond before the breach and bypass flows were found and addressed. The May 2019 analysis examined the feasibility to utilize the flow of the diversion and piping them over to the irrigation pond as a more reliable source of water, and preventing impacts to downstream waterbodies (McKusick Lake, St. Croix River, and occasional overflows to Brown's Creek). In fact, the Stillwater County Club (SCC) has approached the BCWD about a surface runoff reuse for irrigation project and would be interested in additional flow if that were available.

The analysis from May 2019 found some unusual aspect of the system, such as a reduced flow from the diversion for 2017 and 2018 (as much as 2/3 lower than normal conditions), and relatively frequent overflow from McKusick Lake back into Brown's Creek. Difficulties in calibrating at

McKusick Lake (and overflows) is likely due to unknown Lily Lake pumping and periodic clogging at the McKusick Lake outlet. With the lack of a good model calibration and higher project costs to bring water the longer distance from the diversion system, it was determined for the current project to concentrate on the direct drainage to McKusick wetland first. Potentially a "2nd phase" project later could include the larger diversion flows, if warranted and deemed cost effective. Access to a second grant would also be of interest.

The site location is shown on **Figure 1**. Currently OCGC pumps groundwater from two irrigation wells to an irrigation pond. Water is pumped from the pond to sprinkler heads throughout the golf course.

Stormwater flows out of McKusick wetland on the north side of the wetland. The water flows through a pipe below the golf course to Brown's Creek. The water discharging from the pipe to the creek is very warm and has high phosphorus concentrations, as documented in past monitoring and studies. The stormwater reuse system being considered would redirect the water flowing through the pipe to the golf course so it can be used for irrigation, reducing the need for groundwater pumping.

Figure 1. Location Map

Current Conditions

Golf Course

Approximately 130 of the 158 acres of the OGGC are currently irrigated. The irrigation system demand is up to 1,400 gallons per minute (gpm) for seven hours daily, if needed. Based on the number of irrigated acres in the golf course, the estimated irrigation event volume demand can be up to 580,000 gallons, or 77,500 ft^3.

Irrigation water is drawn from the 2.70 acre irrigation pond. The pond has a 16 acre watershed comprised primarily of golf course turf and the club house parking lot. Drain tiles also direct subsurface water into the pond. The pervious nature of the pond's watershed likely yields only a small amount (less than fifteen percent) of the annual amount of water needed for irrigation. The typical drawdown in the pond per irrigation event is approximately 0.5 to 2 feet.

Water is drawn from two MnDNR permitted wells to maintain the level of the irrigation pond. The water appropriation permits for the wells require monthly reporting of the total volume pumped from each well. Since 2000, approximately 68.4M ft^3 have been pumped from the wells for irrigation. The annual pumped volume has ranged from 1.4M to 5.8M ft^3, with July and August being the most demanding months. The average annual volume of water pumped from the wells is 3.8M ft^3. The irrigation needs have seen a downward trend since 2004 which, as reported by Oak Glen staff, may be attributed to their implementation of more water conservation conscious practices, such as turning off watering zones near the rough areas of the playing course and leaving the pond water level low when rain is anticipated. Climate trends over that period have not been examined in detail to determine if that is also a factor in water usage.

McKusick Wetland

Washington Conservation District (WCD) monitors the discharge rate and phosphorus concentration at the pipe from the McKusick Wetland outlet structure on the north side of the wetland since 2017. The outlet structure discharged an average of 2.76M ft^3 (63.3 ac-ft) per year based on the 2017-2018 data. When this volume is multiplied by the average phosphorus concentration, the calculated loading is 55.9 pounds of phosphorus per year that is released to Brown's Creek. It should be noted that this data represents the time when the diversion weir was breached and flow more easily entered McKusick Wetland and Brown's Creek. In the fall of 2018, the breach was repaired, reducing, although not eliminating, overflows to Brown's Creek.

Proposed Infrastructure Changes

The location of the proposed pipe and pump station between McKusick Wetland and the OGGC irrigation pond is shown on **Figure 2**. The pipe will be a 6-inch HDPE or PVC force main. A gravity flow system was considered as an alternative to the force main, but there is not enough elevation difference between the wetland and the irrigation pond to ensure reliable flow volumes and quickly enough. The proposed features of the system include:

- 6-inch HDPE or PVC force main pipe for 450 feet.
- A 60-inch manhole lift station, pumps, and controls constructed near the outlet from the wetland to the force main.
- Wetland inlet structure on the force main with a skimmer top and debris baffle screen.
- Horizontal boring of the pipe below McKusick Road.
- Backflow prevention at the irrigation pond.
- Outlet control structure at the wetland for the pipe to Brown's Creek. The existing structure has rails for stoplogs and may still be functional. The new structure, if needed, would have removable stop logs to control the outlet elevation of the wetland, as necessary.
- Repair and revegetation of all disturbed areas.

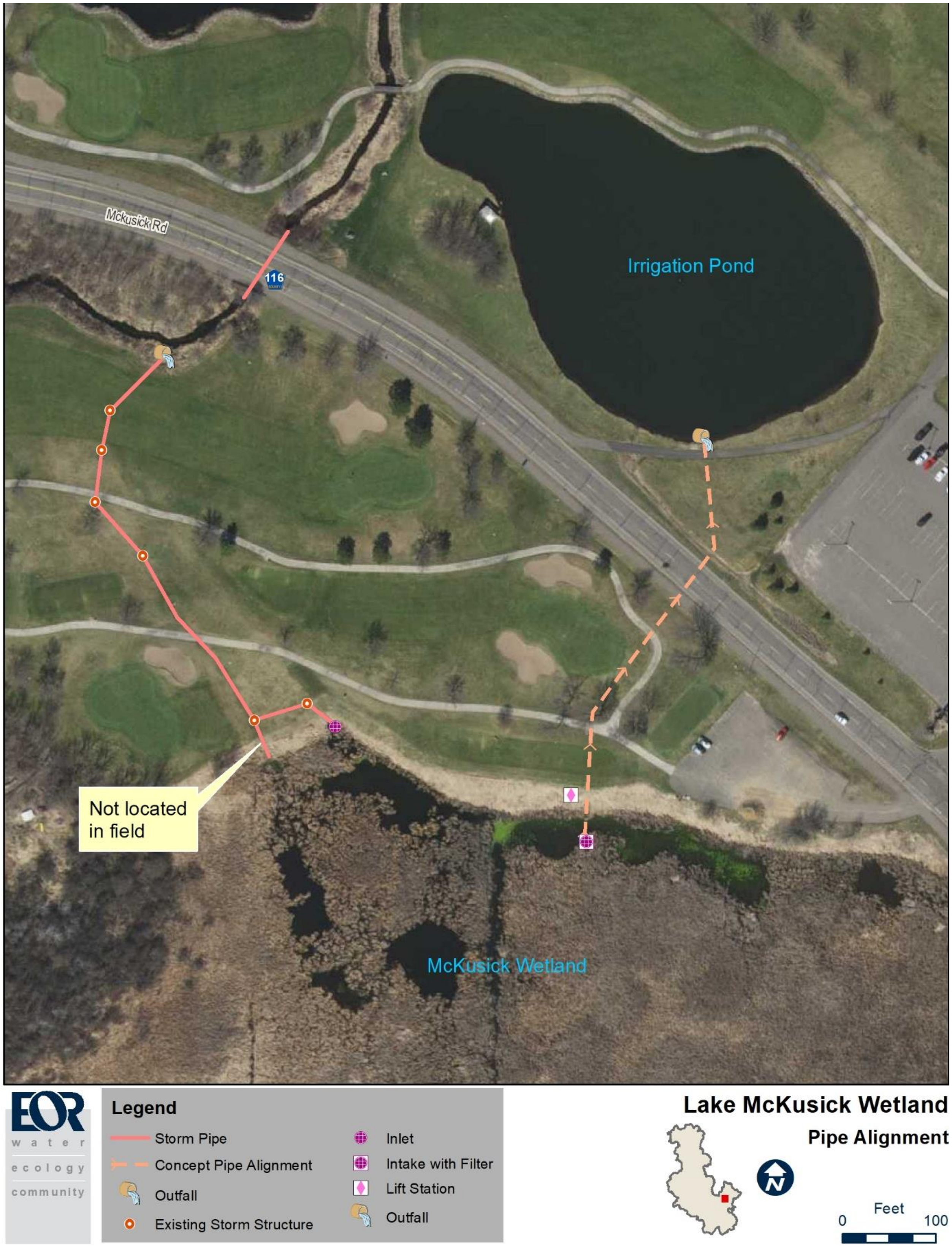


Figure 2. Proposed Pipe Alignment

Scenarios and Evaluation of Performance

Model Scenario Development

A surface water hydrology and hydraulics (H&H) model was used to evaluate the benefit of altering the outflow elevation of McKusick Wetland. The BCWD H&H model was truncated to the direct drainage area of the McKusick Lake Wetland, which totals 126.7 acres as shown in Figure 3. The model calculates the level of water in the wetland at any given time period based on inflows (precipitation) and outflows (discharge, pumping, and evaporation/ET). For this model, we used the daily precipitation and runoff patterns within the watershed from 2009-2018 as inflows. Rather than use a single year, with inherent unique variability, we chose to run a 10-year simulation to even out year-to-year variability. This can be especially sensitive in irrigation-driven reuse analysis.

OGGC does not keep daily irrigation records, but does report monthly water use to the DNR. The Stormwater Harvest and Reuse Calculator ([http://www.minnehahacreek.org/ project/stormwater-harvesting-and-reuse-study](http://www.minnehahacreek.org/project/stormwater-harvesting-and-reuse-study)) was used to determine days in this time period (2009-2018) on which irrigation would likely have taken place. The Calculator is a spreadsheet that tracks daily precipitation, rainfall-runoff, and other factors that determine the need for irrigation.

Monthly pumping for irrigation was obtained from MnDNR pumping records for the two OGGC irrigation wells (DNR permits 1986-6106 and 1986-6107) for the period 2009-2018, as shown in Figure 4. The monthly volumes were then distributed over the irrigated days in each month based on the reuse calculator that accounts for applications rates based on previous days' rainfall. This daily time series was then converted to an hourly pumping rate, assuming that irrigation water was applied between 12:00 midnight and 6:00 AM. Finally this hourly time series was used in the H&H model to withdraw water from a representation of the golf course's irrigation source pond.

Control rules were used in the model to refill the irrigation source pond on demand using water from the wetland when available. The rules stated that water was only to be pumped from the wetland to the pond when both the water level in the pond was below a certain level *and* the water level in the wetland was above a certain level, as described above. In this way, the model was able to estimate the actual availability of water in the wetland and transfer water only at such times as irrigation demand was present.

The current McKusick Wetland outlet structure is a 30-inch CMP pipe. There is also a structure set up for stoplogs with rails in front of the pipe, although currently no stoplogs are installed. Directly in front of the pipe there are also several rocks partially obstructing the flow, with gaps between the rocks that flow passes through. Some field observations also show vegetation growing in and around the outlet area.. There are not frequent water levels recorded for McKusick Wetland. From the observations recorded, water levels do fluctuate, with levels observed between 850.6 and 851.4. Based on the current configuration of the outlet and observed water levels, it is likely the existing outlet is easily obstructed by debris and vegetation. Figure 5 shows the relative elevations at the outlet. It should be noted that confirmation of the same datum being used for all elevation observations has not been verified.

Figure 3. Drainage Area and Surface Water Model Domain

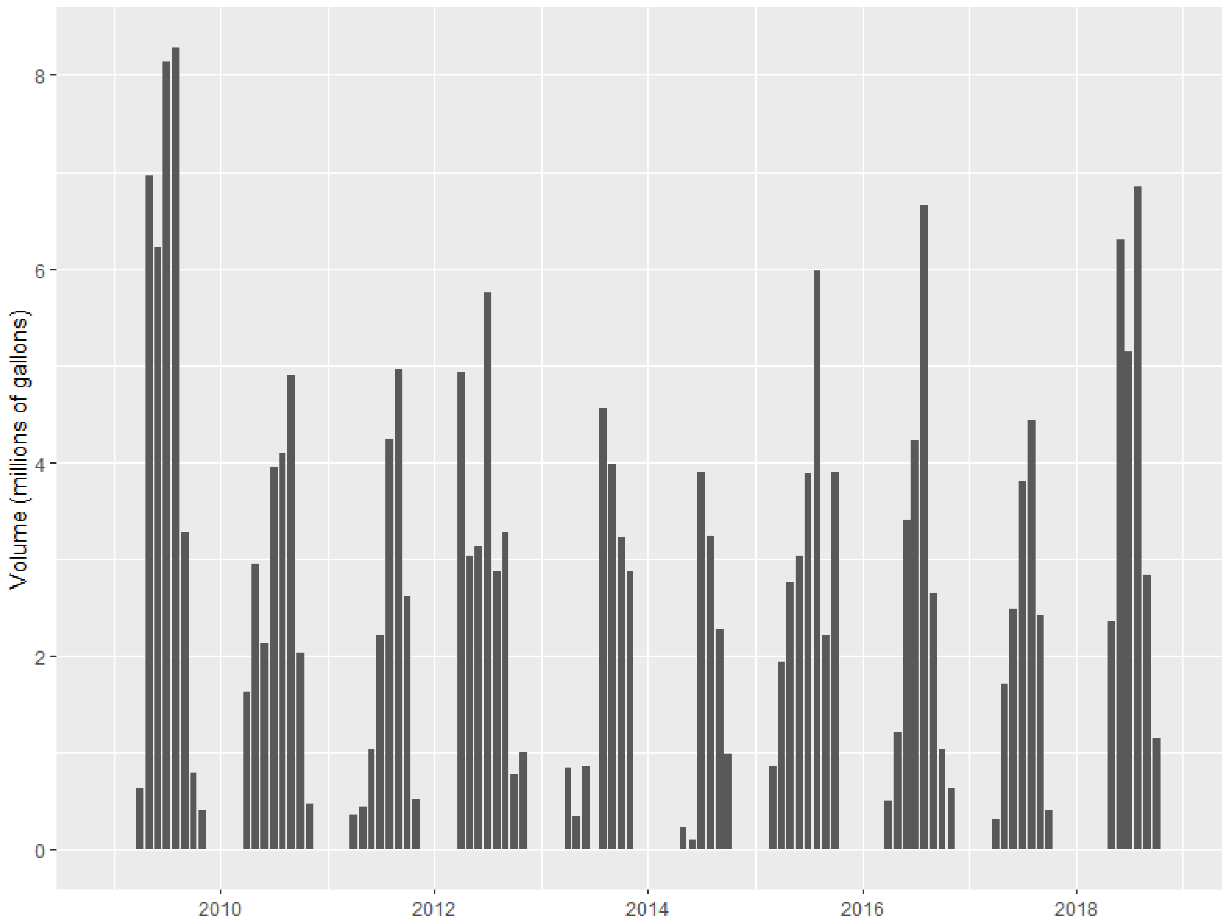


Figure 4. Monthly pumping records from OGGC irrigation wells.

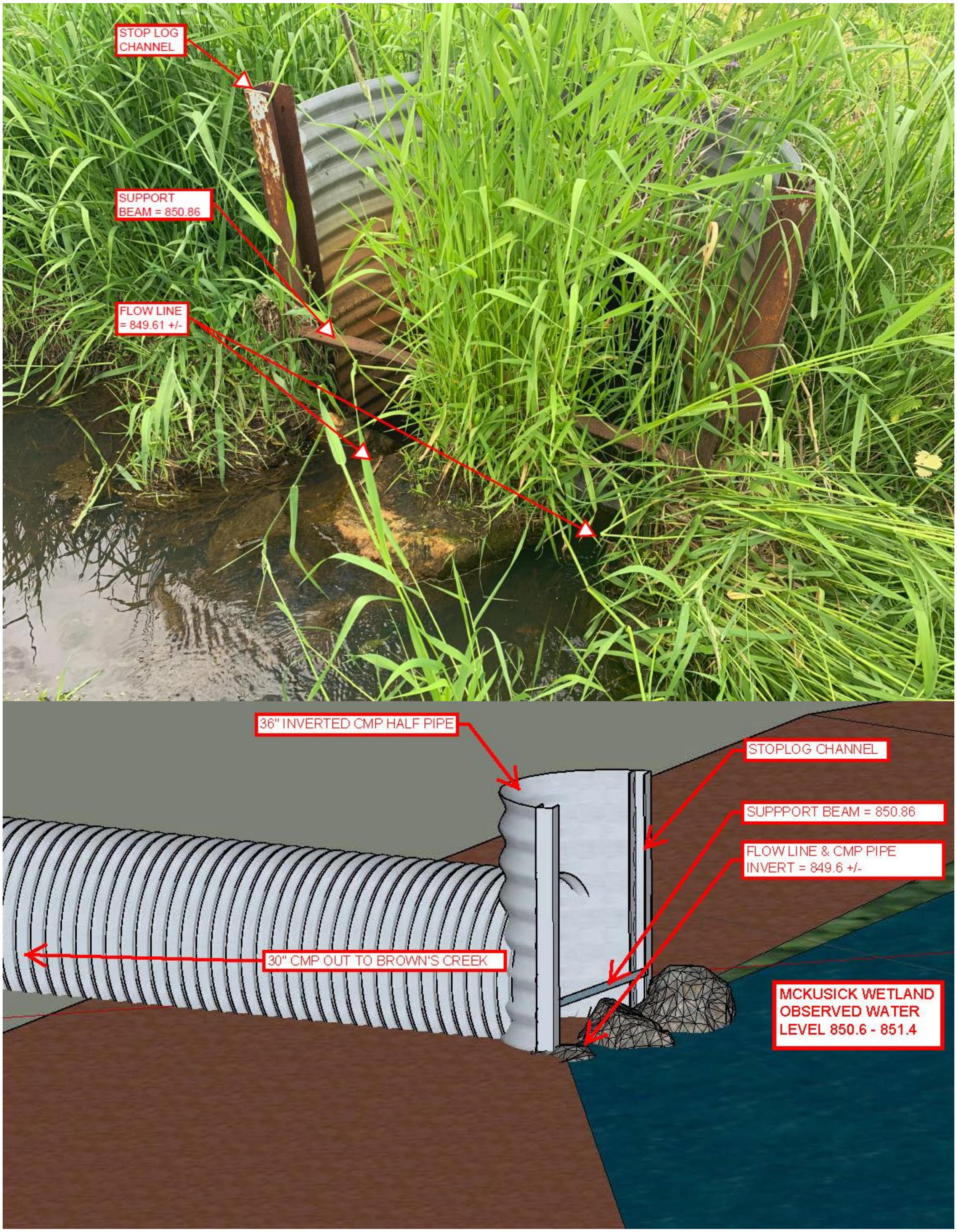


Figure 5. McKusick Wetland Existing Outlet Structure Elevations

It is also important to note that Co. Rd. 64/McKusick Road is located along the northeast and east side of the McKusick Wetland. (See Figure 3) There are some catch basins that discharge road runoff to the wetland that currently have some water in them and with the catch basins along the curb of the road, there is a limit to how much water levels could be raised in the wetland. Based on the information we have, which may be subject to different datums, the elevations of the lowest catch basin rim, and associated bottom invert are, respectively: 852.9'-853.1' and 850.4'-850.6, (+/- 0.2' due to datum uncertainty). For road and catch basin (CB) elevations see CB #58, Co. Road 64 Design Plans, dated 5/28/1992.

Elevations in the wetland, and thus the storage available, has been estimated based on somewhat limited information. There is LIDAR data available for the wetland although the elevations do not seem to correspond with wetland communities observed and mapped. For instance, at the runout level for the wetland (based on existing pipe, albeit subject to blockage), there is virtually no storage based on the LIDAR. However, almost a third of the wetland is mapped as "shallow marsh/shallow open water." LIDAR also lacks the ability to measure below any water surface. Based on casual observations from the field, the geometry of the wetland was adjusted down one foot to correspond with 6"-12" of water in the "shallow marsh/shallow open water." Further field survey and cross sections in the wetland should be performed during further design to allow for a more accurate estimate of storage.

Three model scenarios were developed in order to estimate the potential for McKusick Wetland water (stormwater runoff) to be reused to meet existing irrigation demand at the golf course:

0. Baseline (no reuse), i.e. existing conditions, limited outflow at 849.8', water levels 851+/-
1. Weir at 850.9' pumping to 850.4' (6" below weir)
2. Weir at 850.9', pumping to 849.9' (12" below weir)
3. Weir at 851.4', pumping to 849.9' (18" below weir)

The model results are shown in Table 1. The results, albeit probably best-case-scenario, indicate that outflows and phosphorus loading to Brown's Creek and the need for groundwater pumping by OGGC could be reduced substantially. The reductions are 70% or more under Scenario 1 and could be reduced by 90+% under Scenario 3. The results could be optimistic and on the higher end due to a few factors: uncertainty with wetland topography/bathymetry, current estimates of evaporation/ET used, lack of monitoring data for calibration after the weir breach was repaired, and unquantified overflows from McKusick Lake, among others. However, given these limitations and the type of system, the results provide a relatively good first estimate of relative performance between scenarios.

Results reflecting changes in water levels are indicated in Table 2. These are of interest in terms of wetland communities and nearby road infrastructure. The modeling scenarios are all based on a 10-year continuous simulation (2009-2018) using weather data from the Downtown St. Paul Airport, which is the closest station to the district with year-round hourly (or sub-hourly) precipitation. The high water levels are the peak elevation of the wetland during the 10-yr simulation, and the mean water levels are the average elevation of the wetland over the 10-yr simulation. The ability to model the existing outlet is a challenge. The outlet tends to be relatively efficient in the model as is the case in models, even though varying field conditions and intermittent clogging could occur. Additional losses at the outlet structure were added in the model to simulate some of the uncertainty. Based on limited measured levels, the typical water levels are higher, closer to 850-851, although the model reports 849.84 as an average level.

At outlets that can be subject to clogging by debris or plants, this is not an unusual result (observed > modeled). At the higher elevations, where the proposed weir would be placed, there should be more stability in the water levels, for a few reasons. First, with deeper water at the outlet, small amounts of debris are not as big an influence and rooted mats of grass (currently present) will not survive in the standing water. The design plan includes some excavation in the immediate area of the outlet to make the outlet work more as designed. The golf course would also have a stake in upkeep of the system. Since it is conveniently located within the golf course and the course will be using this as one of its water sources, it would give more attention to how it operates. Finally, there is the pure hydraulics of a weir/drop inlet configuration. It does not take much additional elevation/head to allow high capacity flows over the lip of the weir, thus reducing some of the bounce in any given event.

Table 1. Scenario model results – Volumes and water quality

Scenario	Description	Outflow to Brown's Creek			Total Phosphorus Export to Brown's Creek			Groundwater Pumping		
		Volume (ac-ft/yr)	Reduction (ac-ft/yr)	Reduction (%)	Load (lbs/yr)	Reduction (lbs/yr)	Reduction (%)	Volume (ac-ft/yr)	Reduction (ac-ft/yr)	Reduction (%)
0	Baseline (no reuse)	63.0	-	-	64.4	-	-	64.5	-	-
1	Pumping from Wetland to 6" below outlet (850.4")	17.8	45.2	71.8%	19.3	45.1	70.1%	19.2	45.3	70.2%
2	Pumping from Wetland to 12" below outlet (to 849.9")	15.7	47.3	75.0%	17.4	47.0	73.0%	17.2	47.3	73.3%
3	Pumping from Wetland to 12" below outlet (to 849.9") + outlet raised by 6" (to 851.4")	2.2	60.8	96.5%	3.3	61.1	94.8%	3.7	60.8	94.3%

Note: The model does not take into consideration the direct drainage to the irrigation source pond, nor any overflows from McKusick Lake into the wetland.

Table 2. Scenario model results – Water levels

Scenario	Description	High Water Levels 10-year simulation		Mean Water Levels 10-year simulation	
		Elevation	Elevation Change	Elevation	Elevation Change
0	Baseline (no reuse)	851.53	-	849.84*	-
1	Weir @ 850.9, Pumping 6" below outlet (850.4)	851.59	+ 0.06'	850.39	+ 0.55'
2	Weir @ 850.9, Pumping 12" below outlet (to 849.9)	851.56	+ 0.03'	850.14	+ 0.30'
3	Weir @ 851.4 (raise 6"), Pumping 18" below outlet (to 849.9")	851.57	+ 0.04'	850.25	+ 0.41'

* *Based on observed levels the typical water levels are ~850-851, not quite matching model results.*
At lower elevations, where outlets can be clogged by debris or plants, it is not an unusual result (observed > modeled).

Thermal Analysis

EOR conducted a simple thermal analysis to investigate the effect of reducing the volume of water discharged from McKusick Wetland to Brown's Creek in the September, 2018 analysis. That information is used again here, plus discussion of the added scenarios. The analysis was conducted for three points along Brown's Creek:

- U – An arbitrary point just upstream from the wetland discharge
- W – The wetland discharge point
- M – The Creek at the McKusick Road monitoring station

The temperature and flow at each point are related by the following mixing formula:

$$T_U Q_U + T_W Q_W = T_M Q_M$$

Where:
T = Temperature (^{0}K)
Q = Flow (cfs)

The analysis requires observed data for temperature and flow from both the wetland discharge and the McKusick Road monitoring station. Thus the analysis was limited to the days in 2017 and 2018 when all four data points were recorded. It is important to note that this time period coincided with the time when the weir was breached and before the repair. Since this is the only monitored data available, the analysis provides an estimate of an impact at higher wetland flows. Next, that estimate is modified by applying the proportion of flows after repair compared to the breached amount of flows. This is a very rough estimate of the expected reduction and could be refined much more in the future with more data collection.

The thermal analysis first calculated the upstream temperature and flow (T_U and Q_U) based on the observed data. Second, the wetland flow in the mixing formula was changed according to the model predictions for Scenario 1, 2, and 3 described earlier. Third, the results of the analysis were compared to critical temperature standards for the creek.

The thermal analysis used hourly time steps corresponding to the hourly time steps of the H&H model. A total of 6190 time steps were evaluated. The two critical temperature standards are:

- 18.3 °C - The TMDL threat temperature
- 23.9 °C - The TMDL critical threat temperature

The results are shown in Table 3. The results show a 13% reduction in temperatures above standards for all three scenarios. Reduced wetland discharges caused by repairs to the Lake McKusick weir account for much of the reduction, but water reuse for irrigation by OGGC also contributes to these results. Until additional post-repair monitoring data is available, it will be difficult to separate the effects of the two.

Table 3. Brown's Creek temperature readings at McKusick Road (Based on 2017-2018 data)

	Readings above 18.3 °C	Readings above 23.9 °C	% Reduction
Observed data	1228	0*	
Predicted – Scenario 1	1064	0	13%
Predicted – Scenario 2	1064	0	13%
Predicted – Scenario 2	1064	0	13%

* *Temperatures above 23.9 °C were recorded in 2017-2018, but corresponding data for the wetland discharge were not available for those times.*

Potential Effects of Chloride on OGGC

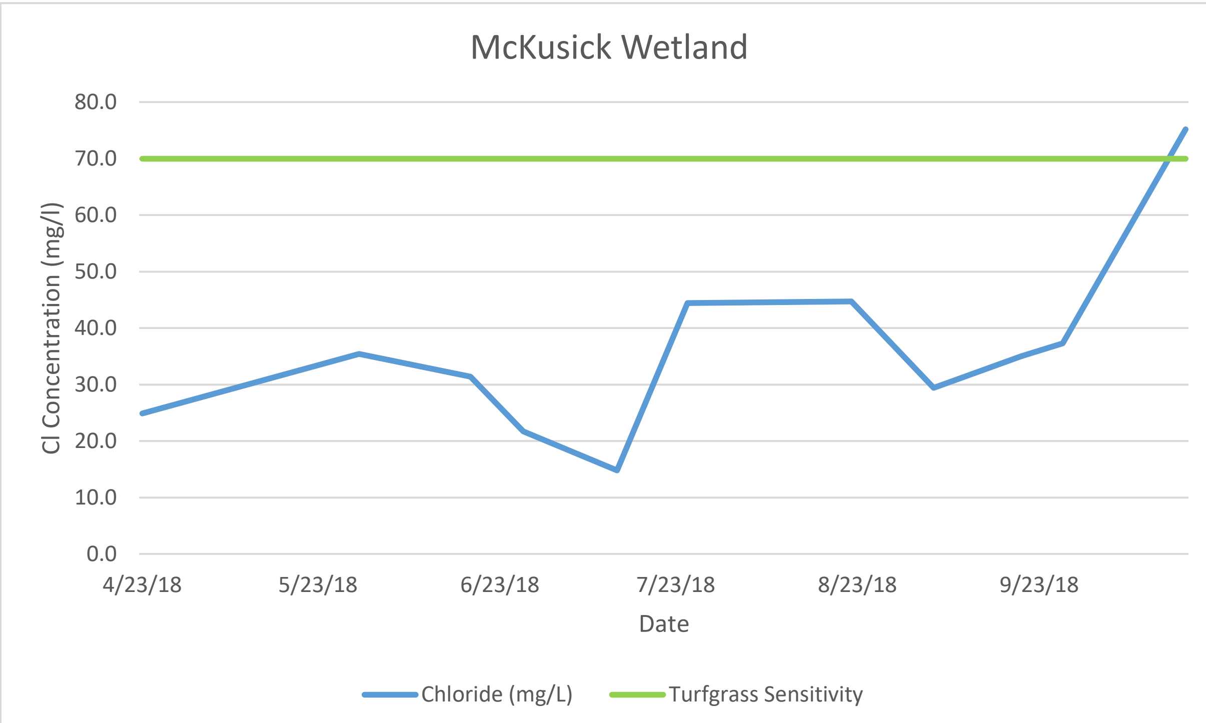
Chloride, primarily from road salts and spring runoff, is a concern in aquatic systems, but also to upland vegetation at high levels (road spray, direct runoff, irrigation). Chloride in the recycled water is not anticipated to have an effect on the turfgrass at OGGC. Turfgrass species are generally quite tolerant to chloride. Literature on using recycled water for golf course irrigation indicates that water below 70 mg/L of chloride is harmless to turfgrass. Between 70 and 355 mg/L, turfgrass may begin to show signs of stress, but water of this quality can be used with some slight restrictions or dilution, if necessary. Water with chloride concentrations above 355 mg/L should be avoided or severely restricted for turfgrass irrigation. Sensitivity to chloride varies between species.

The main danger of irrigating with saline (high chloride) water is salt accumulation in the root zone. Under low enough concentrations of salts in irrigation water, salt will typically be sufficiently flushed from the root zone by rain events. If salt does start to accumulate and cause stress to the turfgrass, the salts can be removed (infiltrated to the subsurface) by overwatering the grass with lower-concentration water. As another point of reference, the TMDL chronic water quality criterion (biota-related, not related to turfgrass health) for chloride is 230 mg/L.

Chloride data are available from McKusick Wetland for 2018 from Brown's Creek (McKusick Road monitoring station) from 2013-2018 (See Table 4 and Figure 6). Data from the McKusick wetland in 2018 showed only one sample out of eleven with chloride concentrations above the minimum concentration of 70 mg/L noted in the literature. No samples were observed at the upper limits of either the biota chronic level of 230 mg/L or turf damage level of 355 mg/L.

Table 4. Chloride concentrations

Location/Area	Years of Observation	Number of Observations	Maximum Cl concentration	Minimum Cl concentration	Average Cl concentration
McKusick Wetland	2018	11	75.2 mg/L	14.8 mg/L	35.8 mg/L
Brown's Creek at McKusick Rd	2003-2013	182	31 mg/L	4 mg/L	16 mg/L



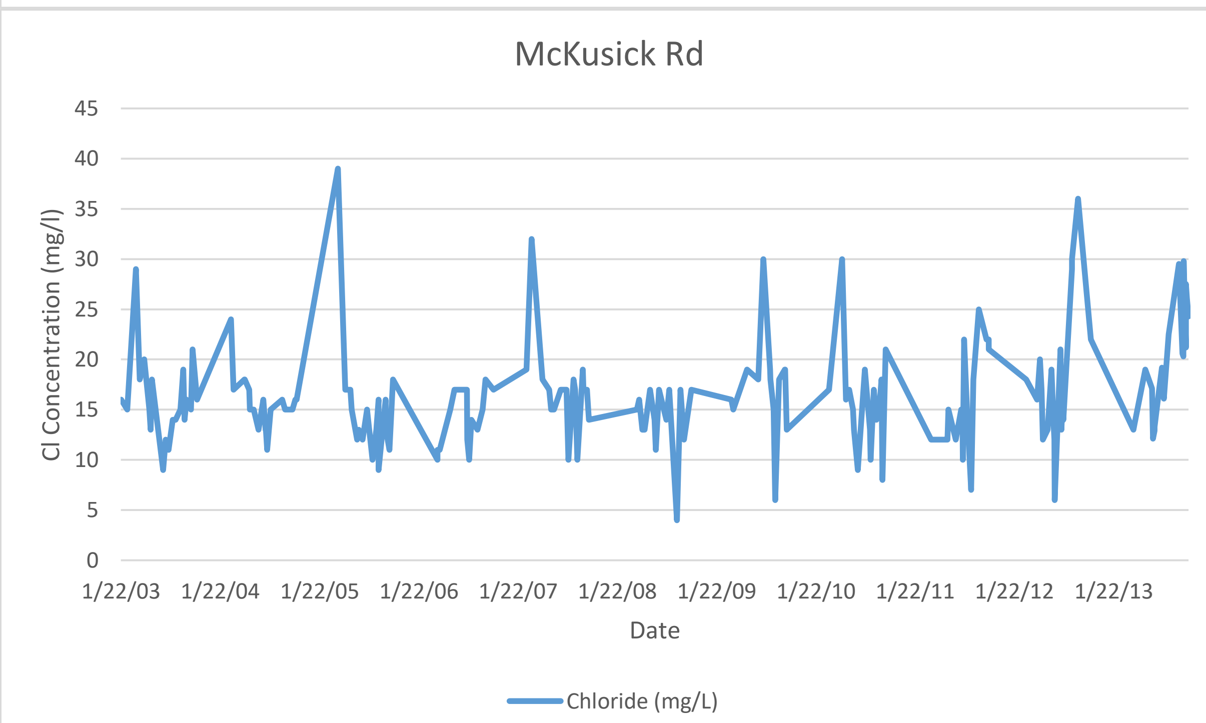


Figure 6. Chloride concentrations in McKusick Wetland and Brown's Creek

Permits

1. Wetlands

A Wetland Conservation Act (WCA) permit and a US Army Corps of Engineers (USACE) Section 404 permit may be required for construction in the wetland. A no-loss determination may apply in this situation, depending on the amount of water level manipulation. The WCA Local Governmental Unit (LGU) is the City of Stillwater, but they contract permit review services to the Washington Conservation District.

2. DNR

- ***Water Appropriations***

  A water appropriations permit is required if the reuse system will take more than 10,000 gal/day or 1,000,000 gal/year from the wetland. Oak Glen Golf Course currently uses on average about 3.8M ft^3 (28,430,000 gal/year) for irrigation, so a water appropriations permit will likely be required. See https://www.dnr.state.mn.us/waters/watermgmt_section/appropriations/permits.html.

  Water appropriations permits may also be required if construction dewatering is required for structures or boring below McKusick Road.

  When water is being taken from a pond, if there are multiple land owners riparian to the pond then they need to be notified of the appropriation, and an effort needs to be made to get them to sign a statement of support for the use of the water. We are considering the diversion ditch on the west side of the wetland to be part of the wetland, so the residential landowners adjacent to the diversion ditch must be notified. The landowners are listed in Table *5*.

  It should be noted that all surface water appropriations that are non-essential (not a first priority use) are subject to be suspended during low flows (droughts).

- ***Public Waters***

  Lake McKusick and Brown's Creek are listed as Public Waters, but McKusick Wetland is not. It is not clear whether DNR will consider the reuse project as impacting a Public Water. We will need to have the DNR area hydrologist involved with the project, and they can determine whether a Public Waters permit is necessary.

3. MPCA – NPDES Construction Stormwater Permit

The project will likely disturb more than one acre of soil, so an NPDES Construction Stormwater Permit will be required. The permit will require a Stormwater Pollution Prevention Plan (SWPPP) and a $400 application fee. See https://www.pca.state.mn.us/water/construction-stormwater.

4. City of Stillwater – Grading Permit

A grading permit will be required from the City of Stillwater. See https://www.ci.stillwater.mn.us/vertical/Sites/%7B5BFEF821-C140-4887-AEB5-99440411EEFD%7D/uploads/Grading_for_Existing_Properties(1).pdf

5. Washington County

Washington County will require a Right of Way permit for work (e.g. boring or trenching) along McKusick Road. See https://www.co.washington.mn.us/1720/Right-of-Way-Permit.

Washington County should also review the project plans and the predicted water levels in the wetlands. There are concerns about the elevation of storm sewers and catch basins along McKusick Road, which occasionally fill with backed-up water.

6. MDH

MDH does not require permits for water reuse for irrigation. They recommend restricting irrigation to nighttime hours to reduce the likelihood of human contact with the reused water. More information is available from:

Anita Anderson
MDH Drinking Water Protection Program
Phone: 218-302-6143 / Fax: 651-201-4701
Email: anita.c.anderson@state.mn.us

7. Utilities

Work permits and clearances may be required from several utilities if they are present in the construction areas.

Project Stakeholders

Besides BCWD, the stakeholders for this project are the landowners of the wetland and adjacent properties (See Figure 7).

1. Oak Glen Golf Course

Oak Glen Golf Course owns the north part of the wetland that includes the current inlet structure. They also own the diversion channel along the west side of the wetland.

2. City of Stillwater

The City of Stillwater owns most of the wetland area, including the control structure at the end of the diversion channel. The inlet for a reuse system would likely extend on to City of Stillwater property.

3. Washington County

Washington County owns McKusick Road (County Road 64)

4. Other Landowners

The residential landowners along the west side of the diversion channel may need to be notified about various permits. Their names and addresses are listed Table *5*.

Table 5. Residential Landowners Directly Adjacent to McKusick Wetland

Name	Address
Larsen-Kenney Jody L	2154 Van Tassel Dr, Stillwater MN 55082
Schmitt Christopher & Jennifer	2138 Van Tassel Dr, Stillwater MN 55082
Lande Eric K & Christine M	1238 Thorene Place, Stillwater MN 55082
Lillo Molly & Kevin	1227 Thorene Pl, Stillwater MN 55082
Landrud Sherie H & Torr J	1240 Lecuyer Cir, Stillwater MN 55082
Thomas J Rooker Rev Trs	1241 Lecuyer Cir, Stillwater MN 55082
Tschida Joseph M & Huss Mary M	1221 Lecuyer Cir, Stillwater MN 55082
Gustafson Marilyn P	1201 Lecuyer Cir, Stillwater MN 55082
Chambers Larry C & Judith M	1151 Lecuyer Ct, Stillwater MN 55082-9131
Johnson John C & Barbara A	1131 Lecuyer Ct, Stillwater MN 55082
Kelley Timothy J & Lori L	1121 Lecuyer Ct, Stillwater MN 55082
Blixrud Chris A & Tonya M	1041 Lecuyer Dr, Stillwater MN 55082
Carlson William V & Phyllis	1031 Lecuyer Dr, Stillwater MN 55082
Grau Matthew M & Laurie E	1021 Lecuyer Dr, Stillwater MN 55082

Figure 7. Properties Directly Adjacent to McKusick Wetland (DNR Appropriations Permit)

Estimated Costs

Estimated costs are summarized in Table 6. The full description of the project and individual line items are described in further detail in the

Proposed Infrastructure Changes section above.

Table 6. Cost Estimate

ENGINEER'S OPINION OF PROBABLE PROJECT COST		Description of Work: Install 6" forcemain line between wetland and irrigation pond (local drainage only, not diversion);
Lake McKusick Wetland & Diversion Pipe to Oak Glen Irrigation Pond		
PREPARED BY EMMONS & OLIVIER RESOURCES, INC.		
JOB NO.	00041-0338	
REVISED:	Tuesday, June 25, 2019	

Item No.	Item	UNITS	ESTIMATED QUANTITY	UNIT COST	TOTAL COST
1	MOBILIZATION	LS	1	$ 32,000.00	$ 32,000.00
2	EROSION & SEDIMENT CONTROL	LS	1	$ 19,000.00	$ 19,000.00
3	DEWATERING	LS	1	$ 20,000.00	$ 20,000.00
4	IRRIGATION REPAIR ALLOWANCE	ALLOW	1	$ 6,000.00	$ 6,000.00
5	6" HDPE DIPS DR-11 (TRENCHLESS)	LF	100	$ 200.00	$ 20,000.00
6	6" FORCEMAIN (PVC C-900) W/12-GA. TRACER WIRE (OPEN CUT)	LF	400	$ 25.00	$ 10,000.00
7	60" MANHOLE LIFT STATION, ELECTRICAL, PUMP & CONTROLS, SCADA (12-FEET DEEP), FLOATS	LS	1	$ 84,000.00	$ 84,000.00
8	WETLAND INLET STRUCTURE W/SKIMMER TOP & DEBRIS BAFFLE SCREEN	LS	1	$ 10,000.00	$ 10,000.00
9	REMOVE AND INSTALL EX. WETLAND OUTLET STRUCTURE	LS	1	$ 10,000.00	$ 10,000.00
10	IRRIGATION POND INLET BACKFLOW PREVENTION	LS	1	$ 4,000.00	$ 4,000.00
11	VEGETATION RESTORATION	LS	1	$ 15,000.00	$ 15,000.00
12	3-YEAR VEGETATION WARRANTY	YR	3	$ 3,750.00	$ 11,250.00
13	TRAIL RESTORATION	SF	500	$ 7.00	$ 3,500.00
				CONSTRUCTION SUBTOTAL	$ 244,750.00
		30.00%		CONSTRUCTION CONTINGENCY	$ 73,425.00
				CONSTRUCTION TOTAL	**$ 318,175.00**
		18.00%		PLANNING, DESIGN & ENGINEERING	$ 57,271.50
		8.00%		PERMITTING AND REGULATORY APPROVALS	$ 25,454.00
		10.00%		BIDDING & CONSTRUCTION ADMINISTRATION	$ 31,817.50
				PROFESSIONAL FEES TOTAL	**$ 114,543.00**
				TOTAL PROJECT COST	**$432,718.00**
ESTIMATED ACCURACY RANGE* **		**-25%**		**$ (108,179.50)**	**$ 324,538.50**
		40%		**$ 173,087.20**	**$ 605,805.20**

***This **funding-level (Class 5, 0 to 2% design completion per ASTM E 2516-06)** cost estimate is based on concept-level designs, alignments, quantities and unit prices. Costs will change with further design. Time value-of-money escalation costs are not included. A construction schedule is not available at this time. Contingency is an allowance for the net sum of costs that will be in the Final Total Project Cost at the time of completion of design, but are not included at this level of project definition. **The estimated accuracy range for the Total Project Cost as the project is defined is -25% to +40%.** The accuracy range is based on professional judgement considering the level of design completed, the complexity of the project and the uncertainties in the project as scoped. **The contingency and the accuracy range are not intended to include costs for future scope changes that are not part of the project as currently scoped or costs for risk contingency.** Operation and Maintenance costs are not included.

Conclusions

The proposed project, concentrating on the local drainage area, shows very promising results for both reducing impacts to Brown's Creek (pollutants, thermal) and St. Croix River (pollutants), as well as offsetting some of the groundwater pumping for irrigation by the Oak Glen Golf Course. The results provided in the summary tables likely represent an upper end of the potential of the system and is the best estimate that can be provided with the available information. Some additional data can be collected during the next design phase, such as bathymetry of the wetland.

Monitoring data for another season (& with the breach repaired) at the outlet from the wetland to Brown's Creek will also provide more information on the dynamics of the system.

Assumptions such as losses to evaporation and ET, along with considerations of flow from McKusick Lake and seepage, should be included in further analysis. Further refinement of the water level manipulations via the outlet control structure (thus storage in the wetland for irrigation) must be balanced with wetland management goals as well as the water levels relatively to Co. Rd. 64/McKusick Rd. With on-going discussions with wetland regulators and the county highway department, the larger retention scenarios (e.g., Scenario 3) are likely difficult to attain, and thus 90+% is likely very optimistic. The Scenarios 1 and 2 are more realistic in the 70% volume and nutrient reductions, as well as 70% irrigation groundwater pumping reductions. This is due to the large storage potential in the wetland, even with small vertical water level changes. Some analysis with different bathymetry provided results in the range of 50% reductions (volume, nutrient, and irrigation off-set), and wetland bathymetry is still an area where additional information should be collected.

In summary, the following are conclusions that support the District moving forward with the project to final design and to utilize the available grant funding.

1. The project is very effective at reducing impacts to Brown's Creek by diverting very nutrient-enriched and warm runoff from the existing wetland, with reductions in runoff volume and phosphorus in the range of 50-70%.
2. Groundwater pumping at the OGGC can be reduced by using diverted runoff in the range of 50-70%, thus providing a more resilient water source for the golf course, while also potentially providing benefits of more groundwater available for baseflow to Brown's Creek.
3. Due to various constraints (wetland management and road flooding), Scenario #2 should be pursued as the preferred design.