FERRIC CHLORIDE WATER TREATMENT FACILITY
2018 ANNUAL REPORT

NPDES/SDS PERMIT NO: MN0067377

Mailed to:
Submittals Center
Minnesota Pollution Control Agency
520 Lafayette Road North
Saint Paul, MN 55155

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PRIOR LAKE – SPRING LAKE
WATERSHED DISTRICT

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BACKGROUND

Spring Lake is a recreational lake located in central Scott County, Minnesota. The lake is listed on the State Impaired Waters List as impaired for aquatic recreation due to excess nutrients. Monitoring completed by the Prior Lake-Spring Lake Watershed District (PLSLWD) in the 1990's identified phosphorus as the nutrient most contributing to water quality impairment and algae blooms. That study also noted that a significant portion of the phosphorus entering Spring Lake was in the form of dissolved phosphorus (soluble reactive phosphorus, or SRP) thus making it readily available for algal uptake. Spring Lake flows directly into Upper Prior Lake, which is also listed as impaired due to excess nutrients.

The treatment system involves the injection of 32.5% liquid $FeCl_3$ solution into a stormwater pond, or desiltation basin. The iron within the $FeCl_3$ binds with the dissolved phosphorus in the water and creates colloidal particles (floc) which settle at the bottom of the basin. The treated water then flows downstream into Spring Lake.

FIGURE 1 FERRIC CHLORIDE SHED AND WEIR

In 1998, the PLSLWD constructed the ferric chloride ($FeCl_3$) treatment system to precipitate SRP out of stormwater from County Ditch 13, the main inflow to Spring Lake. The system was constructed as part of a Minnesota Pollution Control Agency (MPCA) Clean Water Partnership Implementation Project. The treatment system began operating under a permit from the Department of Natural Resources. In 2004, the treatment system permit was renewed as a National Pollutant Discharge Elimination System permit administered by the MPCA. The District applied to the MPCA for a renewed permit in 2009. That permit was approved in 2012. However, the system did not operate in 2011 or 2012 because it no longer met the requirements of the permit. During this time, the District was working toward a design that would meet requirements of the new MPCA permit. The old system injected $FeCl_3$ directly into the channel immediately downstream of the Ferric Chloride weir on the south side of Highway 13 where it would mix until reaching the desiltation pond.

In July 2013, the treatment facility began operating again after it was retrofitted to meet new MPCA permit requirements. The new design transfers $FeCl_3$ underground for 900 feet from the treatment building through a

double walled pipe to a culvert north of Highway 13 that flows directly into the desiltation basin. The new design addresses the previous concerns of the MPCA by avoiding direct discharge into a water of the state, and instead, goes directly into a stormwater pond.

FIGURE 2 BYPASS WEIR

The retrofit project was designed by consultants Bolton and Menk, Inc. and installed by S.M. Hentges & Sons, Inc. The new design allowed for more water to be treated as compared to the old system. With the old system, high flows could resuspend phosphorus-iron flocculants within the basin and flush the flocculent downstream and into Spring Lake. The new system was designed to overtop a bypass weir (and flow around the desiltation basin) before the flows reached a point of resuspension in the pond. This allows for the maximum amount of phosphorus to be treated without resuspending the material in the desiltation basin. Staff reviewed the project design and confirmed it was operating as designed.

FIGURE 3 AERIAL MAP OF FERRIC CHLORIDE TREATMENT SYSTEM

OPERATIONS AND MAINTENANCE

Access is needed to the Desilt pond outlet and injection site. A grass path to the outlet of the Desilt pond was regularly mowed by the homeowner, Gary Stevens. When the water level of the outlet was low enough, he voluntarily drove his lawnmower across the outlet and mowed a path from the outlet of the Desilt pond to the injection site at the berm. When water conditions were too high, staff weed whipped a path to the injection site.

FIGURE 4 WEED WHIPPED PATH FROM DESILT POND OUTLET TO INJECTION SITE

The Scott County Highway department cleared brush and mowed the edges of the driveway to the Ferric Chloride shed. Mowing and clearing is necessary for the Ferric Chloride delivery truck to have a clear path to the shed and to reduce encroachment on the driveway. In 2015, the Highway Department delivered and spread gravel on the driveway to the shed, as well as part of the driveway to the Geis' household, to sustain the weight of the delivery truck. Scott County Highway Department completed this work at no cost to the District for either labor or material.

City of Prior Lake staff (Public Works Water Department) helps PLSLWD staff maintain the pump, hoses, and injection site every year. Each spring, City staff inspects the pump and hoses, replaces old and worn parts, re-installs the injector, starts the pump, and ensures proper pumping. In fall, the City staff winterizes the facility by purging the ferric line to prevent freezing and removes, cleans, and stores the injector in a City facility over-winter.

Other routine maintenance by PLSLWD staff included cleaning the staff gauge, removing debris from the Ferric Chloride and bypass weir, installing snowmobile signs, downloading and calibrating the ultrasonic distance sensor, inspecting the facility 3 times per week, taking flow measurements and weekly samples, and cleaning in and around the shed.

Prior to September 11, 2018 the pump was manually programmed to dose a specified amount of ferric chloride. On September 11, the pump was programmed (with help from Matt Backus at Vessco) to dose ferric chloride based on a relationship with stream height. The maximum dose rate of treatment is 4 gallons per hour at 0.50 feet of depth over the ferric chloride weir. Over 0.50 feet of depth, the pump will continue dosing at 4 gallons per hour based on maximum flow calculations of the desilt pond diversion culvert.

FIGURE 5 FERRIC CHLORIDE DELIVERY TRUCK

FERRIC USAGE

The tank contained 3,700 gallons at the beginning of the season and 1,350 gallons were left in the tank at the end of the season. Only one shipment of Ferric Chloride occurred in 2018 on July 18, totaling 3500 gallons. A total of 5,250 gallons of Ferric Chloride treated the stream before it reached Spring Lake.

FIGURE 6 TANK OVERFILL

During the July 18 delivery, the tank was accidentally overfilled by approximately 40 gallons. All of the ferric chloride was held in the secondary containment with no release into the environment, however the Duty Officer was called to report the spill. The ferric chloride was ordered from Hawkins and delivered by Wayne Transports. Nobody was there during the delivery except the truck driver. The most likely reason for the overfill was not because too much ferric was ordered, but because a burst of air cleans out the lines after the tank has been filled and that probably displaced the ferric enough to overtop the tank. Neither Hawkins or Wayne Transports took responsibility for the clean-up, so PLSLWD hired Mid-America to do the cleanup for $3,847. More information on this spill is documented in a memo to file titled "2018 Ferric Tank Overfill."

FUTURE MAINTENANCE

Carp have been observed in the wetland adjacent to the Ferric Chloride shed (Highway 13 Wetland) and the water has become noticeably more turbid in the past few years (visually and in the data). The turbid water could be a sign of carp infestation which could have been caused by missing tines in the fish barrier on the weir. In 2018, WSB

Consulting estimated 1,452±615 carp are living in the pond, equating to a biomass of 198±61 pounds per acre. Because the current fish barrier is missing tines and inoperable, an engineer at WSB Consulting designed a new concept for the fish barrier. Another option includes an electric barrier immediately downstream of the weir. These options will be further evaluated and if funding is available, construction for a carp barrier may take place in 2019.

The Ferric Chloride weir is also showing signs of age. Repair is anticipated to take place in 2019 to address the cracks, loose boards, and unstable railings.

FIGURE 7 FERRIC CHLORIDE WEIR AND FISH BARRIER

DESILT POND

The desilt pond needs to be cleaned out (dredged) when the pond starts filling up with sediment. In 2016, a company called Platypus mapped the bathymetry of the pond using a remote-control boat and the District's BioBase software. The pond was found to be about 7-8 feet deep in the middle and many years away from needing to be dredged. Vegetation density and bottom hardness are also simultaneously mapped and available upon request. The bathymetry map is shown below.

The last time the pond was dredged was 2012 and it was dredged down to 902 feet in mean sea level. During the time of mapping in 2016, the pond bottom was about 903.5'. As storage volume is reduced, the detention time for settling and pollutant removal efficiency is reduced. Once the pond bottom nears 908', the pond should be dredged again.

Some historic pond dredging and survey information is summarized here:

1978: Desilt pond constructed with a bottom elevation of 902.5', and an outlet elevation of 910.3'
1998: Desilt pond bottom surveyed at 907.8'
1999: Pond was dredged to an elevation of 902.5'
2005: Pond bottom surveyed at 904.5'
2010: Pond bottom surveyed at 906.5'
2012: Pond was dredged to 902.0' (as-built survey available)
2016: Pond mapped by Platypus and estimated to be 903.5' using BioBase software

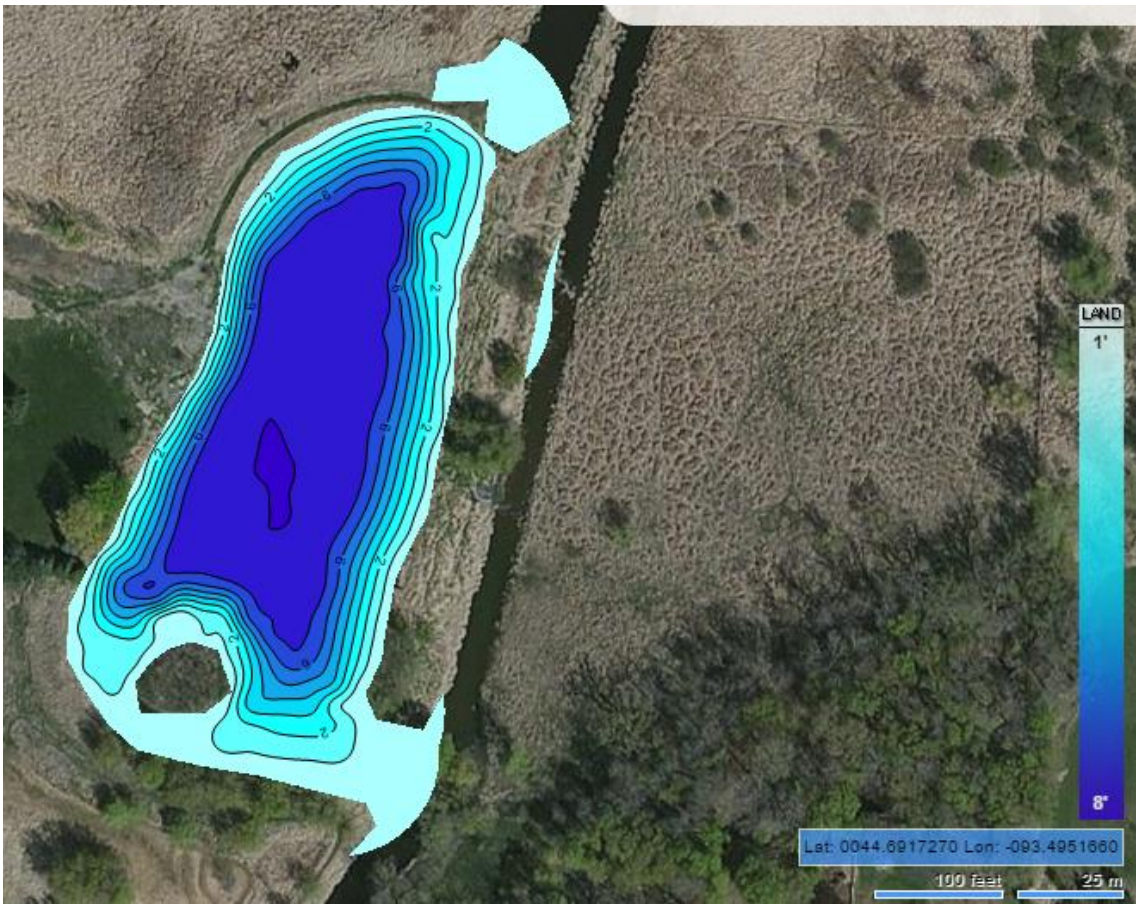


FIGURE 8 BATHYMETRIC MAP CREATED USING BIOBASE SOFTWARE AND PLATYPUS BOAT

RESULTS

During operation in 2018, the system treated approximately 1,614 million gallons (MG) of ditch water. The system reduced the average concentration of Total Phosphorus (TP) by 0.071 mg/L (31%) and removed a calculated 465 pounds of total phosphorus. The concentration of dissolved phosphorus (also referred to as SRP or Soluble Reactive Phosphorus) was reduced by an average of 0.054 mg/L (58%) and approximately 616 pounds of SRP were removed from the system.

TABLE 1 – PHOSPHORUS CONCENTRATIONS AND PERCENT REMOVAL (NEGATIVE VALUES INDICATE A REDUCTION)

	Before Treatment (SW001) Monthly Mean		After Treatment (SD002) Monthly Mean		% Change after Treatment	
Month	**Total Phosphorous (mg/l)**	**SRP (mg/l)**	**Total Phosphorous (mg/l)**	**SRP (mg/l)**	**Total Phosphorous (mg/l)**	**SRP (mg/l)**
April	0.189	0.089	0.189	0.042	0%	-53%
May	0.198	0.040	0.09	0.017	-55%	-58%
June	0.23	0.121	0.266	0.069	16%	-43%
July	0.198	0.044	0.137	0.028	-31%	-36%
August	0.364	0.153	0.188	0.032	-48%	-79%
September	0.399	0.158	0.185	0.04	-54%	-75%
October	0.149	0.097	0.119	0.055	-20%	-43%
November	0.077	0.039	0.064	0.026	-17%	-33%
Average 2018	**0.226**	**.093**	**0.155**	**0.039**	**-31%**	**-58%**

TABLE 2 SUMMARY OF PHOSPHORUS REMOVALS SINCE 2011

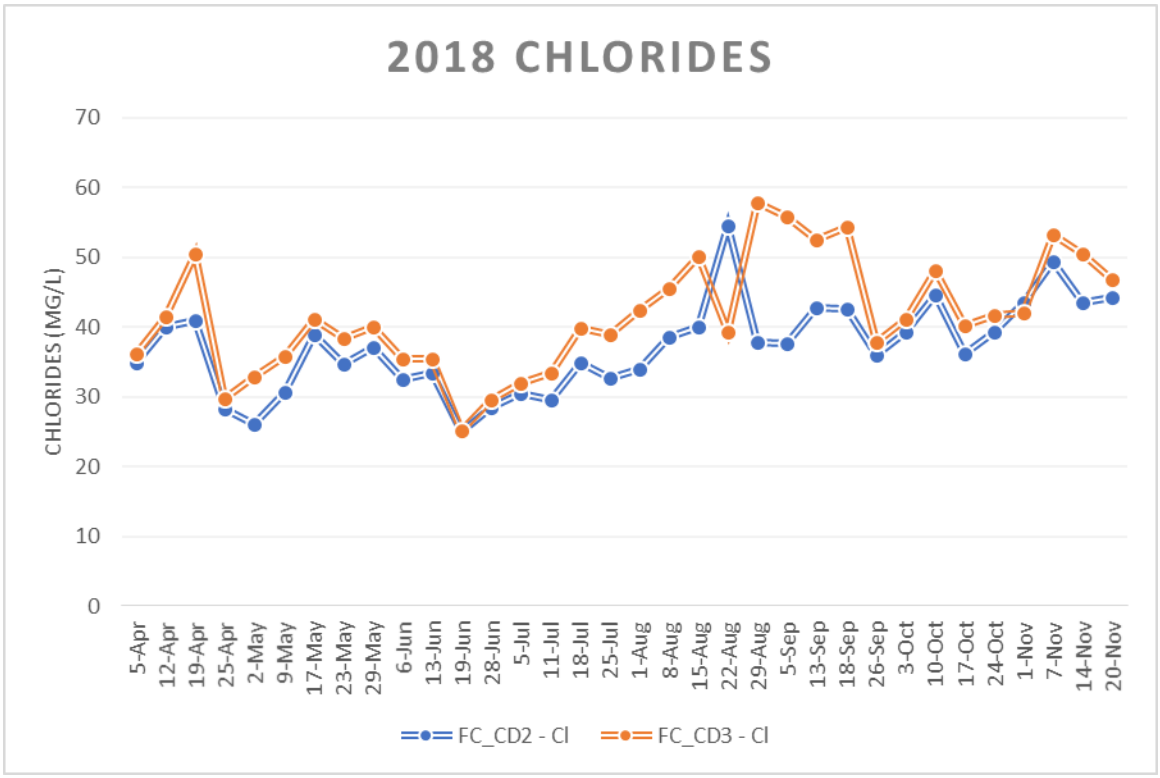
Year	Lbs P Removed	Lbs SRP Removed	% TP Reduction	% SRP Reduction	MG of Water Treated	Notes
2011	N/A	N/A	14% while treating; 1% with no treatment	54% while treating; 5% with no treatment	N/A	Only 30 days total treatment in 2011.
2012	N/A	N/A	12% (no treatment)	7% (no treatment)	N/A	No Treatment this year
2013	449	323	47% (while treating)	56% (while treating)	635	Only 2 months treated
2014	550	752	43%	72%	959	Treatment Apr 1 - Oct 31
2015	402	103	48%	51%	348	Treatment Apr 1 – Oct 31
2016	578	323	36%	64%	1327	Treatment Mar 11 – Nov 10
2017	534	240	35%	58%	938	Treatment Mar 5 – Nov 30
2018	465	616	31%	58%	1614	Treatment April 1-Nov 20

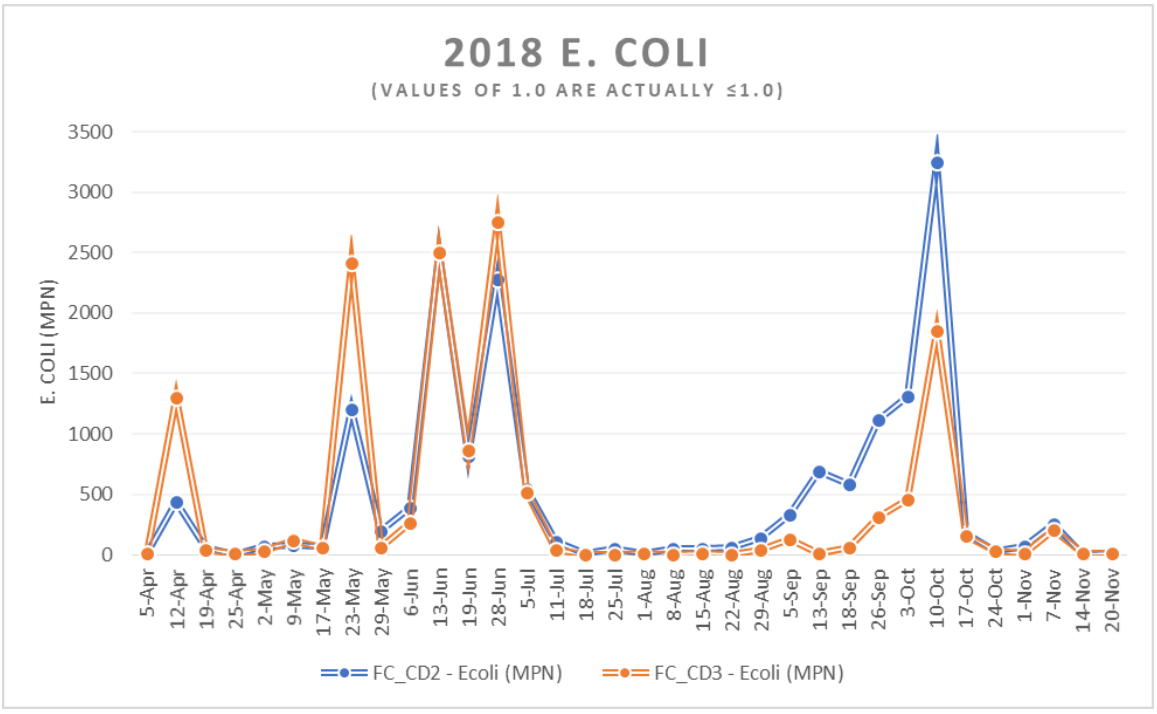
Table 3 Phosphorus Load Reductions

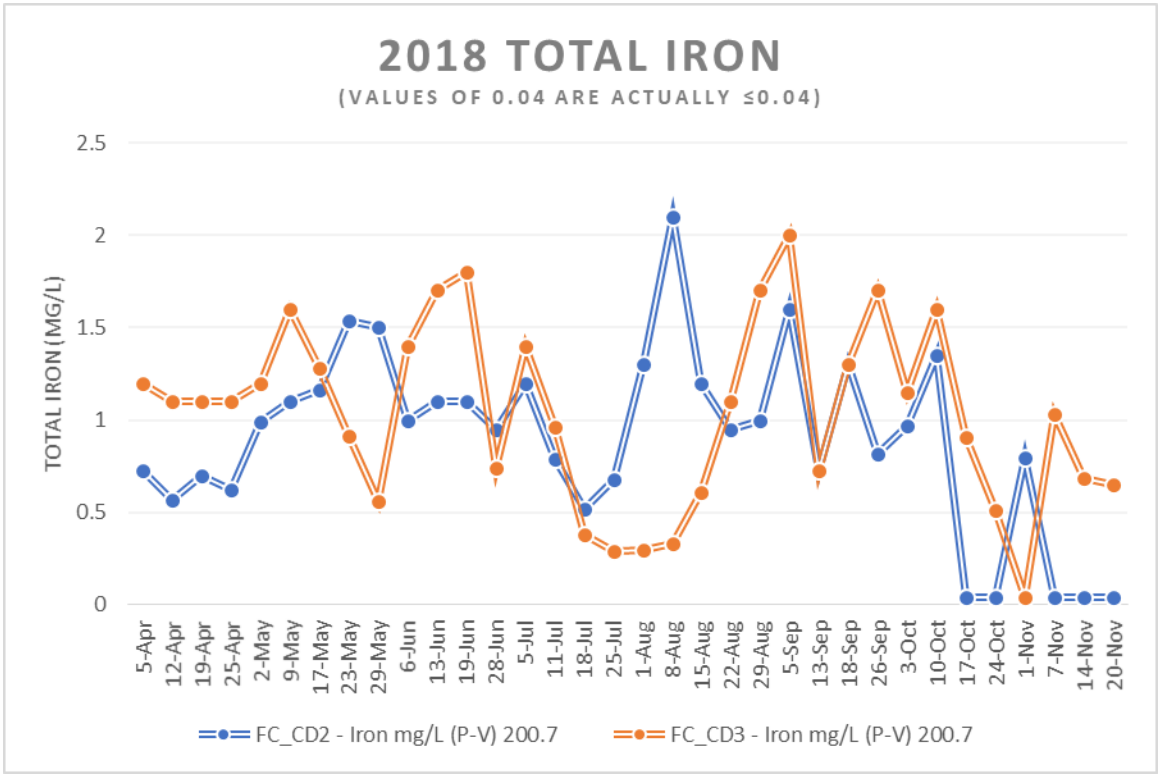
		SW-001	SD-002
April	Average SRP (mg/L)	0.089	0.042
	Average TP (mg/L)	0.189	0.189
	Treated Water (MG)		335.0
	SRP Load Reduction (pounds)		131.3
	TP Load Reduction (pounds)		0.0
May	Average SRP (mg/L)	0.04	0.017
	Average TP (mg/L)	0.198	0.090
	Treated Water (MG)		226.0
	SRP Load Reduction (pounds)		43.4
	TP Load Reduction (pounds)		203.6
June	Average SRP (mg/L)	0.121	0.069
	Average TP (mg/L)	0.23	0.266
	Treated Water (MG)		443.0
	SRP Load Reduction (pounds)		192.1
	TP Load Reduction (pounds)		-133.0
July	Average SRP (mg/L)	0.044	0.028
	Average TP (mg/L)	0.198	0.137
	Treated Water (MG)		142.0
	SRP Load Reduction (pounds)		18.9
	TP Load Reduction (pounds)		72.2
August	Average SRP (mg/L)	0.153	0.032
	Average TP (mg/L)	0.364	0.188
	Treated Water (MG)		29.0
	SRP Load Reduction (pounds)		29.3
	TP Load Reduction (pounds)		42.6
September	Average SRP (mg/L)	0.158	0.0
	Average TP (mg/L)	0.399	0.2
	Treated Water (MG)		122.0
	SRP Load Reduction (pounds)		120.1
	TP Load Reduction (pounds)		217.7
October	Average SRP (mg/L)	0.097	0.055
	Average TP (mg/L)	0.149	0.119
	Treated Water (MG)		193.0
	SRP Load Reduction (pounds)		67.6
	TP Load Reduction (pounds)		48.3
November	Average SRP (mg/L)	0.039	0.026
	Average TP (mg/L)	0.077	0.064
	Treated Water (MG)		124.0
	SRP Load Reduction (pounds)		13.4
	TP Load Reduction (pounds)		13.4
Total	**Total Treated Water (million gallons)**		1614
	Total SRP Load Reduction (pounds)		616
	Total TP Load Reduction (pounds)		465

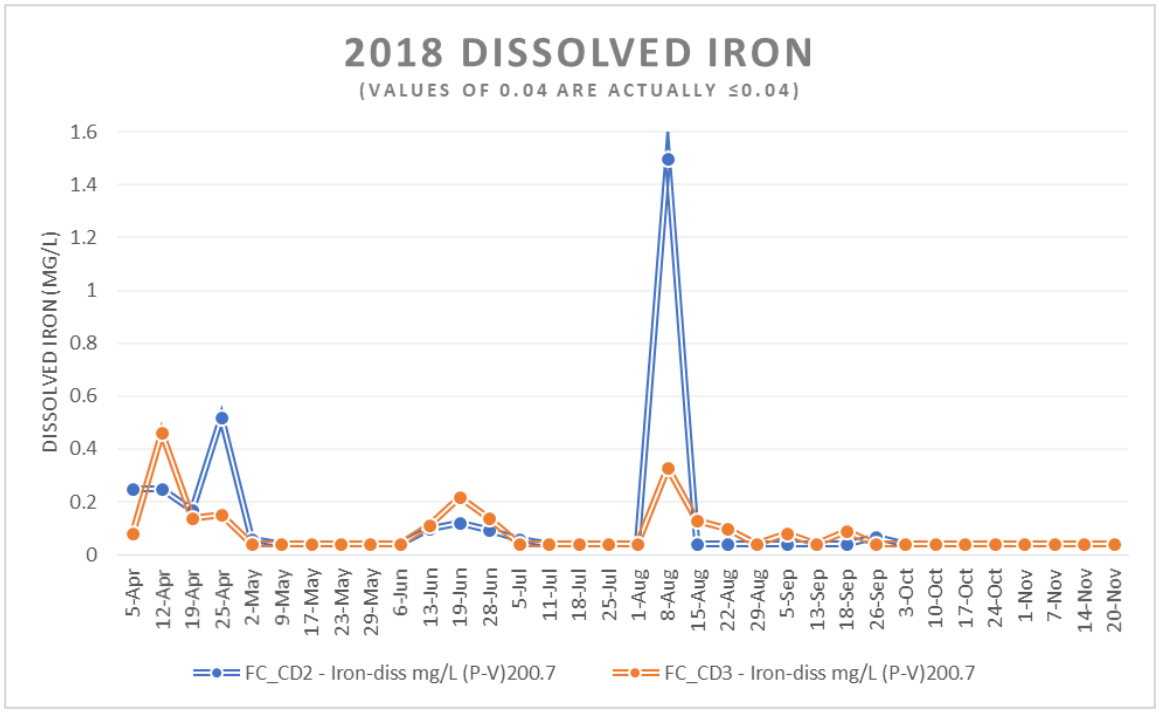
GRAPHS

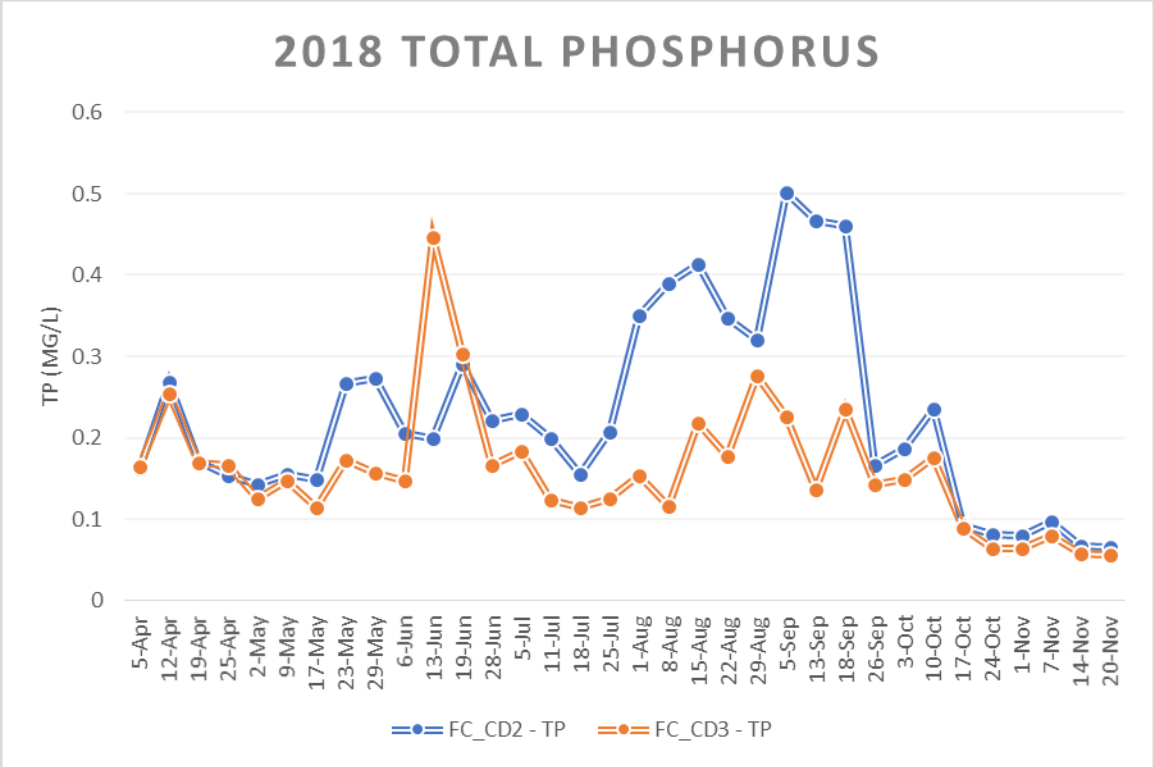
The following graphs display the monthly mean of samples taken in 2018, before treatment at site SW-001 (FC_CD2) and after treatment, at SD-002 (FC_CD3). Treatment began on April 1 and treated continuously until November 20. During that time, samples were taken once per week.

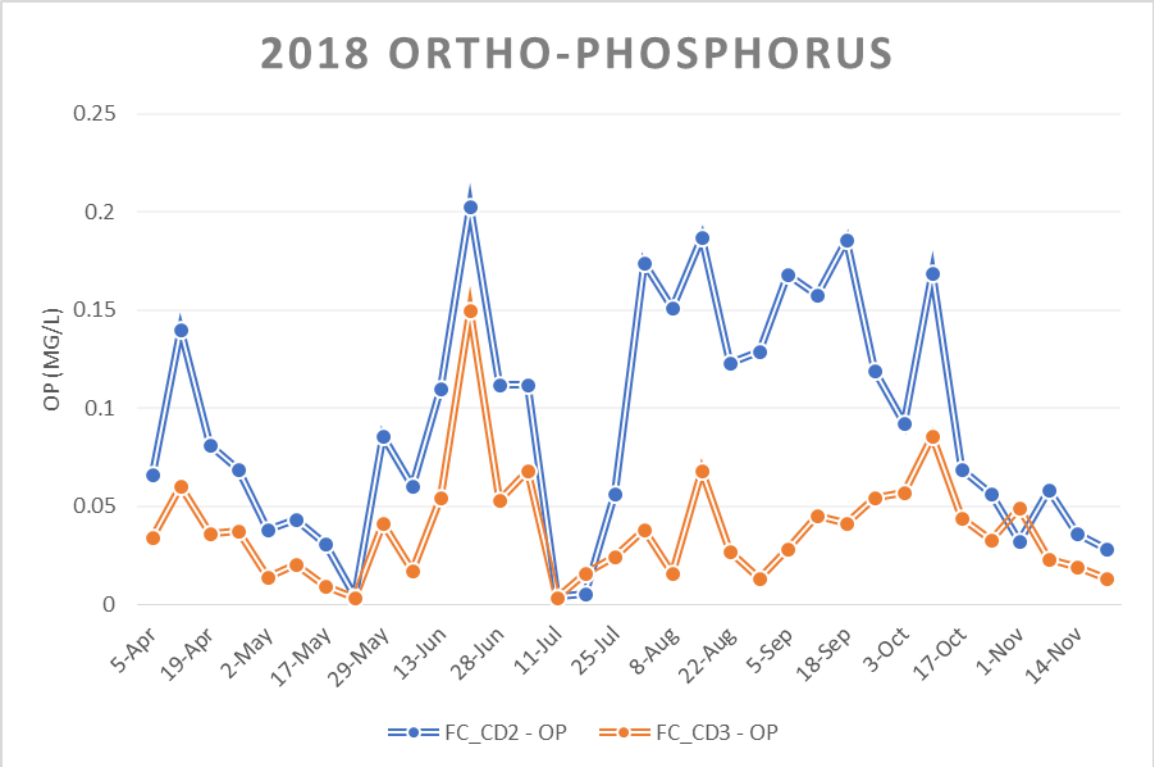


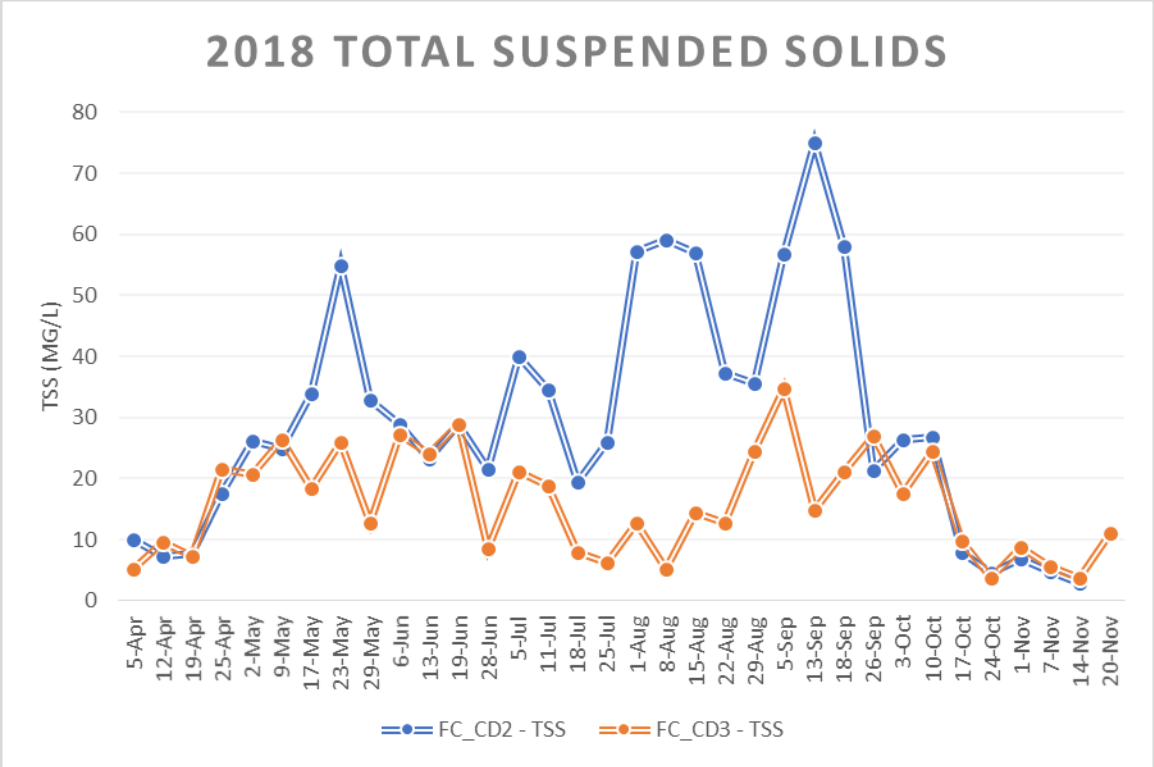


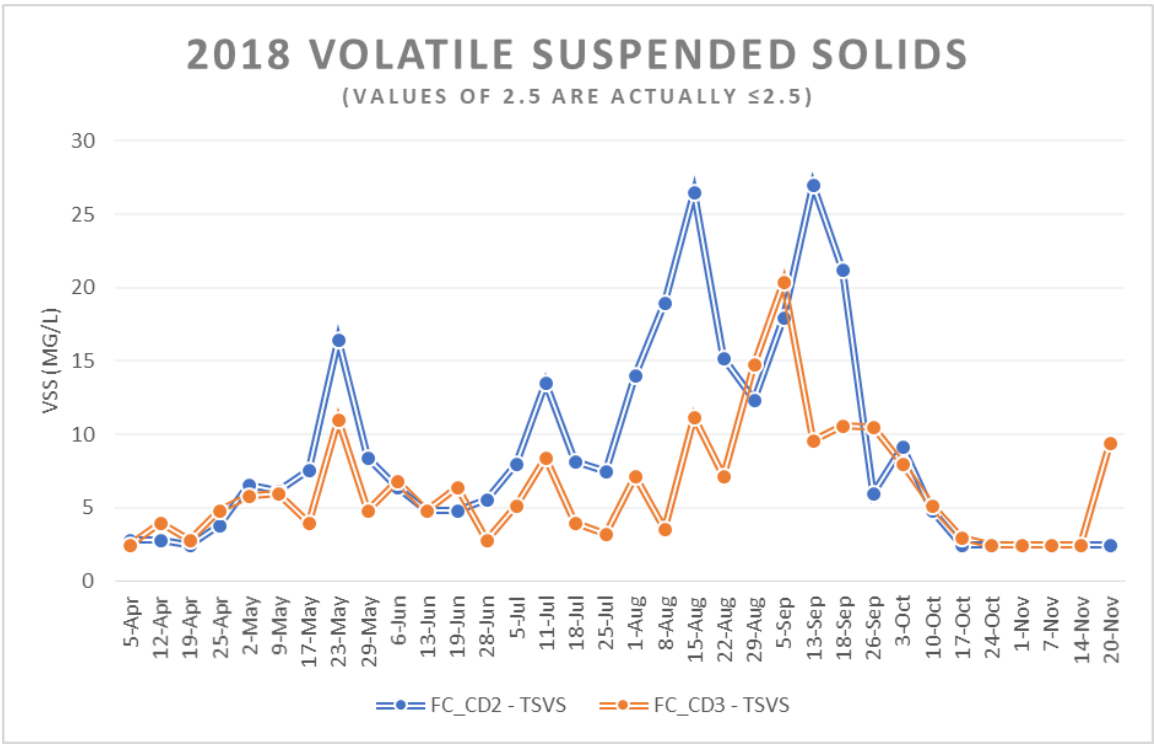

2018 TOTAL IRON
(VALUES OF 0.04 ARE ACTUALLY ≤0.04)
TOTAL IRON (MG/L)
2.5
2
1.5
1
0.5
0
5-Apr
12-Apr
19-Apr
25-Apr
2-May
9-May
17-May
23-May
29-May
6-Jun
13-Jun
19-Jun
28-Jun
5-Jul
11-Jul
18-Jul
25-Jul
1-Aug
8-Aug
15-Aug
22-Aug
29-Aug
5-Sep
13-Sep
18-Sep
26-Sep
3-Oct
10-Oct
17-Oct
24-Oct
1-Nov
7-Nov
14-Nov
20-Nov
FC_CD2 - Iron mg/L (P-V) 200.7
FC_CD3 - Iron mg/L (P-V) 200.7

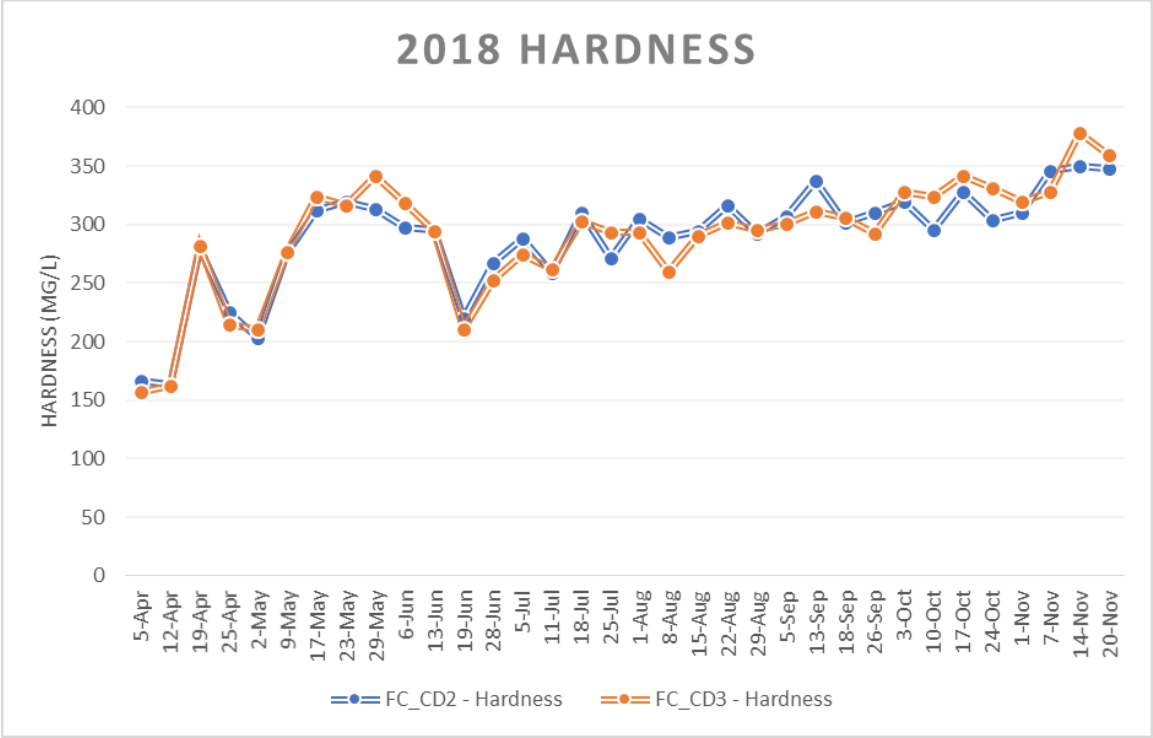

2018 DISSOLVED IRON
(VALUES OF 0.04 ARE ACTUALLY ≤0.04)
DISSOLVED IRON (MG/L)
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
5-Apr
12-Apr
19-Apr
25-Apr
2-May
9-May
17-May
23-May
29-May
6-Jun
13-Jun
19-Jun
28-Jun
5-Jul
11-Jul
18-Jul
25-Jul
1-Aug
8-Aug
15-Aug
22-Aug
29-Aug
5-Sep
13-Sep
18-Sep
26-Sep
3-Oct
10-Oct
17-Oct
24-Oct
1-Nov
7-Nov
14-Nov
20-Nov
FC_CD2 - Iron-diss mg/L (P-V)200.7
FC_CD3 - Iron-diss mg/L (P-V)200.7

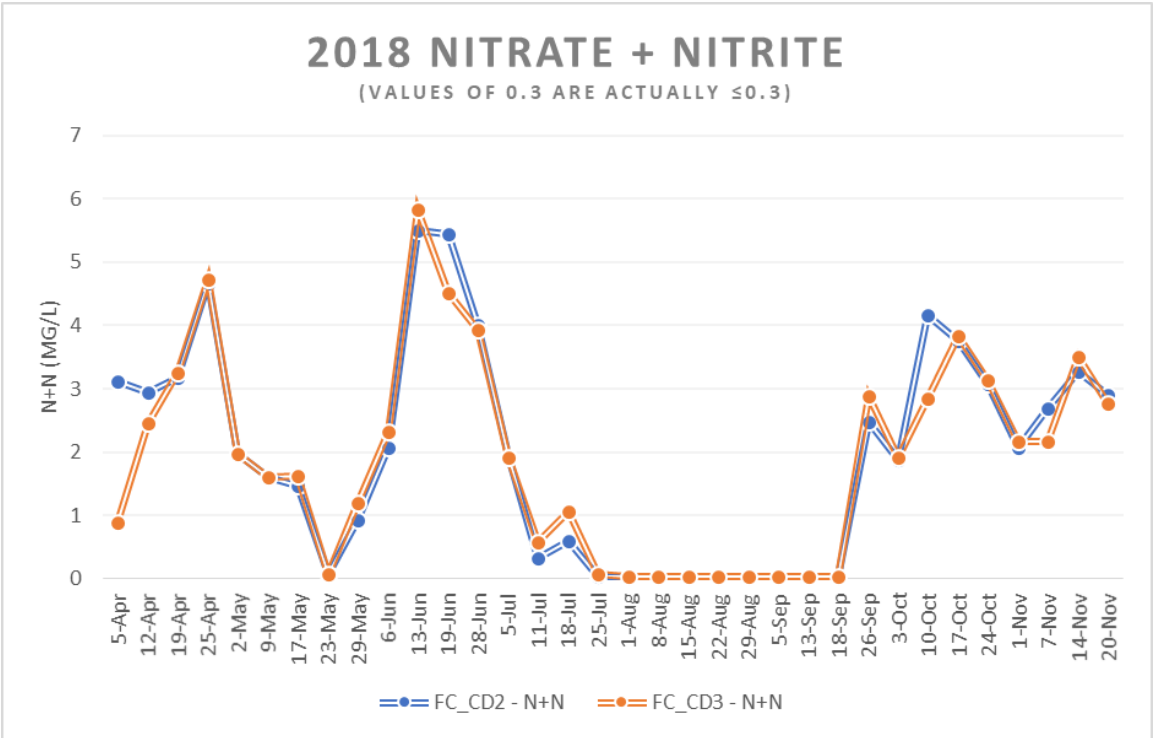

2018 TOTAL PHOSPHORUS
TP (MG/L)
0.6
0.5
0.4
0.3
0.2
0.1
0
5-Apr
12-Apr
19-Apr
25-Apr
2-May
9-May
17-May
23-May
29-May
6-Jun
13-Jun
19-Jun
28-Jun
5-Jul
11-Jul
18-Jul
25-Jul
1-Aug
8-Aug
15-Aug
22-Aug
29-Aug
5-Sep
13-Sep
18-Sep
26-Sep
3-Oct
10-Oct
17-Oct
24-Oct
1-Nov
7-Nov
14-Nov
20-Nov
FC_CD2 - TP
FC_CD3 - TP

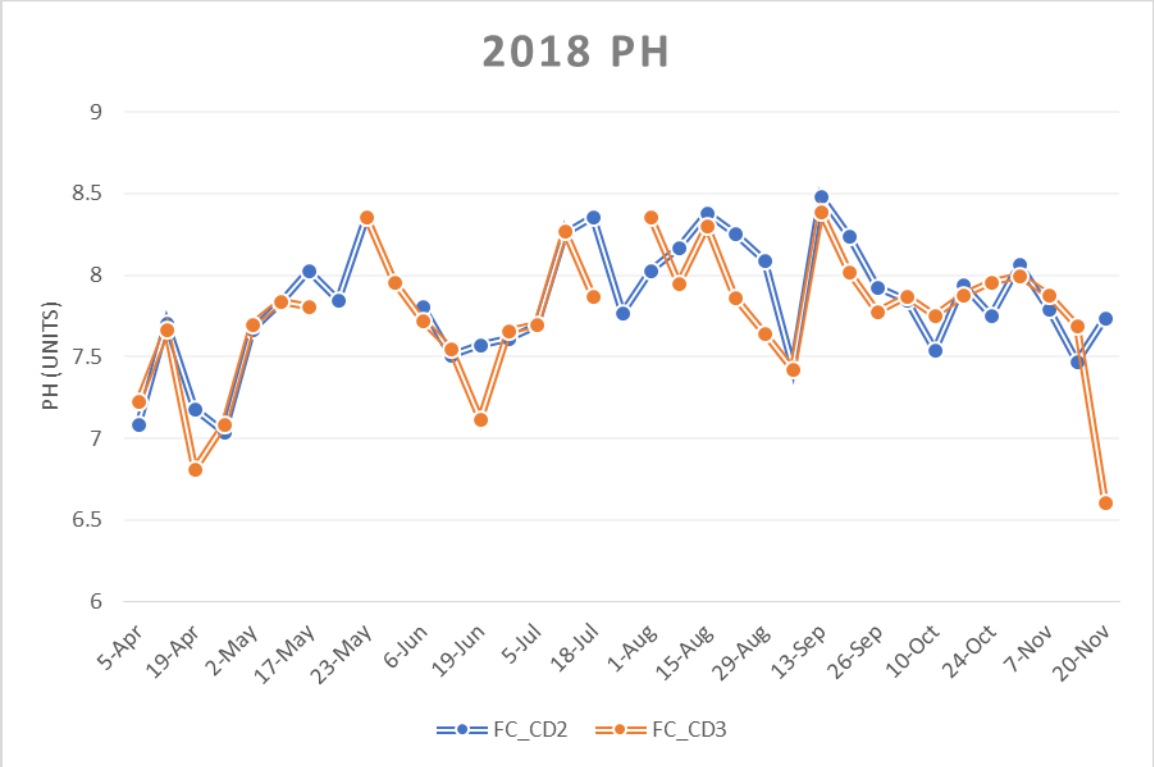

2018 ORTHO-PHOSPHORUS
OP (MG/L)
0.25
0.2
0.15
0.1
0.05
0
5-Apr
19-Apr
2-May
17-May
29-May
13-Jun
28-Jun
11-Jul
25-Jul
8-Aug
22-Aug
5-Sep
18-Sep
3-Oct
17-Oct
1-Nov
14-Nov
FC_CD2 - OP
FC_CD3 - OP


2018 TOTAL SUSPENDED SOLIDS
TSS (MG/L)
80
70
60
50
40
30
20
10
0
5-Apr
12-Apr
19-Apr
25-Apr
2-May
9-May
17-May
23-May
29-May
6-Jun
13-Jun
19-Jun
28-Jun
5-Jul
11-Jul
18-Jul
25-Jul
1-Aug
8-Aug
15-Aug
22-Aug
29-Aug
5-Sep
13-Sep
18-Sep
26-Sep
3-Oct
10-Oct
17-Oct
24-Oct
1-Nov
7-Nov
14-Nov
20-Nov
FC_CD2 - TSS
FC_CD3 - TSS


2018 VOLATILE SUSPENDED SOLIDS
(VALUES OF 2.5 ARE ACTUALLY ≤2.5)
VSS (MG/L)
30
25
20
15
10
5
0
5-Apr
12-Apr
19-Apr
25-Apr
2-May
9-May
17-May
23-May
29-May
6-Jun
13-Jun
19-Jun
28-Jun
5-Jul
11-Jul
18-Jul
25-Jul
1-Aug
8-Aug
15-Aug
22-Aug
29-Aug
5-Sep
13-Sep
18-Sep
26-Sep
3-Oct
10-Oct
17-Oct
24-Oct
1-Nov
7-Nov
14-Nov
20-Nov
FC_CD2 - TSVS
FC_CD3 - TSVS


2018 HARDNESS
HARDNESS (MG/L)
400
350
300
250
200
150
100
50
0
5-Apr
12-Apr
19-Apr
25-Apr
2-May
9-May
17-May
23-May
29-May
6-Jun
13-Jun
19-Jun
28-Jun
5-Jul
11-Jul
18-Jul
25-Jul
1-Aug
8-Aug
15-Aug
22-Aug
29-Aug
5-Sep
13-Sep
18-Sep
26-Sep
3-Oct
10-Oct
17-Oct
24-Oct
1-Nov
7-Nov
14-Nov
20-Nov
FC_CD2 - Hardness
FC_CD3 - Hardness


2018 NITRATE + NITRITE
(VALUES OF 0.3 ARE ACTUALLY ≤0.3)
N+N (MG/L)
7
6
5
4
3
2
1
0
5-Apr
12-Apr
19-Apr
25-Apr
2-May
9-May
17-May
23-May
29-May
6-Jun
13-Jun
19-Jun
28-Jun
5-Jul
11-Jul
18-Jul
25-Jul
1-Aug
8-Aug
15-Aug
22-Aug
29-Aug
5-Sep
13-Sep
18-Sep
26-Sep
3-Oct
10-Oct
17-Oct
24-Oct
1-Nov
7-Nov
14-Nov
20-Nov
FC_CD2 - N+N
FC_CD3 - N+N


2018 PH
PH (UNITS)
9
8.5
8
7.5
7
6.5
6
5-Apr
19-Apr
2-May
17-May
23-May
6-Jun
19-Jun
5-Jul
18-Jul
1-Aug
15-Aug
29-Aug
13-Sep
26-Sep
10-Oct
24-Oct
7-Nov
20-Nov
FC_CD2
FC_CD3