2018 Water Quality Report

Prepared for the City of Plymouth

Prepared by: Three Rivers Park District
DEPARTMENT OF WATER RESOURCES

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1.0 INTRODUCTION

This report summarizes the water quality monitoring conducted by the Three Rivers Park District Water Resources Department for the City of Plymouth during the 2018 calendar year. Ten stormwater sites, two lake sites, and a rain garden were monitored.

In this report, each watershed has several sections including:

- **Watershed:** has an overview description of the watershed, map of stormwater monitoring sites with watershed boundary, and a list of any water quality impairments
- **Stormwater Monitoring:** has monitoring location descriptions and a summary of the monitored watershed acres and impervious acres
    - **Measured Flow:** has a graph showing daily flow during the monitoring season at the monitoring site along with precipitation
    - **Concentrations:** has the average concentrations of all the samples collected and includes a discussion
    - **Loading:** has a summary of the annual load estimates (lbs/year), flow-weighted concentrations, annual flow estimate, and the unit area loads (lbs/acre) for each parameter since monitoring began.
- **Lakes:** has a map showing the watershed and key watershed features
    - **Phosphorus, secchi and Chlorophyll-a:** reports values and how values relate to MPCA standards
    - **Sonde results:** readings of dissolved oxygen, temperature, specific conductivity and pH with depth
    - **Concentrations**: Summarizes the average concentrations at the surface, middle and bottom of the lake
    - **Discussion:** provides a discussion of the lake results

2.0 PRECIPITATION

Precipitation data was collected using a tipping bucket rain gauge located at the City of Plymouth Water facility on Zachary Lane between County Road 9 and Old Rockford Road. Typically, the rain gauge at the City of Plymouth maintenance facility off Fernbrook Lane is used, but there was a clog for much of July and August that skewed readings. From 1/1/2018-4/18/2018 and again from 11/1/2018-12/31/2018, the City of Plymouth tipping buckets did not seem to perform as well in capturing precipitation in the form of snow, so data from the Minneapolis airport rain gauge as reported by NOAA (National Oceanic and Atmospheric Administration) were utilized.

During the monitoring period of April 23rd to October 25th, there were 20.92 inches of rain which accounted for 68% of the total 30.84 inches of precipitation for the calendar year. Typically, the monitoring period represents about 70-80% of the total precipitation. The 2018 total precipitation was just a little over the 19 year average of 29.8 inches at the City of Plymouth rain gauge.

The largest single day precipitation event occurred on 9/20/2018 when 2.47 inches of rain fell. This was part of the year's largest event when 3.86 inches fell over a four-day period from 9/17 to 9/20.

3.0 MONITORING METHODS

Stormwater

Each site was equipped to measure water flow using ISCO flow meters and to take water samples during storm events using ISCO automated samplers. In addition, water samples were taken on a bi-weekly basis to characterize base flow conditions. Stormwater sites were monitored from mid-April to the end of October.

Water samples were analyzed at Three Rivers Park District's certified laboratory for Total Phosphorus (TP), Soluble Reactive Phosphorus (SRP), Total Nitrogen (TN), Total Suspended Solids (TSS), and, at select sites, Chlorides (Cl^-).

To estimate monitoring site loading, the U.S. Army Corps of Engineer's FLUX model version 3.35 was used (Soballe, 2007). The sampling period loading is dependent upon the nutrient concentrations and the sampling period flow. The sampling period loading is extrapolated to the yearly load based on precipitation. The unit area loads (UAL) are determined by converting

the yearly loading to a per acre ratio. The UAL can then be compared to the MPCA Stormwater Manual (MPCA, 2017) typical unit area loads for TP and TSS based on land use (Table 3.1 and Table 3.2).

Table 3.1 MPCA Stormwater manual typical values for Total Phosphorus unit area loads by land use and common range of runoff concentrations by land use (MPCA, 2017).

Typical Total Phosphorus values as stated in the MN Stormwater Manual				
Land Use	Unit Area Loads (lbs/ac)	Median Concentration (mg/L)	Minimum Concentration (mg/L)	Maximum Concentration (mg/L)
Residential	1.35	0.26	< 0.01	19.90
Commercial	2.25	0.20	< 0.01	4.27
Industrial	--	0.23	< 0.02	7.90
Freeway	3.50	--	--	--
Open Space	--	0.13	< 0.01	0.76

Table 3.2 MPCA Stormwater manual typical values for Total Suspended Sediments unit area loads by land use and common range of runoff concentrations by land use (MPCA, 2017).

Typical Total Suspended Solids values as stated in the MN Stormwater Manual				
Land Use	Unit Area Loads (lbs/ac)	Median Concentration (mg/L)	Minimum Concentration (mg/L)	Maximum Concentration (mg/L)
Residential	76	58	< 0.5	4,168
Mixed Residential	111	--	--	--
Commercial	221	52	< 0.5	2,385
Industrial	193	75	< 1	2,490
Freeway	560	--	--	--
Open Space	35	58	< 1	4,168

Lake

The sampling protocols of the U.S. Environmental Protection Agencies Field Operations Manual (2007) were followed. Lakes were monitored bi-weekly from May through September. Pre and post stratification samples were conducted in May and October. Sampling occurred at the deepest portion of the lake. Sampling included: YSI EXO sonde measurements of temperature, dissolved oxygen, specific conductivity and pH at one-meter intervals, secchi disk water clarity measurements, and water samples at three points in the water column. The surface composite

water sample was collected using a two-meter PVC tube with an inside diameter of 3.2 cm. A Kemmerer sampler was used to collect samples at the top of the hypolimnion and within one meter of the lake bottom.

Water samples were analyzed at Three Rivers Park Districts' certified laboratory for: Total Phosphorus (TP), Soluble Reactive Phosphorus (SRP), Total Nitrogen (TN), Chlorophyll-A (Chl-a) and, at select sites, Chlorides (Cl^-). The Standard Methods for the examination of Water and Wastewater 22nd edition (2011) were followed.

To assess the lake data, concentrations were compared to Minnesota Pollution Control Agency (MPCA) standards (MN 7050.0222) and the lake water quality grading system set by the Met Council (MC). The MPCA has set state nutrient standards for deep and shallow lakes based on the ecoregion the lake is located within (Figure 3.1). Hennepin County lies within the North Central Hardwood Forest Ecoregion. The MC has determined a grading system of lake water quality by assessing the average concentrations of TP, Chl-a, and secchi readings in a season (Figure 3.2).

Ecoregion	TP (µg/L)	chl-*a* (µg/L)	Secchi (m)
Northern Lakes and Forest – Lake trout (Class 2A)	< 12	< 3	> 4.8
Northern Lakes and Forest – Stream trout (Class 2A)	< 20	< 6	> 2.5
Northern Lakes and Forest – Aquatic Rec. Use (Class 2B)	< 30	< 9	> 2.0
North Central Hardwood Forest – Stream trout (Class 2A)	< 20	< 6	> 2.5
North Central Hardwood Forest – Aq. Rec. Use (Class 2B)	< 40	< 14	> 1.4
North Central Hardwood Forest – Aq. Rec. Use (Class 2B) Shallow lakes	< 60	< 20	> 1.0
Western Corn Belt Plains & Northern Glaciated Plains – Aq. Rec. Use (Class 2B)	< 65	< 22	> 0.9
Western Corn Belt Plains & Northern Glaciated Plains – Aq. Rec. Use (Class 2B) Shallow lakes	< 90	< 30	> 0.7

Guidance Manual for Assessing the Quality of Minnesota Surface Waters — Minnesota Pollution Control Agency, December 2016

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Figure 3.1 MPCA lake eutrophication water quality standards for aquatic recreational use – all of the city of Plymouth and Hennepin County lie within the North Central Hardwood Forest ecoregion

WATER QUALITY GRADING SYSTEM				
Grade	Total Phosphorus (ug/l)	Chlorophyll -a (ug/l)	Secchi Depth (m)	(ft)
A	<23	<10	>3	>9.8
B	23-32	10-20	2.2-3.0	7.2-9.8
C	32-68	20-48	1.2-2.2	3.9-7.2
D	68-152	48-77	0.7-1.2	2.3-3.9
F	>152	>77	<0.7	<2.3

Figure 3.2 Met Council water quality grading system (Metropolitan Council 2016 Lake Water Quality Summary)

3.1. Parkers Lake Watershed

The Parkers Lake Watershed is 1,150 acres and is located entirely within the City of Plymouth. Two stormwater tributaries to Parker's Lake were monitored at sites PL1 and PL2 (Figure 3.1.1). The two monitoring sites capture almost 40% of the watershed area contributing to Parkers Lake. Parkers Lake has been listed as impaired for Chlorides since 2014.

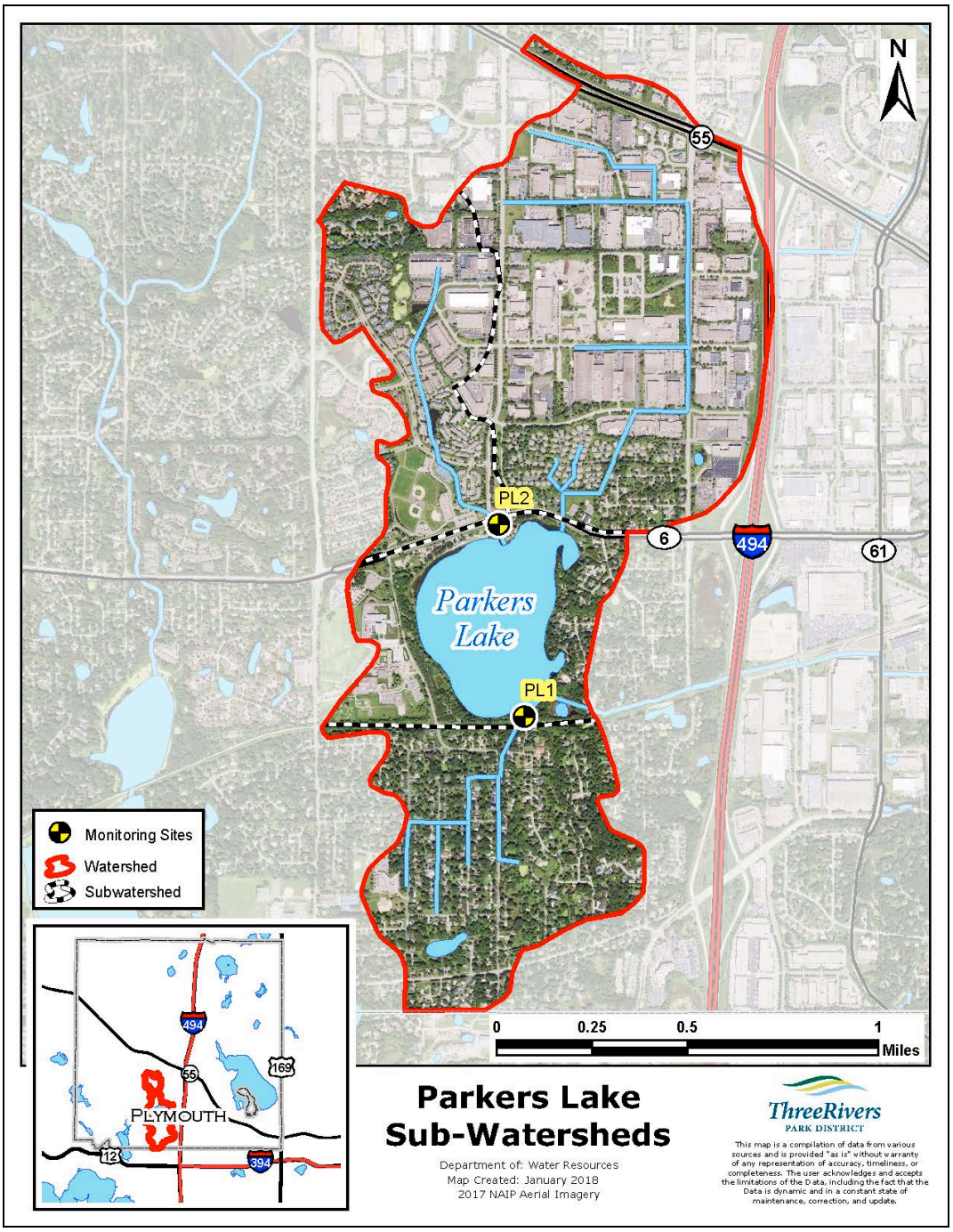


Figure 3.1.1 Parkers Lake sub-watershed map

3.1.1. Stormwater Monitoring Sites

Each of the monitored sites has a 48 inch round stormwater culvert. Site PL1 (Parkers Lake site 1) monitors 258 acres and is located on the south side of the lake off the north side of the Luce Line State Trail. The watershed is about 19% impervious and primarily residential land use. Site PL2 (Parkers Lake site 2) is smaller than PL1 and monitors 189 acres. This site is located on the northwest portion of the lake, west of the public boat access. Site PL2 monitors a watershed that is about 49% impervious and the land use is primarily multi-family residential and industrial (Table 3.1.1).

Table 3.1.1 Summary of watershed characteristics for sites PL1 and PL2

Site	*Subwatershed Area (acres)*	*% impervious (acres)[1]*	*% of Parkers Lake Watershed*	*Dominant land uses[2]*
PL1	258	19% (48 ac.)	22%	Residential
PL2	189	49% (92 ac.)	16%	Multi-family Residential, Industrial

[1] % impervious area determined using the 2016 University of Minnesota TCMA 1-meter land cover classification GIS layer

[2] Dominant Land Uses determined using GIS layer obtained from the City of Plymouth

3.1.2. Measured Flow

Both Parkers Lake sites, PL1 and PL2, respond quickly to precipitation intensity and duration since the watersheds are small and developed. Even though PL2 has a smaller watershed than PL1, the watershed soils, slopes, and impervious areas cause there to be more runoff resulting in higher flows at the PL2 site compared to the PL1 site. At the PL1 monitoring site, there is intermittent flow only in response to rain events (Figure 3.1.2). The PL1 watershed has less impervious area along with sandier soils and flatter topography which allows for more rainfall infiltration and less stream flow. The PL2 monitoring site typically has a base flow but during longer periods without rain, the site can have very little to no flow (Figure 3.1.3). The PL2 watershed has steep elevation changes and more impervious area which leads to more flow.

The largest daily flow pulses for both sites occurred during the late September precipitation events of 3.84 inches. The four days of rain culminated with peak flows at both sites on September 20th. At PL1 the combined storms led to a daily average flow pulse of 1.91 cfs while at PL2 the daily average flow pulse was 9.71 cfs.

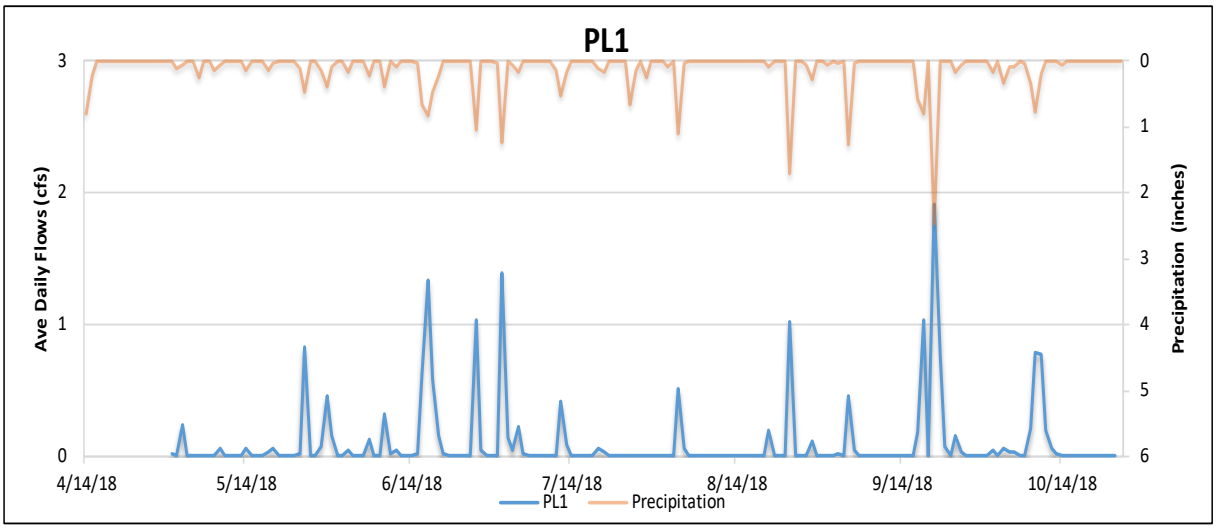


Figure 3.1.2 Average daily flow for Parkers Lake site 1 (PL1)

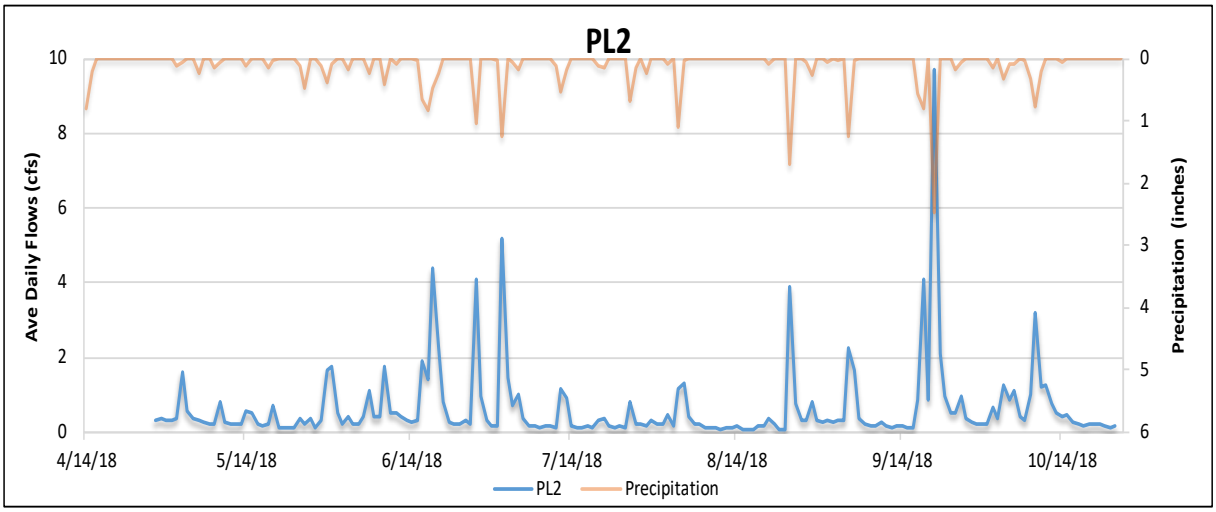


Figure 3.1.3 Average daily flow for Parkers Lake site 2 (PL2)

3.1.3. Concentrations

At PL1, 12 water samples were collected over the season. Typically, more water samples are collected at this location in a year, but due to equipment issues, there were a limited number of samples. Since this site is typically dry, samples are usually collected by an automated sampler during runoff events. However, due to sampler issues, four grab samples were collected during events to supplement the automated samples. At PL2, 27 water samples were collected over the season. Twelve were grab samples and the other 15 were automated composite samples.

Concentrations of TP, SRP and TN were almost double at PL1 compared to PL2. This could be due to dilution at PL2 since it has higher flows. The TSS was 3 times higher at PL2 compared to PL1. The chloride concentrations were 3 times higher at PL2 compared to PL1, which may be due to the higher percentage of impervious area that receives salt during the winter leading to higher concentrations of chlorides. The highest concentrations of chlorides were in May. On average, the SRP made up 43% of the TP at PL1 and at PL2, on average, the SRP made up 40% of the TP (Table 3.1.2 and Figure 3.1.4).

Table 3.1.2 Summary of average, minimum and maximum concentrations for TP, SRP, TN, TSS and Cl at PL1 and PL2

Site	Avg TP (min-max) µg/L	Avg SRP (min-max) µg/L	Avg TN (min-max) mg/L	Avg TSS (min-max) mg/L	Avg Cl (min-max) mg/L
PL1	361 (167 - 868)	155 (68 - 307)	2.2 (1.0 - 4.7)	18.0 (4.2 - 70.0)	54 (8 - 367)
PL2	198 (68 - 512)	79 (15 - 191)	1.5 (0.8 - 8.5)	58.9 (0.4 - 429.0)	172 (62 - 455)

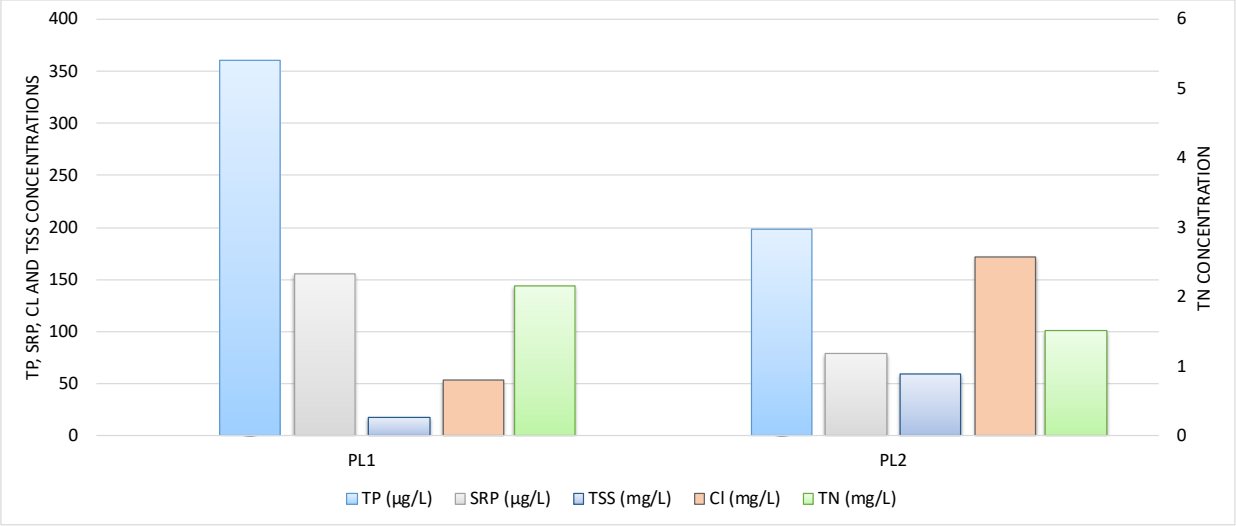


Figure 3.1.4 Histogram of average TP, SRP, TN, TSS and Cl concentrations for PL1 and PL2

3.1.4. Loading

The loading at PL1 is at 3 to 7 times lower (depending on parameter) than the loading at PL2 due to the lower amount of water flowing through the culverts. PL1 has almost seven times less water than at PL2, so even though the concentrations of the parameters are higher at PL1, the overall loading is much less.

PL1

At PL1, data has been collected since 2000. In 2005, there was an installation of ponds and curbs in the watershed. The data in Table 3.1.3 is segmented to reflect the concentrations and loading before and after the installation of the ponds and curbs. The curbs affected runoff by not allowing water to run into ditches and infiltrate. The average flows increased by 80%, while the concentrations had little change, which caused an average increase of 57% in phosphorus loading and an average increase of 97% in nitrogen loading. The ponds seemed to allow sediment settling since there was a 44% reduction in the average TSS concentration that led to an 11% decrease in average TSS loading. In 2018, the concentrations and loadings were within 20% of the 2006-2018 averages for all the parameters except for TSS. The TSS concentration was about half the average concentration thereby making the loading lower.

In 2018, the chloride concentration was two to four times higher than the concentrations from 2013 to 2016, but similar to 2017 concentrations (Table 3.1.4). Typically, the higher chloride concentrations in runoff are in April and May when there may still be road salt that can be washed into the streams. The timing and intensity of the April/May storms seems to be the main driver of the loading that occurs for the watershed each year.

The unit area loads (UAL) by year for PL1 are listed in Table 3.1.5. The average TP UAL of 0.13 lbs/acre is lower than the MPCA Stormwater manual residential UAL of 1.35 lbs/acre. The TSS UAL was below the MPCA Stormwater manual UAL of 77 lbs/acre for residential land in 13 of the 15 monitored years.

Table 3.1.3 Loading and flow weighted concentrations for TP, SRP, TN and TSS at PL1. The data is segmented based on the before and after of the installation of a pond and curbs. The % change compares the average loadings and concentrations before and after restoration work

PL1 - Parkers Lake - Site 1										
Year	Nutrient Loading				Nutrient Concentration				Flow Volume (x 10^6 M^3)	Annual Precipitation (inches)
	TP (lbs/yr)	SRP (lbs/yr)	TN (lbs/yr)	TSS (lbs/yr)	TP (µg/L)	SRP (µg/L)	TN (mg/L)	TSS (mg/L)		
Data Collected before Installation of Water Quality Pond and Curb/Gutter										
2000	6	2	42	1,304	243	89	1.50	48	0.01	32.3
2001	11	6	58	1,392	293	157	1.60	39	0.01	34.6
2002	40	16	225	11,365	318	124	1.80	91	0.05	38.1
2003	39	21	215	12,139	308	165	1.70	95	0.06	25.8
2004	23	14	140	5,531	272	138	1.40	62	0.04	32.1
2005	35	10	230	23,196	377	108	2.60	252	0.04	32.6
Average	26	12	152	9,155	302	130	1.77	98	0.04	32.6
Data Collected after Installation of Water Quality Pond and Curb/Gutter										
2006	27	12	119	10,003	343	169	1.50	126	0.04	29.1
2007	22	8	136	4,419	232	82	1.40	47	0.04	31.1
2009	22	15	75	1,246	291	191	1.00	17	0.03	19.6
2013	49	23	392	10,663	248	119	1.98	54	0.09	31.6
2014	63	37	763	18,517	264	132	2.71	66	0.13	27.5
2015	34	12	241	6,536	302	107	2.15	58	0.04	29.1
2016	59	21	389	10,125	296	103	1.96	51	0.08	38.6
2017	41	17	286	8,269	269	110	1.87	54	0.07	27.8
2018	46	18	290	3,243	321	125	2.02	23	0.06	30.8
Average	40	18	299	8,113	285	126	1.84	55	0.07	29.5
% Change	57	57	97	-11	-6	-3	4	-44	80	-10

Table 3.1.4 Loading and flow weighted concentration of chlorides at PL1 and PL2

Year	PL1		PL2	
	Chloride		Chloride	
	Loading (lbs/Yr)	Concentration (mg/L)	Loading (lbs/Yr)	Concentration (mg/L)
2013	3,239	16.4	105,991	123
2014	1,158	9.1	55,650	103
2015	1,052	9.4	161,814	120
2016	1,797	8.3	66,855	68.1
2017	4,904	32.0	122,460	105
2018	4,701	33.1	138,692	153

Table 3.1.5 Unit area loads for TP, SRP, TN, TSS and Chlorides at PL1

PL1 - Parkers Lake - Site 1					
Year	Load/Acre				
	TP (lbs/acre)	SRP (lbs/acre)	TN (lbs/acre)	TSS (lbs/acre)	Cl (lbs/acre)
2000	0.02	0.01	0.16	5	
2001	0.04	0.02	0.22	5	
2002	0.16	0.06	0.87	44	
2003	0.15	0.08	0.83	47	
2004	0.09	0.05	0.54	21	
2005	0.14	0.04	0.89	90	
2006	0.10	0.05	0.46	39	
2007	0.09	0.03	0.53	17	
2009	0.09	0.06	0.29	5	
2013	0.19	0.09	1.52	41	12.6
2014	0.24	0.14	2.96	72	4.5
2015	0.13	0.05	0.93	25	4.1
2016	0.23	0.08	1.51	39	7.0
2017	0.16	0.07	1.11	32	19.0
2018	0.18	0.07	1.12	13	18.2
Average	0.13	0.06	0.93	33	10.9

PL2

The PL2 site was monitored from 2000-2008 and commenced again from 2013-2018. Comparing the average data between the two monitoring periods, all parameters increased in loading and concentration. There was an increase in flow of about 36%, even though there was very little difference in the average precipitation (Table 3.1.6). Along with the increased flow, there was about a 21% increase in TP and SRP concentrations, a slight increase in TN concentrations and a 41% increase in TSS concentration. The combination of flow and concentration increases led to a 52-67% increase in average loadings for all of the parameters. In 2018, the concentrations and loadings of TP, SRP, TN and TSS were lower than the average concentrations and loadings from 2013 to 2018, while the 2018 chloride concentration was the highest it has been since monitoring began in 2013 (Table 3.1.4).

The unit area loads (UAL) by year are listed in Table 3.1.7. At PL2, the overall average TP UAL of 0.80 lbs/acre and the 2018 UAL of 0.89 lbs/acre are lower than the MPCA Stormwater manual residential UAL of 1.35 lbs/acre. The average TSS UAL of 240 lbs/acre and the 2018 UAL of 199 lbs/acre are much higher than the MPCA Stormwater manual mixed residential UAL of 111 lbs/acre and higher than the UAL for Industrial landuse of 193 lbs/acre. Since this watershed is about 30% industrial and 49% mixed residential (47% multi-family and 3% single family), the TSS loading is still higher than the typical loading for these land uses.

Table 3.1.6 Loading and flow weighted concentrations of TP, SRP, TN and TSS at PL2. Data is segmented by a break in data collection from 2009-2012.

PL2 - Parkers Lake - Site 2										
Year	Nutrient Loading				Nutrient Concentration				Flow Volume (x 106 M3)	Annual Precipitation (inches)
	TP (lbs/yr)	SRP (lbs/yr)	TN (lbs/yr)	TSS (lbs/yr)	TP (µg/L)	SRP (µg/L)	TN (mg/L)	TSS (mg/L)		
2000-2008										
2000	18	5	219	2,459	125	39	1.50	17	0.06	32.3
2001	125	43	1,132	24,170	160	56	1.50	31	0.33	34.6
2002	124	36	1,217	45,038	148	143	1.40	54	0.36	38.1
2003	80	42	882	31,784	121	63	1.30	48	0.30	25.8
2004	117	45	1,131	33,485	136	53	1.30	39	0.39	32.1
2005	126	50	1,243	40,351	125	50	1.20	40	0.45	32.6
2006	176	54	1,632	33,941	153	47	1.40	30	0.52	29.1
2007	255	118	1,780	107,627	239	110	1.70	101	0.48	31.1
2008	48	7	392	2,901	277	39	2.28	17	0.08	20.8
Average	119	44	1,070	35,751	165	67	1.51	42	0.33	30.7
2013-2018										
2013	145	73	1,299	50,840	169	85	1.51	59	0.39	31.6
2014	182	100	1,980	73,498	152	84	1.66	62	0.54	27.5
2015	221	85	1,776	68,765	234	90	1.88	73	0.42	29.1
2016	262	95	1,648	65,665	272	99	1.71	67	0.44	38.6
2017	219	72	1,716	61,684	188	62	1.48	53	0.49	27.8
2018	169	59	1,363	37,574	187	65	1.51	42	0.41	30.8
Average	200	81	1,630	59,671	200	81	1.62	59	0.45	30.9
% Change	68	81	52	67	21	21	8	41	36	0.63

Table 3.1.7 Unit area loading for TP, SRP, TN, TSS and Chlorides for PL2

PL2 - Parkers Lake - Site 2					
Year	Load/Acre				
	TP (lbs/acre)	SRP (lbs/acre)	TN (lbs/acre)	TSS (lbs/acre)	Cl (lbs/acre)
2000	0.10	0.03	1.16	13	
2001	0.66	0.23	5.99	128	
2002	0.66	0.19	6.44	238	
2003	0.42	0.22	4.67	168	
2004	0.62	0.24	5.98	177	
2005	0.67	0.26	6.58	213	
2006	0.93	0.29	8.63	180	
2007	1.35	0.62	9.42	569	
2008	0.25	0.04	2.07	15	
2013	0.77	0.39	6.87	269	561
2014	0.96	0.53	10.48	389	294
2015	1.17	0.45	9.40	364	856
2016	1.39	0.50	8.72	347	354
2017	1.16	0.38	9.08	326	648
2018	0.89	0.31	7.21	199	734
Average	0.80	0.31	6.85	240	574

3.2. Medicine Lake Watershed

The Medicine lake watershed is 11,666 acres that consists of several municipalities. Most of the watershed resides in the City of Plymouth (10,268 acres). The City of Plymouth contracted TRPD to monitor three sites that drain directly to Medicine Lake as well as two sites that drain to Parkers Lake. These monitoring sites account for 56% of the watershed drainage acreage to Medicine Lake (Figure 3.2.1). Medicine Lake has been classified as impaired for excess nutrients since 2004. Plymouth Creek was classified as impaired for Chlorides and *E. Coli* in 2014.

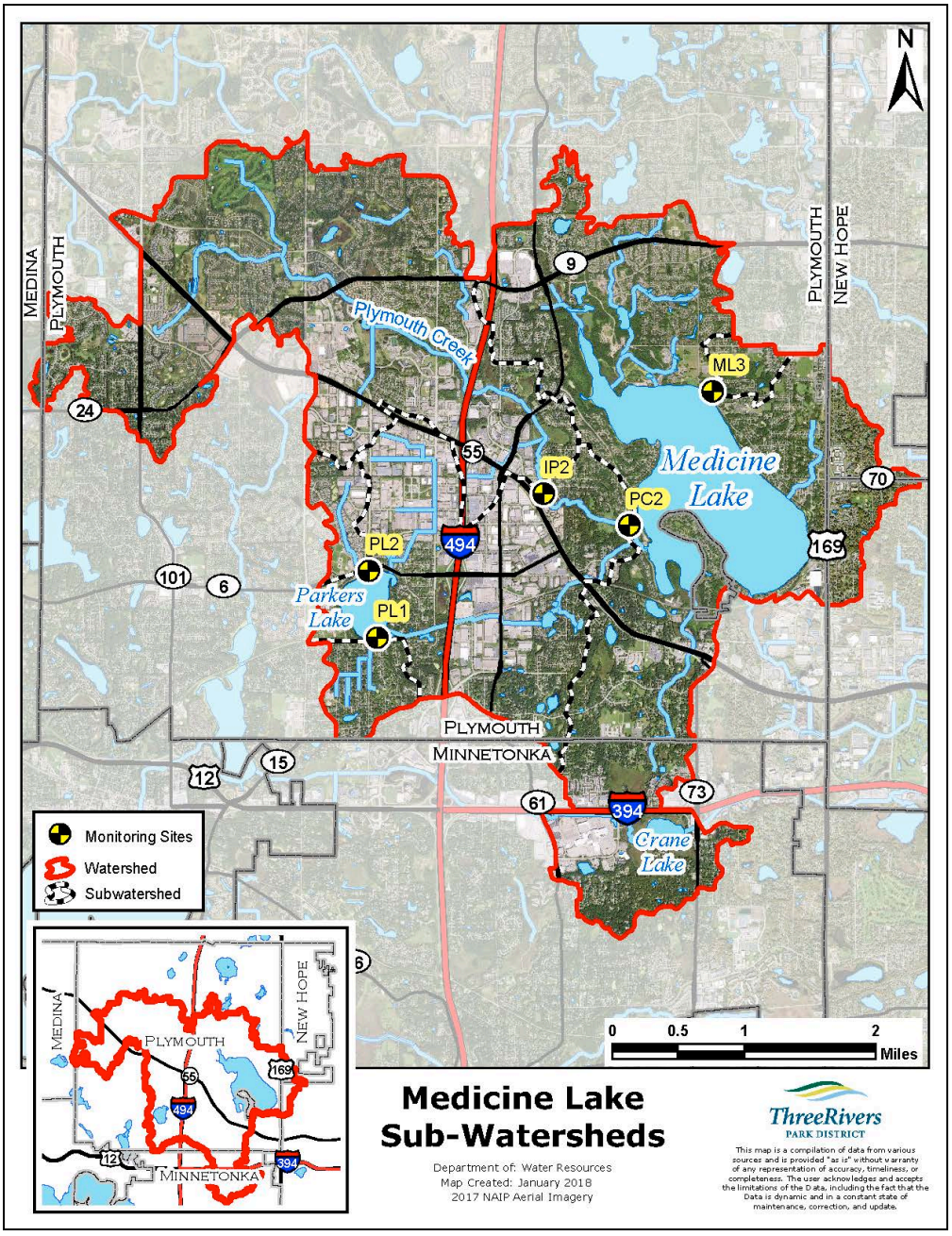


Figure 3.2.1 Medicine Lake sub-watershed map

3.2.1. Stormwater Monitoring Sites

Two stormwater sites were monitored in 2018. IP2 (Industrial Park site 2) and PC2 (Plymouth Creek Site 2) are on the west side of Medicine Lake along Plymouth Creek.

The IP2 monitoring site is located at a 14 foot wide weir structure on Plymouth Creek behind an industrial building (12940 Teakwood Ln N) approximately ¼ mile northeast of the intersection of Highway 55 and Industrial Park Boulevard. The site has a sub-watershed acreage of 3,725 which makes up 32% of the Medicine Lake watershed in Plymouth. This site monitors the nutrient loading from the upstream portions of Plymouth Creek prior to discharging into a wetland complex that flows to Medicine Lake. The watershed is about 34% impervious and primarily residential land use (Table 3.2.1).

The PC2 monitoring site is the furthest downstream sampling site on Plymouth Creek and is at the outlet to Medicine Lake. The site is located downstream of IP2 and includes the drainage coming from Parkers Lake. The site is an open channel located downstream of a detention pond where Plymouth Creek intersects Medicine Lake Drive West. The watershed is 6,390 acres and accounts for 55% of the Medicine Lake watershed in the City of Plymouth. Two detention ponds were constructed from 2009-2010 to reduce nutrient loading and a stream restoration project occurred from 2010 through 2011. The watershed is 37% impervious and primarily residential and commercial land uses (Table 3.2.1).

Table 3.2.1 Summary of watershed characteristics for sites IP2, PC2 and ML3

Site	*Subwatershed Area (acres)*	*% impervious (acres)*[1]	*% of Medicine Lake Watershed*	*Dominant land uses*[2]
IP2	3,725	34% (1,279 ac.)	32%	Residential
PC2	6,390	37% (2,363 ac.)	55%	Residential, commercial

[1] % impervious area determined using the 2016 University of Minnesota TCMA 1-meter land cover classification GIS layer

[2] Dominant Land Uses determined using GIS layer obtained from the City of Plymouth

3.2.2. Measured Flow

With IP2 monitoring a 3,725 acre watershed that has several large wetlands in the watershed, there is a lag time before the flow pulse after a precipitation event. There is a lag time at downstream PC2 also since the watershed is larger and has detention ponds. The flow at IP2 can be higher than the flow at downstream PC2 due to the constructed retention ponds and wetland areas that increase infiltration and evapotranspiration along with providing storage

between IP2 and PC2. The falling limbs of the hydrographs at PC2 are more drawn out than at IP2 due to the lake effect caused by proximity to Medicine Lake.

For each site, different storm events caused the largest flow pulse. For IP2, the largest average daily flow pulse of 60 cfs occurred on Sept 21st after the cumulative precipitation events from Sept 17-20th of 3.86 inches of rain (Figure 3.2.2). PC2 had its largest flow pulse on October 10th with 67 cfs after 3 days of precipitation led to 1.3 inches of rain (Figure 3.2.2).

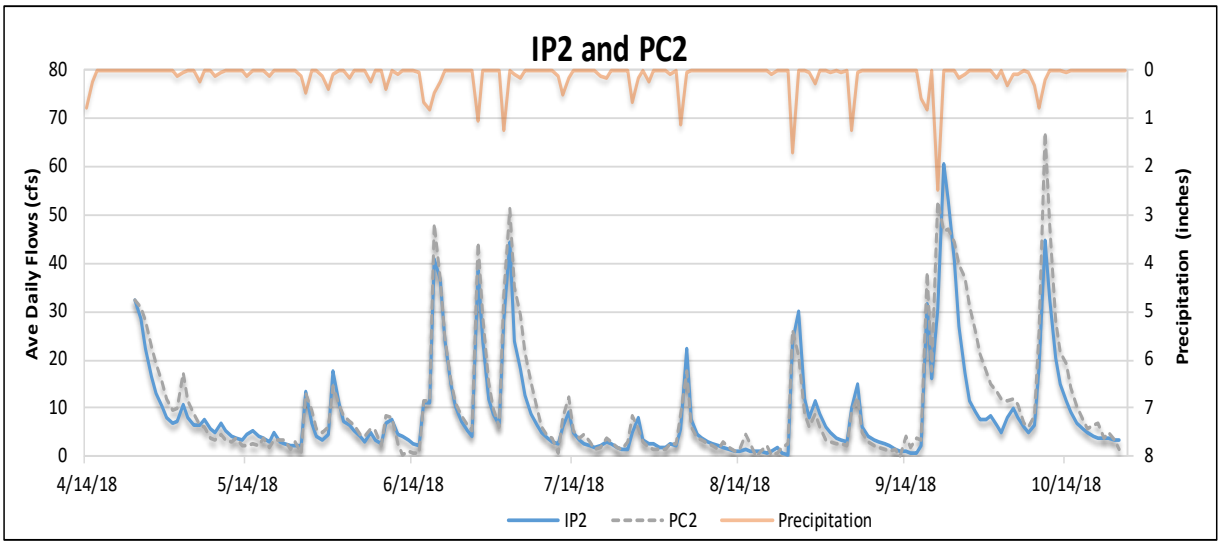


Figure 3.2.2 Average daily flow for Industrial Park site 2 (IP2) and downstream Plymouth Creek Site 2 (PC2)

3.2.3. Concentrations

A summary of the average sample concentrations for TP, SRP, TN, TSS and Cl at IP2 and PC2 are in Table 3.2.2 and Figure 3.2.3. At IP2, 27 water samples were collected over the season. On average, the SRP was 30% of the TP. At PC2, 21 water samples were collected over the season. On average, the SRP was 37% of TP. Concentrations at IP2 were higher than PC2 for TP, TSS, and Chloride. TN and SRP were about the same at PC2 and IP2. The lower concentrations at PC2 may be attributed to the stream stabilization and ponds allowing the setting of suspended sediment.

Table 3.2.2 Summary of sample average, minimum and maximum concentrations for TP, SRP, TN, TSS and Cl at IP2 and PC2

Site	Avg TP (min-max) µg/L	Avg SRP (min-max) µg/L	Avg TN (min-max) mg/L	Avg TSS (min-max) mg/L	Avg Cl (min-max) mg/L
IP2	164 (71 - 339)	49 (6 - 97)	1.5 (0.8 - 2.5)	21.5 (1.0 - 113.3)	178 (50 - 396)
PC2	139 (54 - 219)	51 (5 - 90)	1.5 (0.7 - 4.4)	15.5 (1.5 - 65.3)	157 (60 - 344)

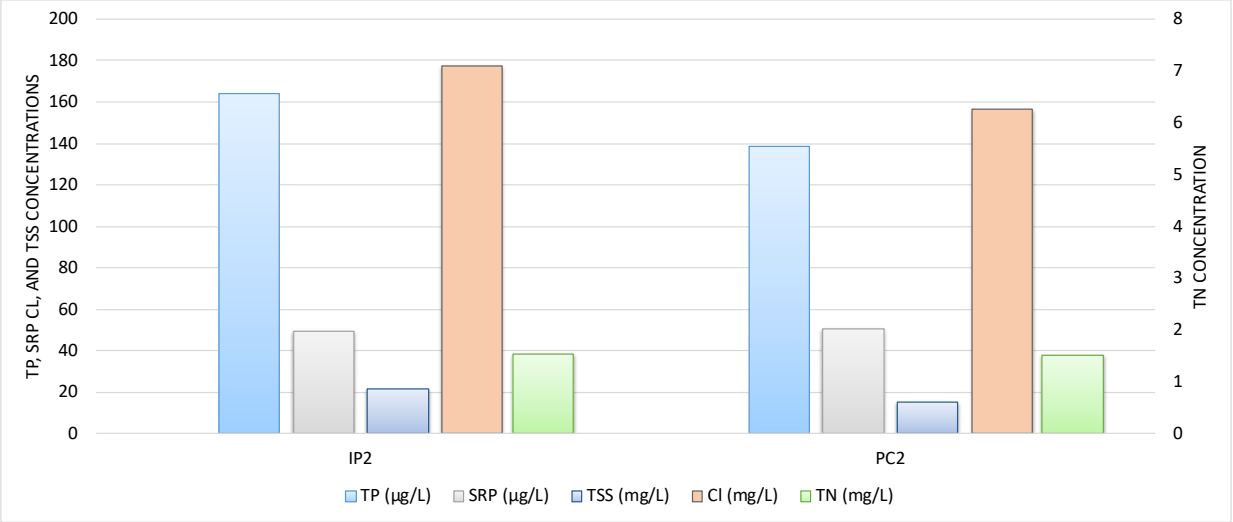


Figure 3.2.3 Average concentrations of TP, SRP, TSS chlorides and TN for the Medicine Lake Watershed sites including IP2 and PC2

3.2.4. Loading

IP2

At IP2, data has been collected since 2004 with breaks in 2007, 2010, and 2011. In Table 3.2.3, the concentrations and loadings are averaged before the break in 2011 and after since this coincides with the downstream restorations between IP2 and PC2. The average precipitation for the 5 monitored years before 2011 was an average of 3 inches less than after 2011. This led to an increase in flow volume and loading. The average concentrations for TP, SRP and TN all increased between the time periods while the average TSS concentration remained the same. Between the increase in concentration and the increase in flow, there was a 29% to 104% increase in loading for the different parameters. In 2018, the concentrations and loadings for TP, SRP and TSS increased compared to 2017, while TN concentration remained the same. Table 3.2.4, shows the chloride data for the past 5 years. In 2018, the chloride concentration and loading were higher than 2017, but were similar to the 5 year average.

The unit area loads (UAL) by year are listed in Table 3.2.5. The TP UAL's at IP2 have an average of 0.55 lbs/acre and have been lower than the MPCA Stormwater manual of 1.35 lbs/acre for residential land use since monitoring began. The average TSS UAL of 80 lbs/acre is slightly over the MPCA Stormwater manual value of 77 lbs/acre for residential land use.

A capital improvement project began in winter of 2017 and finished in 2018 that included streambank stabilization upstream of IP2. It is anticipated that this project will reduce nutrient loading in the future.

Table 3.2.3 Loading and flow weighted concentrations for IP2.

IP2 - Industrial Park site 2										
	Nutrient Loading				Nutrient Concentration					
Year	TP (lbs/yr)	SRP (lbs/yr)	TN (lbs/yr)	TSS (lbs/yr)	TP (µg/L)	SRP (µg/L)	TN (mg/L)	TSS (mg/L)	Flow Volume (x 10^6 M3)	Annual Precipitation (inches)
2004-2009										
2004	1,716	1,081	13,441	189,407	128	81	1.00	14	6.04	32.1
2005	1,785	816	13,080	348,060	144	66	1.06	24	4.69	32.6
2006	1,768	558	15,039	497,672	147	46	1.25	41	5.47	29.1
2008	1,228	265	9,131	183,900	147	36	1.20	25	3.35	20.8
2009	713	338	5,520	52,461	127	61	0.99	9	2.54	19.6
Average	1,442	612	11,242	254,300	139	58	1.10	23	4.42	26.9
2012-2018										
2012	2,168	920	20,615	392,171	171	73	1.62	31	5.75	26.7
2013	2,812	1,438	25,699	338,965	161	82	1.47	19	7.93	31.6
2014	2,153	882	24,143	405,612	161	66	1.81	30	6.06	27.5
2015	2,237	693	17,870	164,959	191	59	1.53	14	3.89	29.1
2016	3,704	1,403	33,662	412,583	183	70	1.67	20	9.16	38.6
2017	1,864	569	19,240	273,001	142	43	1.47	21	5.94	27.8
2018	2,309	746	19,523	306,631	173	56	1.47	23	6.04	30.8
Average	2,464	950	22,964	327,703	169	64	1.58	23	6.40	30.3
% Change	71	55	104	29	22	11	43	0	45	13

Table 3.2.4 Loading and flow weighted chlorides at IP2 and PC2.

	IP2		PC2	
	Chloride		Chloride	
	Loading	Concentration	Loading	Concentration
Year	(lbs/Yr)	(mg/L)	(lbs/Yr)	(mg/L)
2014	1,651,825	124	3,482,178	127
2015	2,038,841	174	1,512,773	154
2016	2,492,823	123	2,472,477	95
2017	1,515,227	115	1,153,509	96
2018	1,865,496	140	1,901,731	120
Average	1,912,842	135	2,216,322	118

Table 3.2.5 Unit area loads for TP, SRP, TN, TSS and Chlorides at IP2

Industrial Park - Site 2					
	Load/Acre				
Year	TP (lbs/acre)	SRP (lbs/acre)	TN (lbs/acre)	TSS (lbs/acre)	Cl (lbs/acre)
2004	0.46	0.29	3.61	51	
2005	0.48	0.22	3.51	93	
2006	0.47	0.15	4.04	134	
2008	0.33	0.07	2.45	49	
2009	0.19	0.09	1.48	14	
2012	0.58	0.25	5.53	105	
2013	0.75	0.39	6.90	91	
2014	0.58	0.24	6.48	109	443
2015	0.60	0.19	4.80	44	547
2016	0.99	0.38	9.04	111	669
2017	0.50	0.15	5.17	73	407
2018	0.62	0.20	5.24	82	501
Average	0.55	0.22	4.85	80	514

PC2

At PC2, data was collected since 2001. In 2010 and 2011, restoration work included adding several settling ponds and a stream bank stabilization along Plymouth Creek between sites IP2 and PC2 to improve the conveyance of water and reduce flooding impacts. Pre and post construction data are compared for PC2 in Table 3.2.6. After the stabilization, there was an 84% increase in flow with reductions in average concentrations of TSS by 67%, TP concentrations by 30%, SRP concentrations by 31% and TN concentrations by 7%. Even with reduced concentrations of TP, SRP and TN, the increase in flow caused increases in loadings of 11%, 23% and 56%, respectively. The decrease in TSS concentration, however, was large enough to decrease TSS loading by 33%.

Comparing 2018 data to 2017, the loading for each parameter was greater in 2018 due to a slight increase in precipitation and increase in total flow. Typically, after a restoration, about 5 years are needed to see the restoration effects. Continued monitoring will determine if lower concentrations will continue. Five years of data have been collected for Chlorides and 2018 was about average in terms of flow weighted chloride concentration (Table 3.2.4).

The unit area loads (UAL) by year are listed in Table 3.2.7. The TP UAL's at PC2 have an average of 0.34 lbs/acre and have been lower than the MPCA Stormwater manual of 1.35 lbs/acre for

residential land use since monitoring began. The average TSS UAL of 74 lbs/acre is similar to the MPCA Stormwater manual values of 77 lbs/acre for residential land use.

Table 3.2.6 Loading and flow weighted concentrations for TP, SRP, TN and TSS at PC2. The data is segmented based on the before and after of pond installation and stream stabilization. The % change compares the average loadings and concentrations before and after the restoration work

PC2 - Plymouth Creek Site 2										
	Nutrient Loading				Nutrient Concentration					
Year	TP (lbs/yr)	SRP (lbs/yr)	TN (lbs/yr)	TSS (lbs/yr)	TP (µg/L)	SRP (µg/L)	TN (mg/L)	TSS (mg/L)	Flow Volume (x 106 M3)	Annual Precipitation (inches)
2001	1,484	534	7,416	95,455	236	85	1.20	15	2.92	34.6
2002	3,931	1,761	21,261	316,003	212	110	1.30	20	8.41	38.1
2003	2,274	1,125	11,040	208,858	216	107	1.05	20	4.76	25.8
2004	2,306	1,052	12,630	490,844	182	83	1.00	42	5.73	32.1
2005	1,327	783	10,761	421,668	161	95	1.30	51	3.14	32.6
2006	2,619	983	22,491	1,623,423	272	102	2.34	169	4.42	29.1
2007	3,157	1,244	23,625	1,319,995	275	108	2.06	115	5.22	31.1
2008	969	191	9,925	827,829	206	105	2.10	175	2.14	20.8
2009	496	222	4,834	121,726	131	59	1.28	32	1.71	19.6
2010	1,588	790	12,118	80,263	134	67	1.02	7	5.40	31.2
2011	2,737	851	30,284	468,328	148	46	1.64	25	8.37	26.3
Average	2,081	867	15,126	543,127	198	88	1.48	61	4.75	29.2
After ponds and stream restoration										
2012	2,049	740	19,555	273,588	149	54	1.42	20	6.25	26.7
2013	2,487	1,198	22,839	395,732	157	76	1.44	25	13.75	31.6
2014	2,920	1,602	35,271	686,184	125	59	1.29	25	12.42	27.5
2015	1,289	599	12,577	104,856	131	61	1.28	11	4.46	29.1
2016	3,846	1,899	35,957	494,863	147	73	1.37	19	11.88	38.6
2017	1,323	622	15,689	255,076	110	52	1.30	21	5.13	27.8
2018	2,296	827	23,727	331,692	145	52	1.50	21	7.18	30.8
Average	2,315	1,069	23,649	363,052	138	61	1.37	20	8.72	30.3
% Change	11	23	56	-33	-30	-31	-7	-67	84	4

Table 3.2.7 Unit area loads for TP, SRP, TN, TSS and Chlorides at PC2

Plymouth Creek Site 2 - PC2					
	Load/Acre				
Year	TP (lbs/acre)	SRP (lbs/acre)	TN (lbs/acre)	TSS (lbs/acre)	Cl (lbs/acre)
2001	0.23	0.08	1.16	15	
2002	0.62	0.28	3.33	49	
2003	0.36	0.18	1.73	33	
2004	0.36	0.16	1.98	77	
2005	0.21	0.12	1.68	66	
2006	0.41	0.15	3.52	254	
2007	0.49	0.19	3.70	207	
2008	0.15	0.03	1.55	130	
2009	0.08	0.03	0.76	19	
2010	0.25	0.12	1.90	13	
2011	0.43	0.13	4.74	73	
2012	0.32	0.12	3.06	43	
2013	0.39	0.19	3.57	62	
2014	0.46	0.25	5.52	107	545
2015	0.20	0.09	1.96	16	324
2016	0.60	0.30	5.63	77	387
2017	0.21	0.10	2.46	40	181
2018	0.36	0.13	3.71	52	298
Average	0.34	0.15	2.89	74	347

3.3. Northwood Lake Sub-watershed

The Northwood Lake Sub-watershed creates the headwaters of the North Branch of Bassett Creek. The monitored site's watershed is located entirely within the City of Plymouth and is upstream of Northwood Lake, which is in the City of New Hope (Figure 3.3.1). The water level in Northwood Lake is controlled by a 10' wide weir outlet structure along Boone Ave. This weir causes the water to back up to the monitoring station in the City of Plymouth. In 2016-2017, the City of New Hope installed several improvements around the lake to reduce the phosphorus loading. More information about these BMP improvements can be found at the City of New Hope's website. Northwood Lake has been classified as impaired for excess nutrients since 2004.

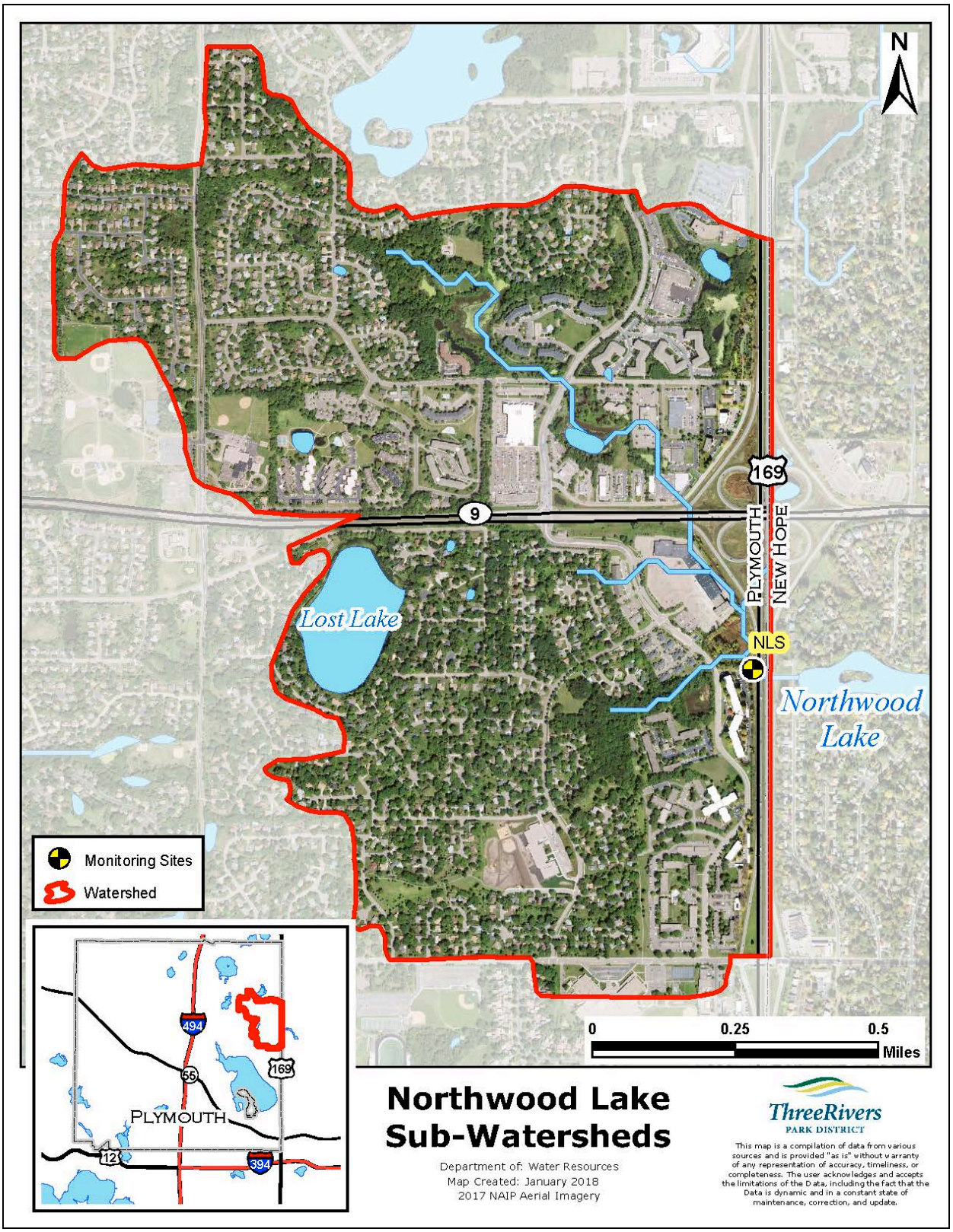


Figure 3.3.1 Northwood Lake Sub-watershed map

3.3.1. Stormwater Monitoring Site

The Northwood Lake Sub-watershed (NLS) monitoring site is located at the edge of the City of Plymouth. The site monitors flow from 835 acres which is 34% impervious. The sampling site is east of Lancaster Lane North and south of County Road 9 behind an apartment complex. The site is located in a six foot culvert just before the stream flows under Highway 169. The site receives runoff from two tributaries. One branch from the north and the other from the west (Figure 3.3.1).

Table 3.3.1 Summary of watershed characteristics for NLS

Site	*Subwatershed Area (acres)*	*% impervious (acres)*[1]	*% of Watershed in Plymouth*	*Dominant land uses*[2]
NLS	835	34% (285 ac.)	100%	Residential

[1] % impervious area determined using the 2016 University of Minnesota TCMA 1-meter land cover classification GIS layer

[2] Dominant Land Uses determined using GIS layer obtained from the City of Plymouth

3.3.2. Measured Flow

Due to the outlet of Northwood Lake being a weir, the NLS site typically goes stagnant at a level of about 1.3 feet on the staff gage. Being at the headwaters of the North Branch of Bassett Creek, this site is quite flashy and responds quickly to precipitation. During the 2018 sampling period, the largest daily average flow of 23.1 cfs occurred on September 21st following several days of rain (Figure 3.3.2). Flows were generally low at this site with an average daily flow of 2.2 cfs and several periods of zero flow.

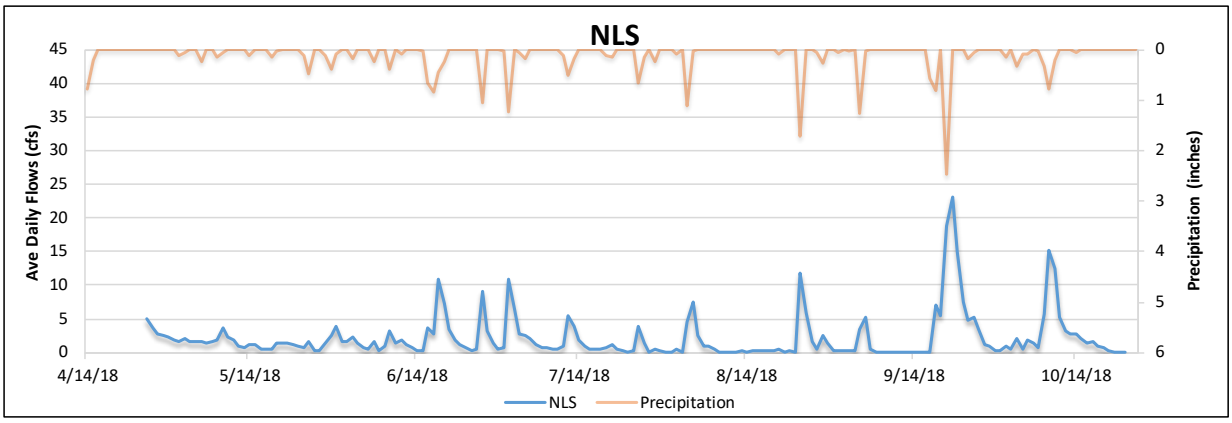


Figure 3.3.2 Average daily flow for Northwood Lake Sub-watershed (NLS)

3.3.3. Concentrations

At NLS, 18 water samples were collected over the 2018 season. Table 3.3.2 summarizes the average concentrations from the collected samples. On average, the SRP was 27.6% of TP.

Table 3.3.2 Summary of average, minimum and maximum concentrations for TP, SRP, TN and TSS at NLS

Site	Avg TP (min-max) µg/L	Avg SRP (min-max) µg/L	Avg TN (min-max) mg/L	Avg TSS (min-max) mg/L
NLS	374 (81 - 1161)	103 (7 - 266)	2.5 (0.6 - 6.4)	146.1 (2.2 - 558.0)

3.3.4. Loading

At NLS, water quality has been monitored since 2012 (Table 3.3.3). Since 2016, monitored flows may have been impacted by several stormwater infrastructure projects adjacent to Northwood Lake. In 2018, the flow weighted concentrations for TP, SRP, TN, and TSS were either the highest or second highest concentrations since monitoring began which led to higher loadings. This site can be flashy and become very turbid. Typically, during rain events, this site will have more visually turbid water coming from the west tributary than from the north tributary.

The unit area loads (UAL) by year are listed in Table 3.3.4. At NLS, the average TP UAL of 1.07 lbs/acre is lower than the MPCA Stormwater Manual residential UAL of 1.35 lbs/acre, but in 2018 the TP UAL was slightly higher at 1.49 lbs/acre. The average TSS UAL of 355 is much higher than the MPCA Stormwater Manual residential UAL of 77 lbs/acre.

Table 3.3.3 Loading and flow weighted concentrations of TP, SRP, TN and TSS at NLS.

NLS - Northwood Lake Subwatershed										
	Nutrient Loading				Nutrient Concentration					
Year	TP (lbs/yr)	SRP (lbs/yr)	TN (lbs/yr)	TSS (lbs/yr)	TP (µg/L)	SRP (µg/L)	TN (mg/L)	TSS (mg/L)	Flow Volume (x 10^6 M^3)	Annual Precipitation (inches)
2012	641	254	6,198	98,605	153	61	1.48	24	1.90	26.7
2013	821	361	7,492	225,785	185	83	1.71	52	1.99	31.6
2014	1,279	589	12,748	377,933	265	122	2.64	78	1.87	27.5
2015	933	296	8,142	266,447	214	68	1.87	61	1.97	29.1
2016	585	195	5,211	240,786	278	93	2.47	114	0.95	38.6
2017	803	210	7,401	439,568	254	66	2.34	139	1.35	27.8
2018	1,215	372	8,202	427,514	388	119	2.62	137	1.42	30.8

Table 3.3.4 Unit area loading for TP, SRP, TN and TSS at NLS.

NLS - Northwood Lake Subwatershed				
	Load/Acre			
Year	TP (lbs/acre)	SRP (lbs/acre)	TN (lbs/acre)	TSS (lbs/acre)
2012	0.77	0.30	7.42	118
2013	0.98	0.43	8.97	270
2014	1.53	0.71	15.26	453
2015	1.12	0.35	9.75	319
2016	0.70	0.23	6.24	288
2017	0.96	0.25	8.86	526
2018	1.46	0.45	9.82	512
Average	1.07	0.39	9.47	355

3.4. Bass Lake Watershed

The Bass Lake watershed is 3,105 acres and is located entirely within the City of Plymouth. The largest subwatershed of Bass Lake is monitored at BL3 (Bass Lake site 3), accounting for about 59% of the Bass Lake watershed area (Figure 3.4.1).

Bass Lake was classified as impaired for excess nutrients in 2002. A TMDL was completed in 2009 to address the nutrient impairments in Bass, Schmidt and Pomerleau Lakes (Wenck, 2009) and in 2017 a follow up document reviewed the progress toward meeting reductions in the TMDL report (Wenck, 2017). Alum treatments are planned for both Pomerleau Lake and Bass Lake in 2019.

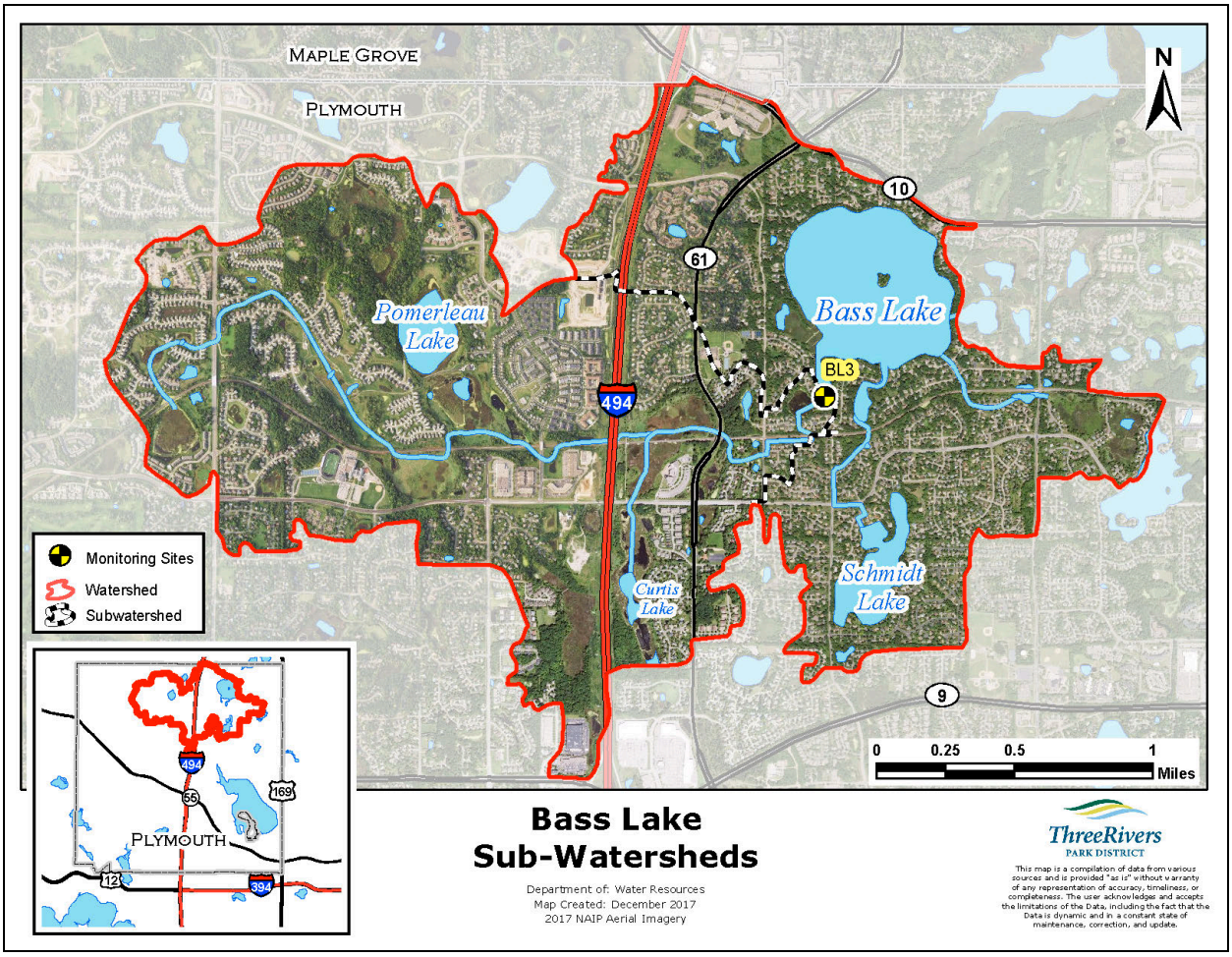


Figure 3.4.1 Bass Lake sub-watershed map

3.4.1. Stormwater Monitoring Site

The BL3 (Bass Lake site 3) sampling site is located 0.1 miles southeast of the 54th Ave N and Norwood Lane North intersection. The site receives runoff from 1,846 acres, of which 28% is impervious surface (Table 3.4.1). The site is downstream of a 6.5 acre pond that attenuates flow and allows settling of particulates. There are two adjacent 24 inch round culverts at the BL3 sampling site referred to as "east" and "west". Flow measurements are taken in both culverts while water samples are only taken from the west culvert. Since the culverts convey the same source water, nutrient concentrations from the west culvert were used to estimate nutrient loading for both culverts.

Table 3.4.1 Summary of watershed characteristics for site BL3

Site	*Subwatershed Area (acres)*	*% impervious (acres)[1]*	*% of Bass Lake Watershed*	*Dominant land uses[2]*
BL3	1,846	28% (511 ac.)	59%	Residential

[1] % impervious area determined using the 2016 University of Minnesota TCMA 1-meter land cover classification GIS layer

[2] Dominant Land Uses determined using GIS layer obtained from the City of Plymouth

3.4.2. Measured Flow

The measured flow of the east culvert was 8% lower than the measured flow for the west culvert. The west culvert sits a little lower than the east culvert, resulting in slightly more flow. The pond on the upstream side of the culvert causes a delay in the flow hydrograph after precipitation events.

The largest flow pulse in each culvert was just over 8 cfs and occurred September 21st after the combined 3.86 inches or rainfall over the previous four days (Figure 3.4.2). Flows were also high when equipment was installed in April. There was a large April snowstorm that contributed to a large spring snow melt event this year.

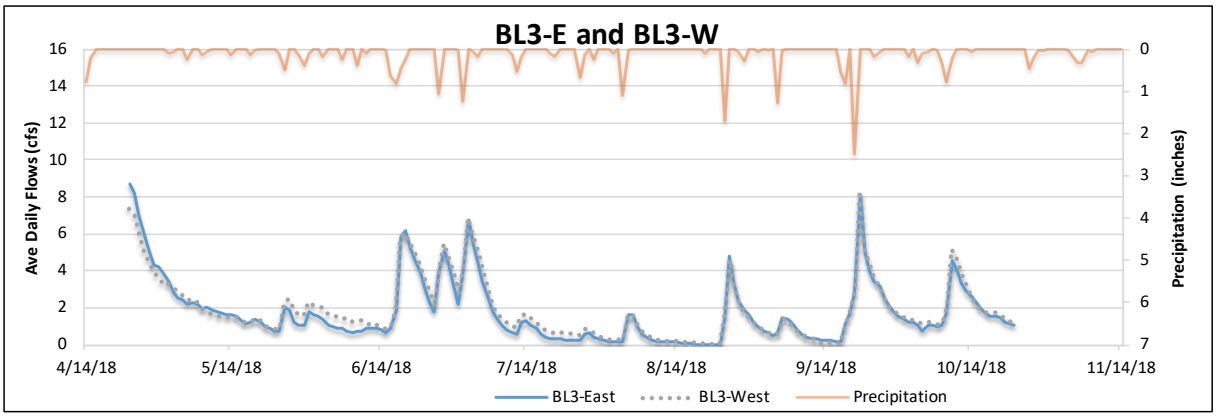


Figure 3.4.2 Average daily flow for Bass Lake site 3 East and West (BL3-E and BL3-W)

3.4.3. Concentrations

At BL3-W, 27 water samples were collected over the season. The average concentrations are listed in Table 3.4.2. On average, the SRP was 40% of TP.

Table 3.4.2 Summary of average, minimum and maximum concentrations for TP, SRP, TN and TSS at BL3-W

Site	Avg TP (min-max) µg/L	Avg SRP (min-max) µg/L	Avg TN (min-max) mg/L	Avg TSS (min-max) mg/L
BL3-W	128 (37 - 317)	48 (9 - 125)	1.4 (0.6 - 3.5)	6.1 (0.8 - 23.6)

3.4.4. Loading

At BL3, data has been collected since 2015 (Table 3.4.3). The 2018 flows and loading were higher than 2017, but lower than the high values that occurred in 2015. While the dataset is not extensive, 2018 values seemed average for this site.

The unit area loads (UAL) by year are listed in Table 3.4.4. At BL3, the 2018 TP UAL of 0.33 lbs/acre is lower than the MPCA Stormwater Manual residential UAL of 1.35 lbs/acre. The 2018 TSS UAL of 20 is much lower than the MPCA Stormwater Manual residential UAL of 77 lbs/acre.

Table 3.4.3 Loading and flow weighted concentrations of TP, SRP, TN and TSS at BL3

BL3 - Bass Lake Site 3										
	Nutrient Loading				Nutrient Concentration					
Year	TP (lbs/yr)	SRP (lbs/yr)	TN (lbs/yr)	TSS (lbs/yr)	TP (µg/L)	SRP (µg/L)	TN (mg/L)	TSS (mg/L)	Flow Volume (x 10^6 M^3)	Annual Precipitation (inches)
2015	1,079	396	9,546	40,986	172	63	1.52	6.5	2.84	29.1
2016	800	368	8,774	24,015	111	51	1.22	3.3	3.27	38.6
2017	316	121	4,739	17,210	69	26	1.04	3.8	1.04	27.8
2018	612	248	6,983	36,118	114	46	1.30	6.7	2.44	30.8

Table 3.4.4 Unit area loading for TP, SRP, TN and TSS at BL3

Bass Lake - Site 3				
	Load/Acre			
Year	TP (lbs/acre)	SRP (lbs/acre)	TN (lbs/acre)	TSS (lbs/acre)
2015	0.58	0.21	5.17	22
2016	0.43	0.20	4.75	13
2017	0.17	0.07	2.57	9
2018	0.33	0.13	3.78	20
Average	0.38	0.15	4.07	16

3.4.5.Pomerleau Lake

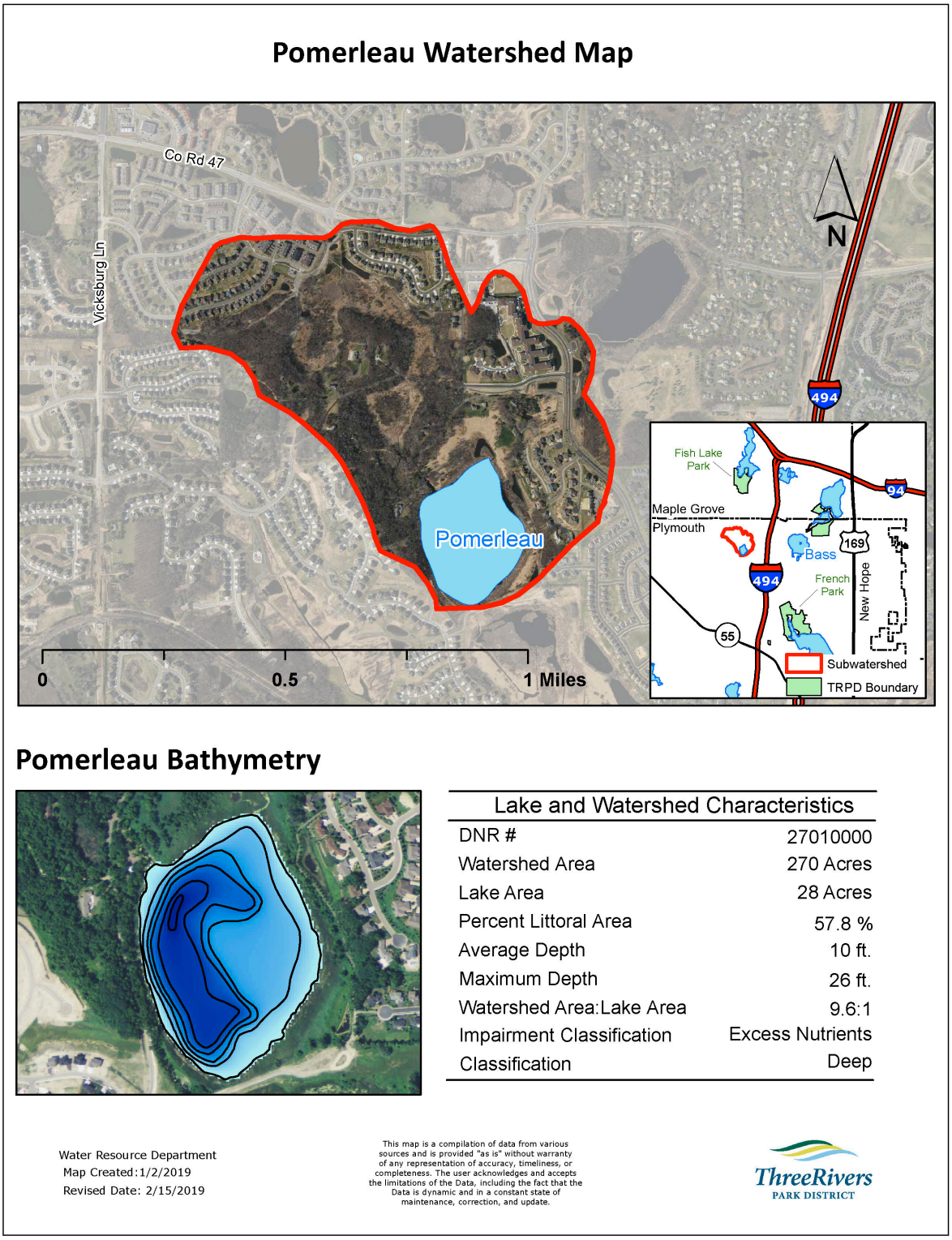
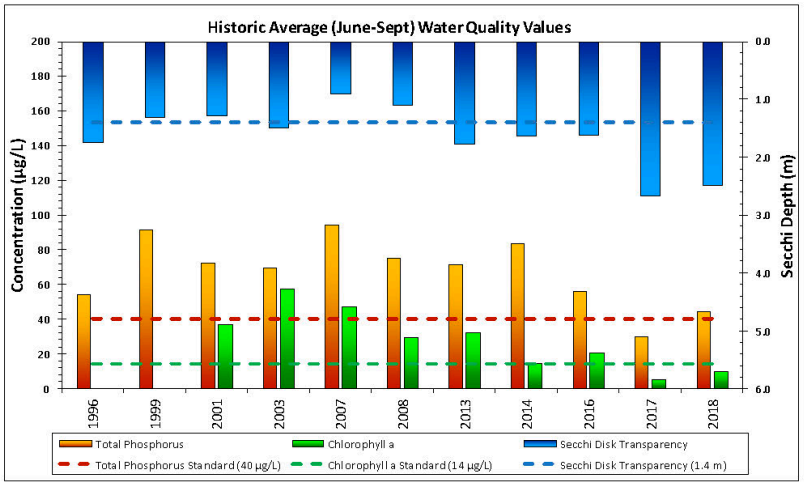
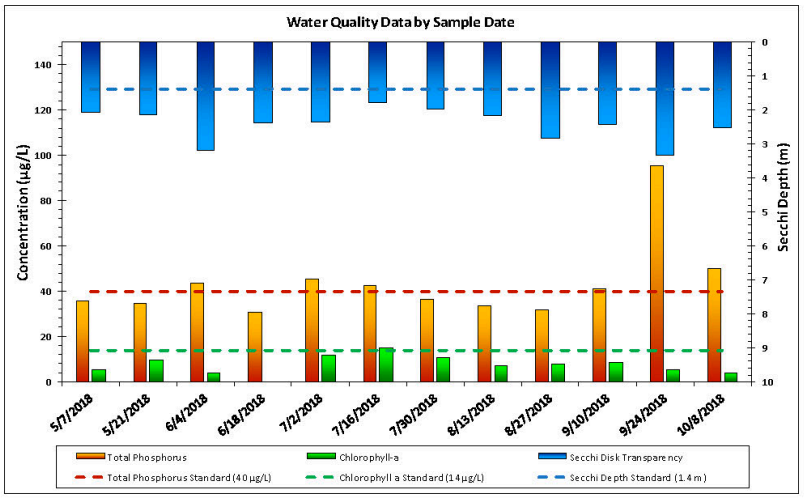
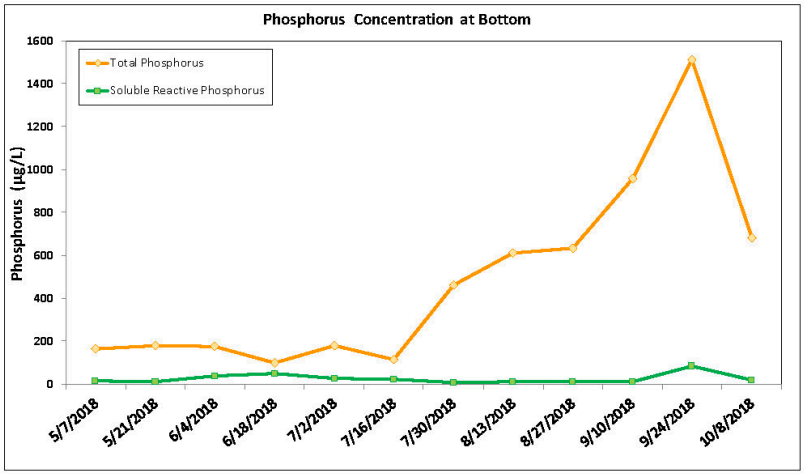


Figure 3.4.3 A summary of the watershed characteristics for Pomerleau Lake within the Bass Lake watershed



*TRPD collected data in 2007, 2008, 2013, 2016 and 2018. Other data collected by: Shingle Creek Watershed Management Commission Routine Monitoring, MCES Citizen Assisted Lake Monitoring Program, or City of Plymouth.





Pomerleau Water Quality Report Card				
Year	TP	Chl-a	Secchi	Avg Grade
1996	C		C	
1999	D		C	
2001	D	C	C	C-
2003	D	D	C	D+
2007	D	C	D	D+
2008	D	C	D	D+
2010	D	C		
2011	F	C		
2013	D	C	C	C-
2014	D	B	C	C
2016	C	B	C	C+
2017	B	A	B	B+
2018	C	A	B	B
MPCA Standard	C	B	C	C+

Met Council Grading System for Lake Water Quality

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Figure 3.4.4 A summary of the total phosphorus, secchi and Chlorophyll-A averages as they relate to the MPCA June-September averages, the results of each 2018 sample, the phosphorus concentration at the bottom of the lake and a "report card" grade as defined by the Met Council and as the water quality relates to the MPCA guidelines

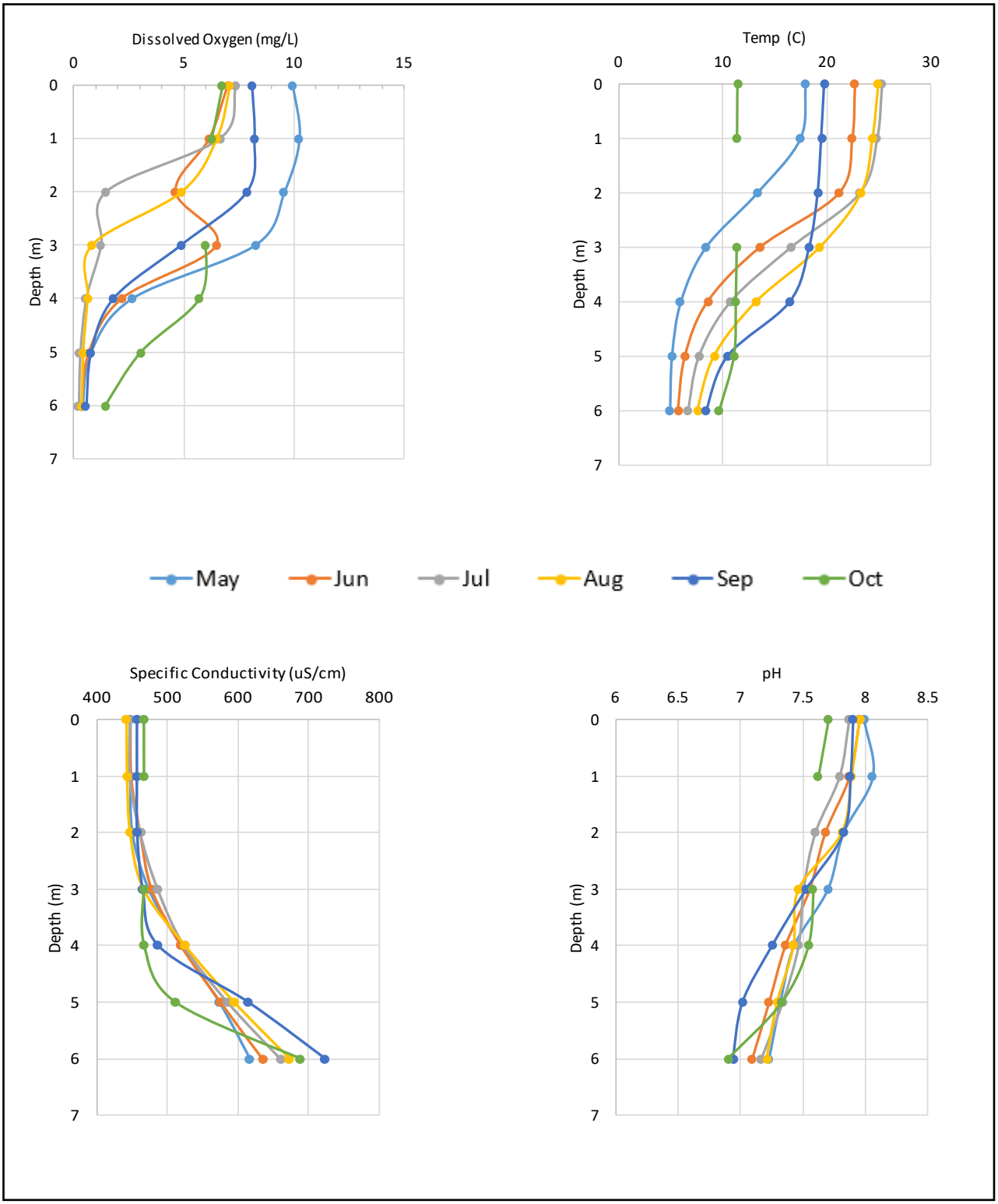


Figure 3.4.5 Sonde readings with depth (from the surface of the lake to near the bottom) averaged by month at Pomerleau Lake for dissolved oxygen, temperature, specific conductivity and pH. A data point is missing in October making gaps in the data

Concentrations

Table 3.4.5 Average, minimum and maximum Total Phosphorus, Soluble Phosphorus, Total Nitrogen, Chlorophyll-A and TP to SRP values at the Surface (S), top of the hypolimnion (M) and bottom (B) of the lake for the entire sampling season at Pomerleau Lake

	TP (ug/L)				SRP (ug/L)				TN (mg/L)				CHL-a (ug/L)				
Site	Count	Ave	Min	Max	Count	Average	Min	Max	Count	Ave	Min	Max	Count	Average	Min	Max	TP:SRP ratio
POM																	
S	12	43	31	95	12	5.97	0.23	15	12	1.00	0.81	1.57	11	8.04	3.80	15.08	12.85%
M	12	63	39	86	12	9.41	1.40	22									14.62%
B	12	480	97	1,512	12	24.59	6.60	81									11.01%

Discussion

The Pomerleau Lake watershed makes up almost 9% of the Bass Lake watershed. Figure 3.4.3 shows the Pomerleau watershed and some characteristics of the watershed. The watershed is only 28 acres with about half of the watershed in residential landuse. The lake is classified as a deep lake in the Central Hardwood forests ecoregion.

Figure 3.4.4 shows the concentrations of total phosphorus, chlorophyll-a, and secchi depths. In the top half of the image is a graph of the historical averages and a table with the report card grades of water quality based on the average concentrations from June to September and how they relate to the MPCA standards. In 2007, 2008, 2013, 2016, and 2018, the samples were collected by TRPD, previous samples were collected by either volunteer citizens or the City of Plymouth. While historical data shows Pomerleau Lake as not meeting MPCA standards, in 2017 and 2018 the lake was close to or meeting MPCA standards. Overall, the grade of Pomerleau Lake has been increasing since monitoring began with 2018 receiving an overall grade of a "B". The middle graph shows the surface sample concentrations for each sample in 2018. While most of the samples were meeting standards, one sample had a very high total phosphorus concentration that skewed the average up. The graph at the bottom shows the total and soluble phosphorus concentrations at the bottom of the lake. The total phosphorus concentrations began increasing in July and had the highest measured TP on 9/24 at a concentration of 1.5 mg/L.

Figure 3.4.5 shows the sonde profiles for dissolved oxygen, temperature, specific conductivity and pH averaged by month. In May, when sampling began, Pomerleau had already begun to stratify based on both the dissolved oxygen and temperature profiles. July had the shallowest oxygenated profile, with the lake going anoxic at about 2 meters below surface. July and August had the highest surface water temperature.

Table 3.4.5 lists the average, minimum and maximum concentrations for total phosphorus, soluble reactive phosphorus, total nitrogen and chlorophyll-A at the surface, top of hypolimnion and bottom of the lake for the entire sampling season. The oxic surface had an average TP and SRP concentrations of 43 and 6 µg/L, respectively, with an average TP: SRP ratio of about 13%. The anoxic bottom samples had average TP and SRP concentrations of 480 and 26 µg/L, respectively, with an average TP: SRP ratio of about 11%.

3.4.6. Bass Lake

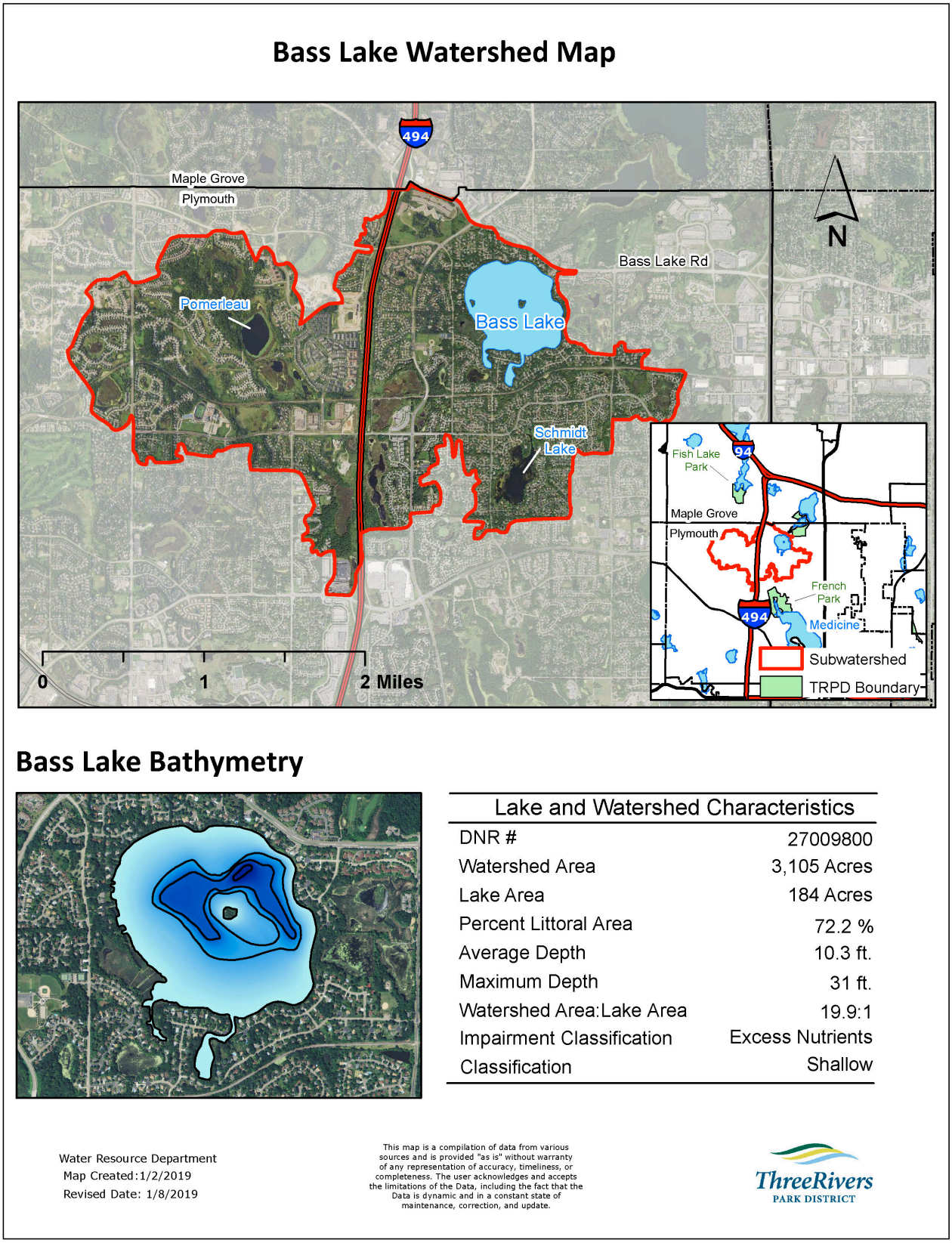
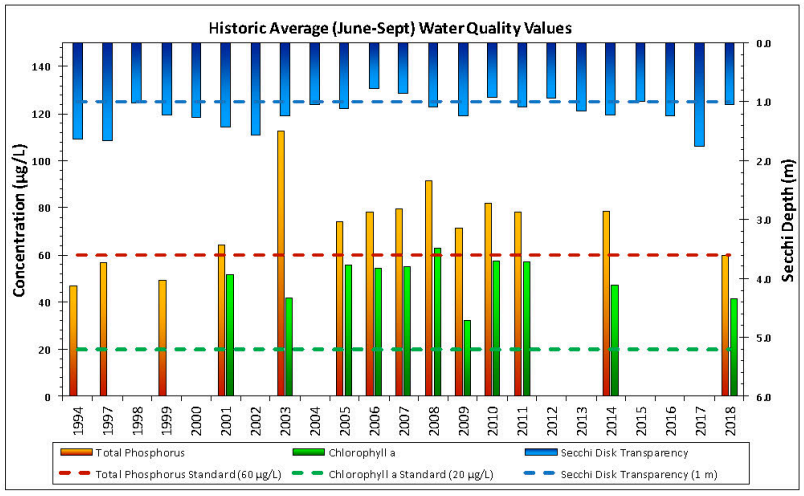
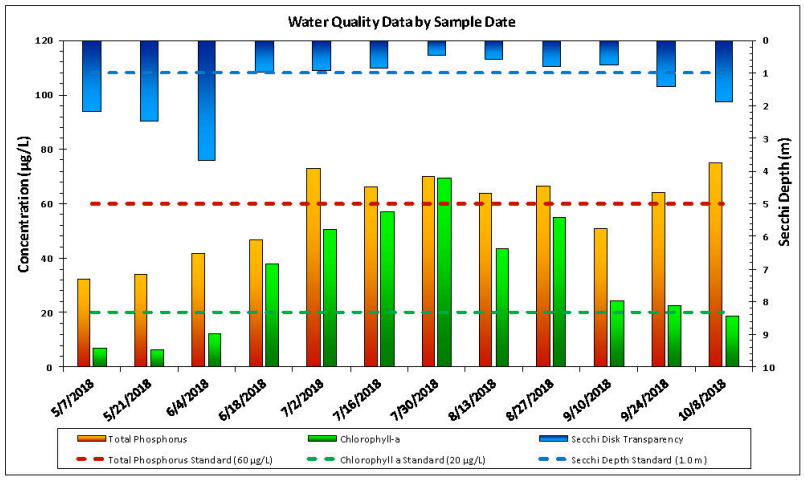
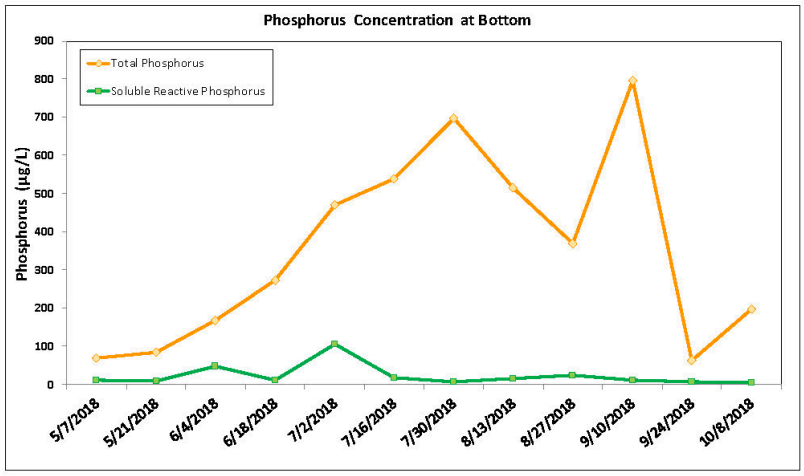


Figure 3.4.6 A summary of the watershed characteristics for Bass Lake



*TRPD collected data in 2006 – 2008, 2011, and 2018. Other data was collected by: Shingle Creek Watershed Management Commission Routine Monitoring, MCES Citizen Assisted Lake Monitoring Program, or City of Plymouth.





Bass Water Quality Report Card				
Year	TP	Chl-a	Secchi	Avg Grade
1994	C		C	
1997	C		C	
1998			D	
1999	C		C	
2000			C	
2001	C	D	C	C-
2002			C	
2003	D	C	C	C-
2004			D	
2005	C	C	C	C
2006	D	D	D	D
2007	C	C	D	C-
2008	D	D	C	D+
2009	C	C	C	C
2010	C	D	C	C-
2011	C	C	C	C
2012			C	
2013			C	
2014	D	C	C	C-
2015			C	
2016			C	
2017			B	
2018	C	C	C	C
MPCA Standard	C	B	C	C+

Met Council Grading System for Lake Water Quality

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Figure 3.4.7 A summary of the total phosphorus, secchi and Chlorophyll-A averages as they relate to the MPCA June-September averages, the results of each 2018 sample, the phosphorus concentration at the bottom of the lake and a "report card" grade as defined by the Met Council and as the water quality relates to the MPCA guidelines

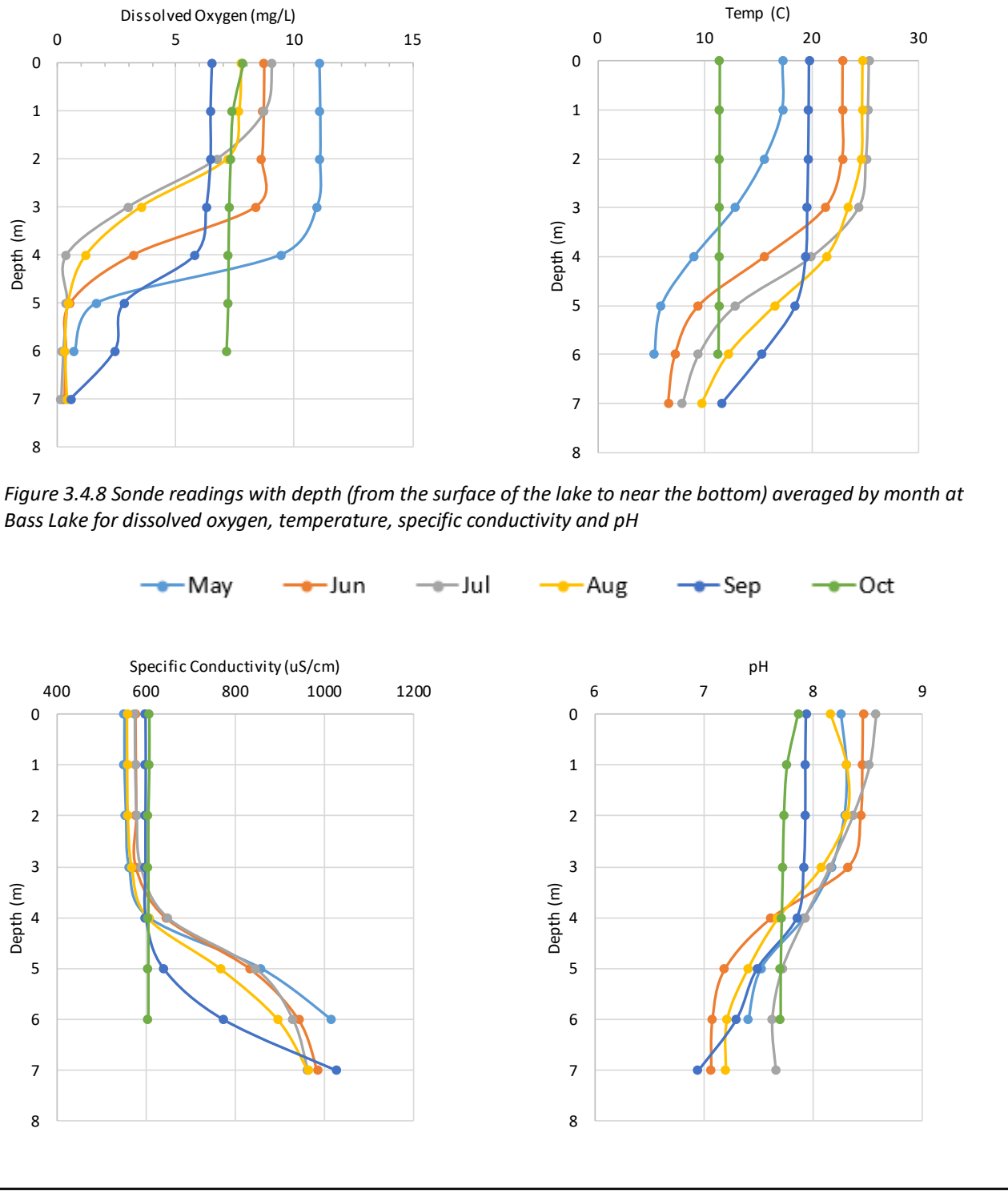

Figure 3.4.8 Sonde readings with depth (from the surface of the lake to near the bottom) averaged by month at Bass Lake for dissolved oxygen, temperature, specific conductivity and pH

Concentrations

Table 3.4.6 Average, minimum and maximum Total Phosphorus, Soluble Phosphorus, Total Nitrogen, Chlorophyll-A and TP to SRP values at the Surface (S), top of the hypolimnion (M) and bottom (B) of the lake for the entire sampling season at Bass Lake

	TP (ug/L)				SRP (ug/L)				TN (mg/L)				CHL-a (ug/L)				TP:SRP ratio
Site	Count	Ave	Min	Max	Count	Average	Min	Max	Count	Ave	Min	Max	Count	Average	Min	Max	
BASS																	
S	12	57	32	75	12	6.96	2.43	23	12	1.16	0.63	1.78	12	33.67	6.30	69.43	12.53%
M	12	62	32	90	12	9.55	2.04	23									18.48%
B	12	353	62	797	12	21.60	4.65	105									8.59%

Discussion

Figure 3.4.6 shows the Bass Lake watershed and some characteristics of the watershed. The lake is classified as a shallow lake in the Central Hardwood forests ecoregion.

Figure 3.4.7 shows the concentrations of total phosphorus, chlorophyll-a, and secchi depths. In the top half of the image is a graph of the historical averages and a table with the report card grades of water quality based on the average concentrations from June to September and how they relate to the MPCA standards. In 2006-2008, 2011 and 2018, the samples were collected by TRPD, other years were collected by either volunteer citizens or the City of Plymouth. While historical data shows Bass Lake as not meeting MPCA standards, in 2018, the lake was close to meeting MPCA standards for total phosphorus and secchi depth, but chlorophyll-a was not meeting MPCA standards. Overall, the grade for Bass Lake has been a “C” or “D”, but a grade of a “C-“ would qualify the lake as meeting MPCA standards. The middle graph shows the surface sample concentrations for each sample event in 2018. In June and before the lake stratified, the water quality parameters were close to the standards, but by mid-June, water clarity had decreased and chlorophyll-a numbers had increased. The graph at the bottom of the image shows the total and soluble phosphorus concentrations at the bottom of the lake. The total phosphorus concentrations began increasing in June and stayed above 0.3 mg/L until fall turnover in late September.

Figure 3.4.8 shows the sonde profiles for dissolved oxygen, temperature, specific conductivity and pH averaged by month. In May, when sampling began, Bass Lake had begun to stratify based on both the dissolved oxygen and temperature profiles. July and August had the highest surface temperatures and the shallowest oxygenated profile, with the lake going anoxic at

about 3 meters. The lake began to turnover in late September and was completely mixed for the October sampling.

Table 3.4.6 lists the average, minimum and maximum concentrations for total phosphorus, soluble reactive phosphorus, total nitrogen and chlorophyll-A at the surface, top of hypolimnion and bottom of the lake for the entire sampling season. The oxic surface had average TP and SRP concentrations of 57 and 7 µg/L, respectively, with an average TP: SRP ratio of about 13%. The anoxic bottom samples had average TP and SRP concentrations of 353 and 22 µg/L, respectively, and a TP: SRP ratio of about 9%. The middle samples had the highest TP to SRP ratio at about 18.5%.

3.5. Gleason Lake Watershed

The Gleason Lake Watershed is 2,643 acres with 93% of the watershed in the City of Plymouth (Figure 3.5.1). One monitoring location was installed upstream of Gleason Lake along Gleason Creek (GC-1). This site receives runoff from 62% of the watershed area. Gleason Lake has been classified as impaired for excess nutrients since 2010.

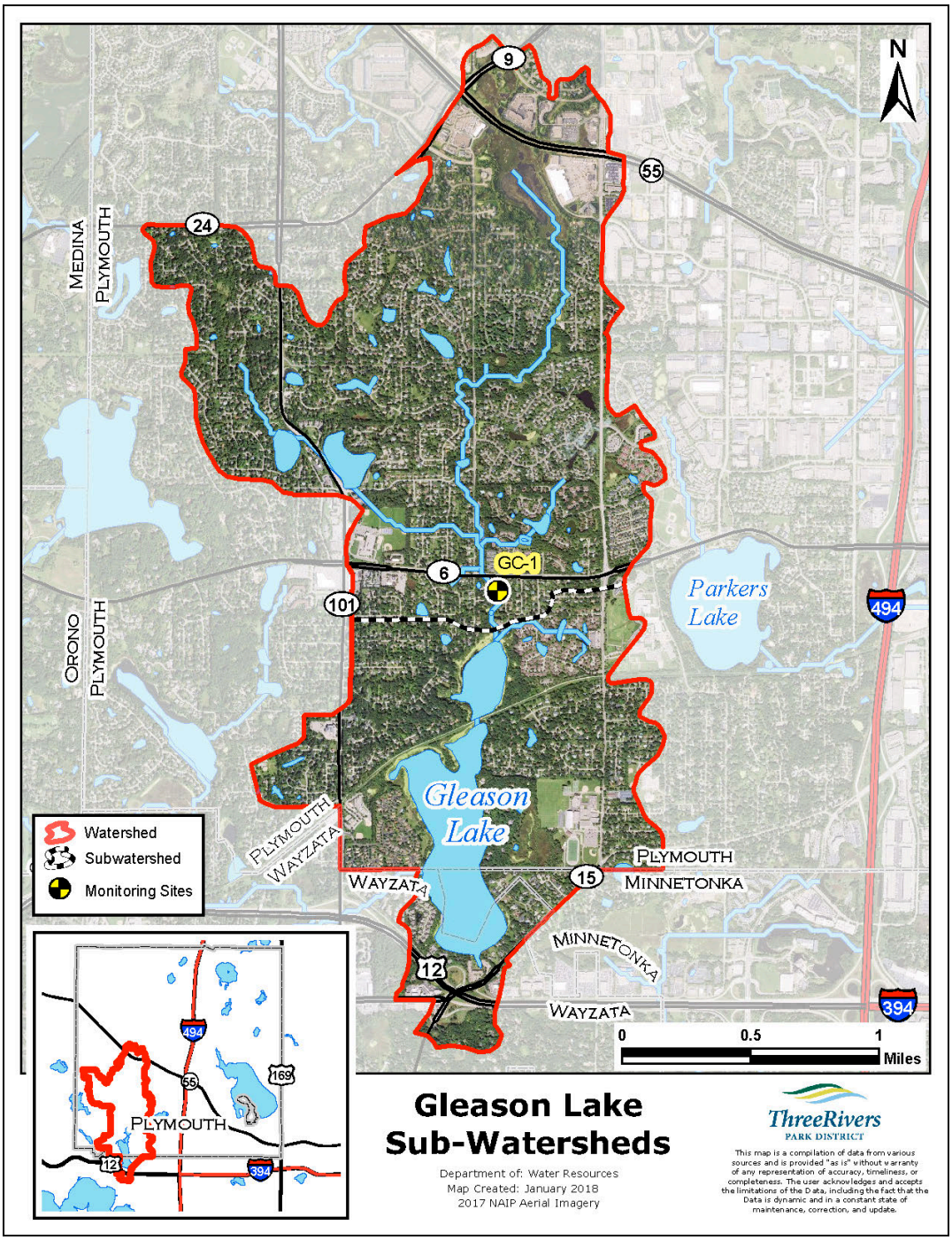

Figure 3.5.1 Gleason Creek sub-watershed map

3.5.1. Stormwater Monitoring

The GC-1 (Gleason Creek site 1) sampling site is an open channel just north of Gleason Lake off a bike path that connects Highway 6 and Black Oaks Lane North. The site monitors flow from 1,650 acres, of which about 28% is impervious surface and the landuse is primarily residential (Table 3.5.1).

Table 3.5.1 Summary of watershed characteristics for sites GC-1

Site	*Subwatershed Area (acres)*	*% impervious (acres)*[1]	*% of Gleason Lake Watershed*	*Dominant land uses*[2]
GC-1	1,650	28% (454 ac.)	67%	Residential

[1] % impervious area determined using the 2016 University of Minnesota TCMA 1-meter land cover classification GIS layer

[2] Dominant Land Uses determined using GIS layer obtained from the City of Plymouth

3.5.2. Measured Flow

The GC-1 hydrograph has flow responses that increase immediately following precipitation events, but has a delayed receding limb following storm events that persist for several days. During the sampling period, the largest flow pulse of 14.5 cfs occurred on September 20th (Figure 3.5.2). The next three largest flow pulses of 8.4, 9.4, and 11.5 cfs occurred between June 18th and July 1st. However, flows at this site averaged 1.5 cfs and experienced periods of no flow.

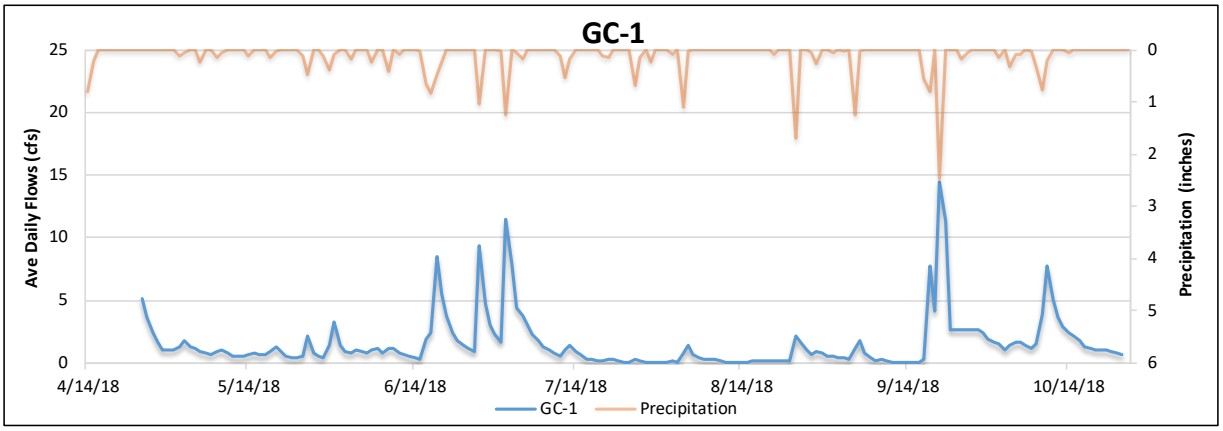

Figure 3.5.2 Average daily flow for Gleason Creek site 1 (GC-1)

3.5.3. Concentrations

At GC-1, 26 water samples were collected over the season. The average TP, SRP, TN and TSS concentrations are listed in Table 3.5.2. On average, the SRP was 30% of TP.

Table 3.5.2 Summary of average, minimum and maximum concentrations for TP, SRP, TN and TSS at GC-1

Site	Avg TP (min-max) µg/L	Avg SRP (min-max) µg/L	Avg TN (min-max) mg/L	Avg TSS (min-max) mg/L
GC-1	200 (81 - 570)	62 (21 - 107)	1.5 (0.8 - 3.8)	53.3 (0.3 - 283.3)

3.5.4. Loading

This was the second year of data collected by Three Rivers Park District (TRPD) at site GC-1. In 2005 and from 2007-2016, Minnehaha Creek Watershed District (MCWD) collected flow and concentration data and calculated loading. The loading and flow-weighted results are listed in Table 3.5.3, but caution should be exercised when comparing TRPD results to MCWD results since methodology was different. MCWD focused on collecting bi-weekly and weekly grabs, while TRPD collected bi-weekly grabs along with storm event samples which would explain the higher TP and TSS concentrations in recent years. In addition, the loading calculated by MCWD is for the sampling period while TRPD extrapolated the loading to the full year based on annual precipitation. More monitoring data will help determine if there are any trends between concentration, flow or loading.

The unit area loads (UAL) for 2018 are listed in Table 3.5.4. At GC-1, the 2018 TP UAL of 0.30 lbs/acre is much lower than the MPCA Stormwater Manual residential UAL of 1.35 lbs/acre. The 2018 TSS UAL of 118 lbs/acre is higher than the MPCA Stormwater Manual residential UAL of 77 lbs/acre.

Table 3.5.3 Loading and flow weighted concentrations of TP, SRP, TN and TSS at GC-1. Data is a compilation from Three Rivers Park District and Minnehaha Creek Watershed District and caution should be used when assessing the data for trends since different methodologies were used by the two agencies. In addition, loading from 2005-2016 is for the sampling period while the loading listed for 2017 is for the year

GC1 - Gleason Lake Subwatershed										
	Nutrient Loading				Nutrient Concentration					
Year	TP (lbs)	SRP (lbs)	TN (lbs)	TSS (lbs)	TP (µg/L)	SRP (µg/L)	TN (mg/L)	TSS (mg/L)	Flow Volume (x 106 M3)	Annual Precipitation (inches)
2005*	156	34	1,031	15,376	197	42	1.30	19	0.77	32.6
2007*	456	72	2,621	39,107	228	36	1.31	17	1.64	31.1
2008*	75	15	854	10,337	123	24	1.39	17	0.58	20.8
2009*	35	7	283	2,487	129	26	1.03	9	0.23	19.6
2010*	232	100	2,095	7,377	123	53	1.12	4	1.46	31.2
2011*	387	133	3,537	43,103	143	49	1.31	16	2.10	26.3
2012*	214	75	1,004	14,450	149	52	0.70	10	1.58	26.7
2013*	583	297	1,691	28,555	194	99	0.56	10	2.84	31.6
2014*	576	308	4,978	15,477	147	79	1.27	4	3.59	27.5
2015*	331	137	1,648	25,900	161	67	0.80	13	1.51	29.1
2016*	266	104	1,914	11,035	143	56	1.03	6	1.24	38.6
2017	479	85	4,194	120,809	211	37	1.85	53	0.97	27.8
2018	498	150	3,812	194,593	216	65	1.66	85	1.04	30.8

*** Data collected by Minnehaha Creek Watershed District (MCWD) [1]**

Table 3.5.4 Loading per acre for TP, SRP, TN and TSS for GC-1

GC-1				
	Load/Acre			
Year	TP (lbs/acre)	SRP (lbs/acre)	TN (lbs/acre)	TSS (lbs/acre)
2017	0.29	0.05	2.54	73
2018	0.30	0.09	2.31	118

[1] MCWD Disclaimer: The data to which this notice is attached are made available pursuant to the Minnesota Government Data Practices Act (Minnesota Statutes Chapter 13). THE DATA ARE PROVIDED TO YOU AS IS AND WITHOUT ANY WARRANTY AS TO THEIR PERFORMANCE, MERCHANTABILITY, OR FITNESS FOR ANY PARTICULAR PURPOSE. These data were developed by the Minnehaha Creek Watershed District for its own business purposes. The Minnehaha Creek Watershed District (MCWD) makes every effort to assure that the data and the associated documentation are error-free, complete, current, and accurate; however, the Minnehaha Creek Watershed District does not guarantee this. The Minnehaha Creek Watershed District is NOT responsible for any consequences resulting from your use of the data. You should consult the available online documentation or contact the staff contact listed in the MCWD's website to determine the limitations of the data. If you transmit or provide the data (or any portion of it) to another user, the data must include a copy of this disclaimer.

3.6. Elm Creek Watershed

A portion of Elm Creek runs through the northwest corner of the City of Plymouth (Figure 3.6.1). A TMDL (Total Maximum Daily Load) report was completed for the Elm Creek watershed and approved by the EPA in 2017. Elm Creek was listed as impaired for Chlorides and Dissolved Oxygen in 2014 and *E. Coli* in 2010. Several lakes in the watershed are also listed as impaired for excess nutrients. Along the segment of Elm Creek that runs through the City of Plymouth, several BMP's were installed in 2016 to reduce nutrient loading including stream restoration, retention ponds, and iron enhanced benches within a retention pond.

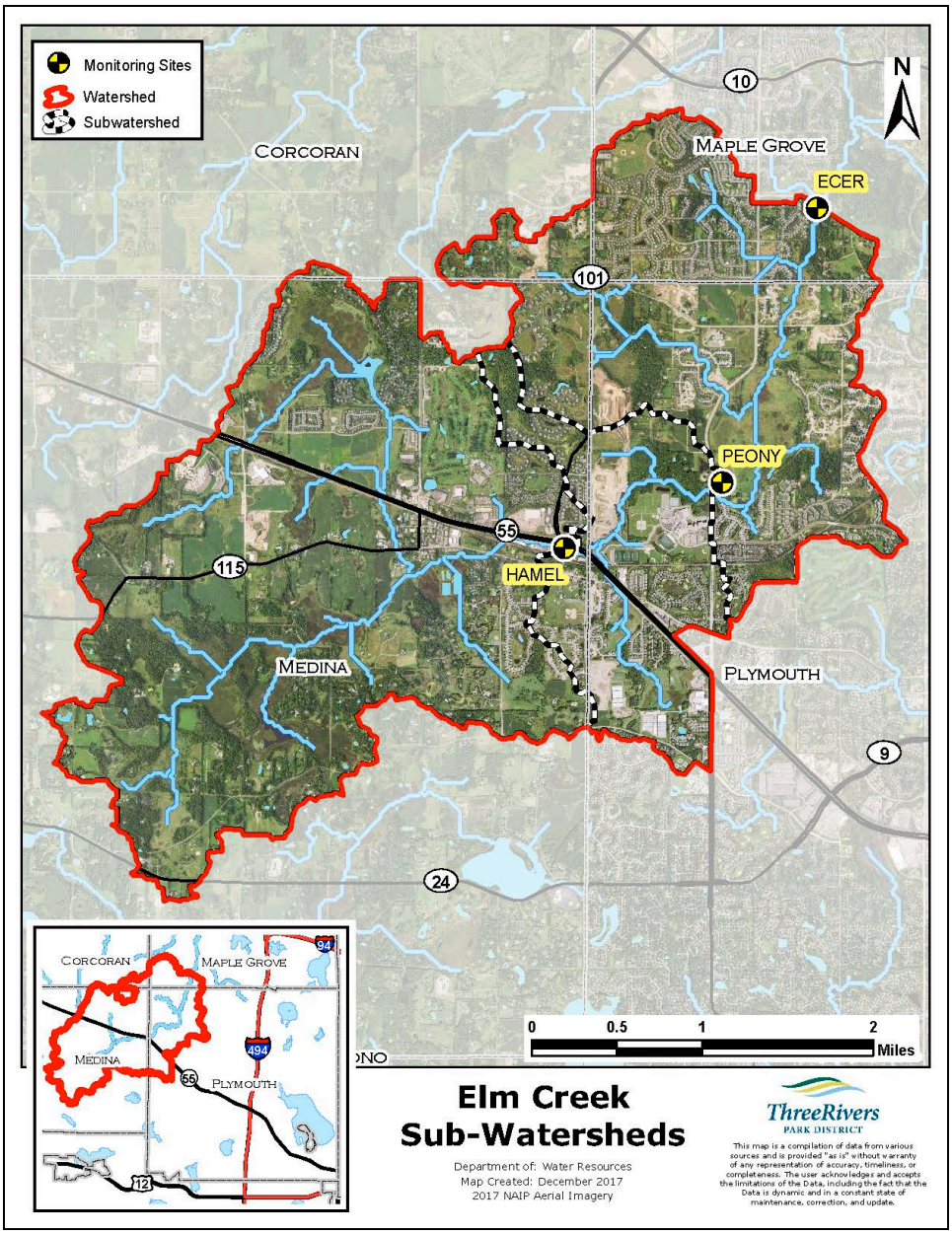

Figure 3.6.1 Elm Creek sub-watershed map

3.6.1. Stormwater Monitoring Sites

To monitor the portion of Elm Creek that flows through Plymouth, three sites were utilized. One site is before Elm Creek reaches the City of Plymouth (Hamel), another mid-way through the City of Plymouth (Peony) and the final site after Elm Creek leaves the City of Plymouth and flows into Maple Grove (ECER). The percent of total watershed for in the City of Plymouth for each site is summarized in Table 3.6.1.

The uppermost site, Hamel, is located at the intersection of Hamel Road and Hwy 55. It is an eight foot wide by four foot tall culvert. The Peony site is in an open channel just downstream of several BMP improvements near the Wayzata High School off Peony Lane N. While the Peony site is in an area that does not flood, it is surrounded by floodplain and when the stream rises to about 2.2 feet, a side channel forms and some of the flow bypasses the main stream channel. The furthest downstream monitoring site, ECER, is in an open channel along a walking path off Elm Road. This site is downstream of a 210 acre wetland complex that captures nutrients and allows sediment to settle.

Table 3.6.1 Summary of Elm Creek watershed characteristics for sites Hamel, Peony and ECER

Site	*Subwatershed Area (acres)*	*% impervious (acres)[1]*	*% of Total Watershed in Plymouth*
Hamel	4,272	12% (506 ac.)	0%
Peony	5,429	15% (811 ac.)	17%
ECER	7,921	18% (1,414 ac.)	29%

[1] % impervious area determined using the 2016 University of Minnesota TCMA 1-meter land cover classification GIS layer

3.6.2. Measured Flow

Since these three sites are cumulative, the flow increases with watershed size and distance downstream. There is an increase in the lag time of the flow pulse at downstream sites after a precipitation event. The largest flow pulses occurred after the precipitation event of 1.24 inches on July 1st. Flow at each site peaked on July 2nd with daily average flows of 52 cfs at Hamel, 54 cfs at Peony, and 102 cfs at ECER (Figure 3.6.2). The flows at Peony are only slightly higher than upstream Hamel, but ECER flows are nearly double Hamel during rain events.

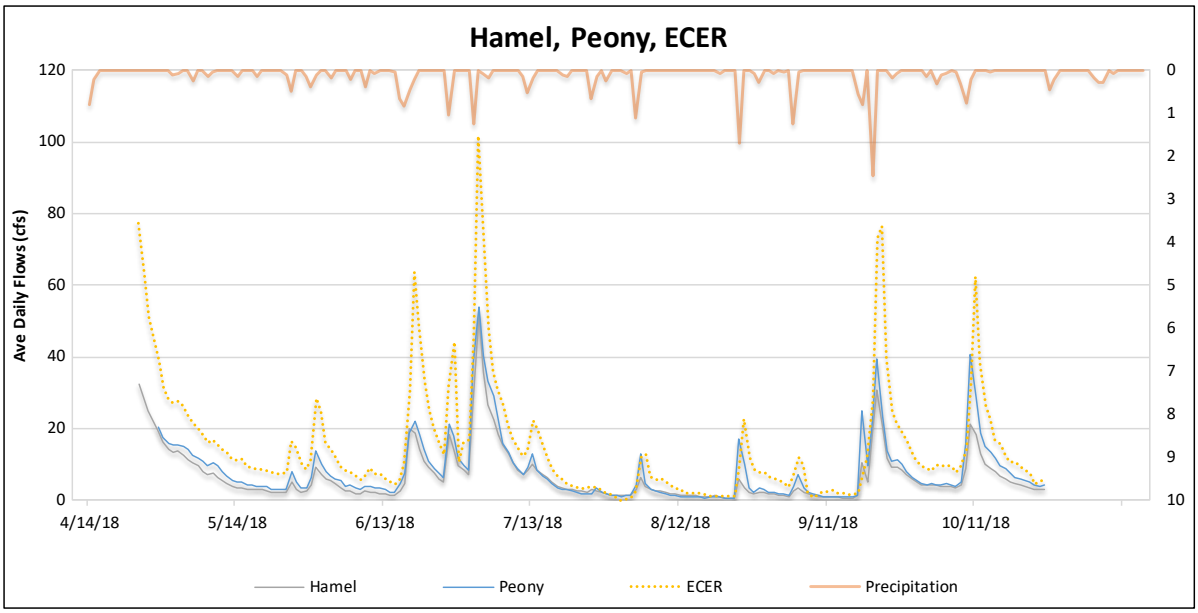

Figure 3.6.2 Average daily flow for Elm Creek watershed sites: Hamel, Peony and ECER

3.6.3. Concentrations

A summary of the TP, SRP, TN and TSS average concentrations for the Elm Creek monitoring sites are displayed in Table 3.6.2 and Figure 3.6.3. In general, the parameters increase in concentration between Hamel and Peony and then decrease between Peony and ECER.

At Hamel, 22 water samples were collected over the season. On average, the SRP was 38% of TP. At Peony, 27 water samples were collected over the season. On average, the SRP was 32% of TP. At ECER, 24 water samples were collected over the season. On average, the SRP was 46% of TP. In the wetland complex between Peony and ECER, much of the sediments settle out causing the TSS concentration to be 6 times lower and the TP, SRP and TN concentrations to be up to 1.5 times lower at ECER compared to upstream Peony.

Table 3.6.2 Summary of average, minimum and maximum concentrations for TP, SRP, TN and TSS at Hamel, Peony and ECER

Site	Avg TP (min-max) µg/L	Avg SRP (min-max) µg/L	Avg TN (min-max) mg/L	Avg TSS (min-max) mg/L
HAMEL	234 (84 - 636)	92 (18 - 183)	1.9 (1.2 - 2.6)	36.7 (2.3 - 178.7)
PEONY	422 (123 - 1439)	165 (40 - 351)	2.0 (1.1 - 5.0)	252.3 (3.0 - 1704.0)
ECER	250 (90 - 511)	108 (30 - 188)	1.7 (0.9 - 3.8)	40.1 (1.5 - 257.0)

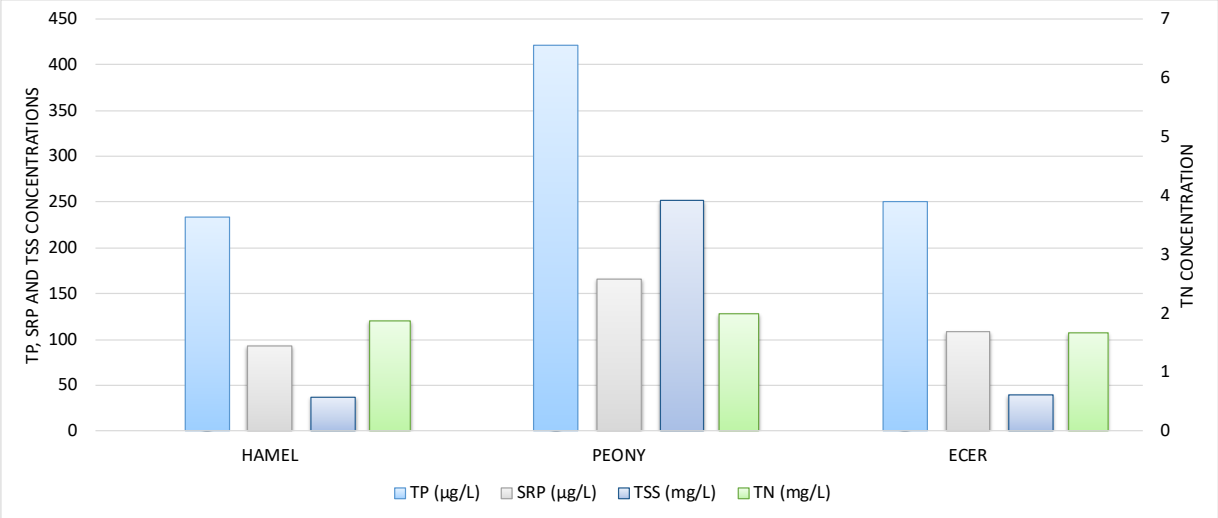

Figure 3.6.3 Average concentrations of TP, SRP, TSS and TN for the Elm Creek Watershed sites including: Hamel, Peony and ECER

3.6.4. Loading

The loading along Elm Creek has been monitored since 2000 at the Hamel site and the downstream site of ECER. The Peony site was added in 2016 to monitor between Hamel and ECER as well as monitor the effects of upstream retention ponds, stream restoration and iron enhanced retention ponds that were installed in 2016. Nutrient and sediment loading was greater at ECER than Hamel every year due to a larger watershed size and flow volumes. However, due to a large wetland complex between these sites, the nutrient and sediment concentrations are reduced at ECER compared with Hamel.

Hamel

At Hamel, data has been collected since 2000 except for 2004-2006 and 2013-2015 (Table 3.6.3). Immediately downstream of the monitoring site, a stream restoration project was completed in 2015. The project included the construction of a small retention pond and planting of native species on the stream banks. Around the end of June 2018, a culvert collapsed just upstream of the monitoring site. The excess sediment created new sandbars in the channel near the monitoring site and resulted in a grab sample having higher than normal TSS concentrations. While the culvert collapse created higher concentrations of TSS, the overall TSS concentration decreased in 2018 compared to 2017. With an increase in flow, total loading increased at Hamel for TP, SRP and TN compared to 2017.

The unit area loads (UAL) by year are listed in Table 3.6.4. At Hamel, the 2018 TP UAL of 0.58 lbs/acre is lower than the MPCA Stormwater Manual residential UAL of 1.35 lbs/acre. The 2018

TSS UAL of 127 is higher than the MPCA Stormwater Manual residential UAL of 77 lbs/acre. The TSS UAL in the last 4 monitored years (2012 and 2016 - 2018) were higher than the previous 6 years of monitoring which could be due to the stream restoration and construction work that occurred close to the stream.

Table 3.6.3 Loading and flow weighted concentrations of TP, SRP, TN and TSS at Hamel.

Hamel										
	Nutrient Loading				Nutrient Concentration					
Year	TP (lbs/yr)	SRP (lbs/yr)	TN (lbs/yr)	TSS (lbs/yr)	TP (µg/L)	SRP (µg/L)	TN (mg/L)	TSS (mg/L)	Flow Volume (x 10^6 M^3)	Annual Precipitation (inches)
2000	195	73	1,288	32,551	304	113	2.00	54	0.31	32.3
2001	1,164	533	5,922	39,637	354	162	1.80	12	1.97	34.6
2002	5,967	2,769	30,496	771,083	378	175	1.90	49	7.14	38.1
2003	1,233	703	9,442	141,995	234	133	1.80	27	2.39	25.8
2007	308	171	4,268	155,002	158	88	2.19	98	0.88	31.1
2008	798	261	7,111	246,323	208	68	1.85	76	3.22	20.8
2009	280	122	3,425	40,295	187	82	2.29	30	0.68	19.6
2010	2,157	721	9,810	166,074	331	111	1.51	25	2.95	31.2
2011	4,021	1,004	36,604	365,365	301	75	2.74	27	6.07	26.3
2012	2,459	853	20,583	645,515	349	121	2.92	92	3.20	26.7
2016	7,803	1,877	50,003	1,377,750	435	103	2.74	76	8.13	38.6
2017	1,601	475	16,871	670,208	214	64	2.25	90	3.19	27.8
2018	2,497	935	19,250	543,975	247	93	1.91	54	4.58	30.8

Table 3.6.4 Unit area loading for TP, SRP, TN and TSS at Hamel

Hamel				
	Load/Acre			
Year	TP (lbs/acre)	SRP (lbs/acre)	TN (lbs/acre)	TSS (lbs/acre)
2000	0.05	0.02	0.30	8
2001	0.27	0.12	1.39	9
2002	1.40	0.65	7.14	180
2003	0.29	0.16	2.21	33
2007	0.07	0.04	1.00	36
2008	0.19	0.06	1.66	58
2009	0.07	0.03	0.80	9
2010	0.50	0.17	2.30	39
2011	0.94	0.24	8.57	86
2012	0.58	0.20	4.82	151
2016	1.83	0.44	11.70	323
2017	0.37	0.11	3.95	157
2018	0.58	0.22	4.51	127
Average	0.55	0.19	3.87	94

Peony

At Peony, data has been collected since 2016 (Table 3.6.5). In 2018, the concentrations of TP, SRP, TN and TSS increased compared to 2017, therefore there was an increase in loading in 2018 compared to 2017. While the loading was higher in 2018 compared to 2017, the loading of TP, SRP and TN were less than 2016 loadings when the BMP's were installed. The TSS concentration and loading has increased from 2016 to 2018. Continued monitoring will provide more information and provide data to assess the effects of the BMP's.

The unit area loads (UAL) by year are listed in Table 3.6.6. At Peony, the average TP UAL of 1.25 lbs/acre is similar to the MPCA Stormwater Manual residential UAL of 1.35 lbs/acre. The average TSS UAL of 896 lbs/acre is much higher than the MPCA Stormwater Manual residential UAL of 77 lbs/acre.

The UAL's were also assessed between Hamel and Peony by subtracting the Hamel load from the Peony load and assessing the loading for the contributing acres between Hamel and Peony ([Peony load – Hamel load] ÷ [Peony watershed acres – Hamel watershed acres]). This shows how concentrated the loading of sediment and phosphorus are between Hamel and Peony. The TP and SRP UALs are double and the TSS UAL is almost four times higher in the additional 1,000 acres of land between Hamel and Peony. The average TN UAL decreases due to high loading in 2016 when more of the TN load was coming from above the Hamel site.

Table 3.6.5 Loading and flow weighted concentrations of TP, SRP, TN and TSS at Peony.

Peony										
	Nutrient Loading				Nutrient Concentration					
Year	TP (lbs/yr)	SRP (lbs/yr)	TN (lbs/yr)	TSS (lbs/yr)	TP (µg/L)	SRP (µg/L)	TN (mg/L)	TSS (mg/L)	Flow Volume (x 10^6 M^3)	Annual Precipitation (inches)
2016	11,470	2,575	54,362	4,284,931	643	144	3.05	240	8.08	31.2
2017	3,734	1,549	22,516	5,139,148	317	127	1.85	422	5.19	27.8
2018	5,161	1,659	28,147	5,167,027	453	146	2.47	453	5.17	30.8

Table 3.6.6 Unit area loads for TP, SRP, TN and TSS at Peony along with the unit area loads at Peony adjusted for the Hamel loading

	Peony				Peony adjusted for Hamel loading			
	Load/Acre				Load/Acre			
Year	TP (lbs/acre)	SRP (lbs/acre)	TN (lbs/acre)	TSS (lbs/acre)	TP (lbs/acre)	SRP (lbs/acre)	TN (lbs/acre)	TSS (lbs/acre)
2016	2.11	0.47	10.01	789	3.17	0.60	3.77	2513
2017	0.69	0.29	4.15	947	1.84	0.93	4.88	3863
2018	0.95	0.31	5.18	952	2.30	0.63	7.69	3996
Average	1.25	0.36	6.45	896	2.44	0.72	5.45	3457

ECER

At ECER, data has been collected since 2000 except for 2004-2006 and 2013-2015 (Table 3.6.7). The TP, SRP, TN, and TSS concentrations and total loadings were higher in 2018 compared to 2017. The TSS concentration was four times higher in 2018 compared to 2017, but compared to upstream site Peony, the total TSS loading was about half. Continued monitoring will assess the loading that leaves the City of Plymouth in Elm Creek.

The unit area loads (UAL) by year are listed in Table 3.6.8. At ECER, the average TP UAL of 0.46 lbs/acre is lower than the MPCA Stormwater Manual residential UAL of 1.35 lbs/acre. The average TSS UAL of 74 is close to the MPCA Stormwater Manual residential UAL of 77 lbs/acre. However, the 2018 TSS UAL of 296 mg/L is almost 4 times the MPCA Stormwater Manual UAL.

The UAL's were also assessed between Peony and ECER by subtracting the Peony load from the ECER load and assessing the loading for the 1,157 acres in between Peony and ECER ([ECER load – Peony load] ÷ [ECER watershed acres – Peony watershed acres]). Between Peony and ECER, the UAL for TP and TSS decreased, while the UAL for SRP and TN increased. The main driver of these interactions is that Elm Creek flows through a 210 acre wetland complex. The wetland removes TP and TSS by filtering/settling of suspended sediments. The decomposition of organic material in the wetland may be a source of SRP and TN release.

Table 3.6.7 Loading and flow weighted concentrations of TP, SRP, TN and TSS at ECER.

ECER - Elm Creek @ Elm Road										
	Nutrient Loading				Nutrient Concentration					
Year	TP (lbs/yr)	SRP (lbs/yr)	TN (lbs/yr)	TSS (lbs/yr)	TP (µg/L)	SRP (µg/L)	TN (mg/L)	TSS (mg/L)	Flow Volume (x 10^6 M^3)	Annual Precipitation (inches)
2000	869	261	6,415	104,191	232	70	1.70	28	1.62	32.3
2001	4,408	1,946	26,544	342,708	289	131	1.80	23	5.37	34.6
2002	7,994	2,911	30,541	838,460	416	151	1.60	44	8.72	38.1
2003	2,218	968	12,840	215,520	263	115	1.50	26	3.82	25.8
2007	659	583	8,238	390,206	227	201	2.84	134	2.29	31.1
2008	941	576	8,744	473,456	261	160	2.43	131	2.25	20.8
2009	654	372	4,539	65,183	232	132	1.61	23	1.42	19.6
2010	3,601	2,063	19,074	728,546	381	218	2.02	77	5.19	31.2
2011	5,615	2,753	18,313	147,238	287	141	1.98	16	9.81	26.3
2012	2,784	1,890	22,641	284,335	209	142	1.70	21	7.08	26.7
2016	8,214	2,731	54,385	1,198,469	333	111	2.20	49	11.47	38.6
2017	3,281	1,889	26,705	460,503	184	106	1.50	26	7.60	27.8
2018	6,388	2,907	43,845	2,341,010	276	126	1.90	101	10.48	30.8

Table 3.6.8 Unit area loads for TP, SRP, TN and TSS at ECER along with loadings adjusted for Peony loading

	ECER				ECER adjusted for Peony loading			
	Load/Acre				Load/Acre			
Year	TP (lbs/acre)	SRP (lbs/acre)	TN (lbs/acre)	TSS (lbs/acre)	TP (lbs/acre)	SRP (lbs/acre)	TN (lbs/acre)	TSS (lbs/acre)
2000	0.11	0.03	0.81	13				
2001	0.56	0.25	3.35	43				
2002	1.01	0.37	3.86	106				
2003	0.28	0.12	1.62	27				
2007	0.08	0.07	1.04	49				
2008	0.12	0.07	1.10	60				
2009	0.08	0.05	0.57	8				
2010	0.45	0.26	2.41	92				
2011	0.71	0.35	2.31	19				
2012	0.35	0.24	2.86	36				
2016	1.04	0.34	6.87	151	-1.31	0.06	0.01	-1239
2017	0.41	0.24	3.37	58	-0.18	0.14	1.68	-1877
2018	0.81	0.37	5.54	296	0.49	0.50	6.30	-1134
Average	0.46	0.21	2.75	74	-0.33	0.23	2.66	-1417

3.7. Ponderosa Rain Garden (PRG)

An iron enhanced rain garden was installed near 2625 Garland Lane North in the summer of 2016. Water samples were collected from street runoff flowing into the rain garden (PRG-In). Samples were also collected at the outlet of the rain garden from a perforated pipe that runs under the rain garden to a nearby storm drain (PRG-Out). TRPD collected samples in 2017 and 2018.

3.7.1. Concentration

In 2018, there were 8 samples collected during rain events (PRG-In: 4, PRG-Out: 4). Typically, the "Out" sample has more coloration than the "In" sample (Figure 3.7.1). The concentrations of TP, SRP and TN were all higher in the "Out" sample compared to the "In" sample except for the SRP on 7/25 when there was a 70% decrease (Figure 3.7.2). The TSS decreased between the "In" and "Out" samples by at least 38% and up to 97%. On average, the SRP was 40% of TP for the PRG-In samples. For 3 of the PRG-out samples, the SRP was 82% of the TP, but one SRP sample was only 1% of the TP on July 25th.

When compared by year, the TP, SRP and TSS concentrations were lower in 2018 compared to 2017 (Table 3.7.1). This may have been due to timing of the sample collection since the street run-off (In sample) was also lower.

Figure 3.7.1 PRG-In sample (left) and PRG-Out sample (right) collected on 6/18/18 shows the color difference that occurs by the rain water going through the wetland.

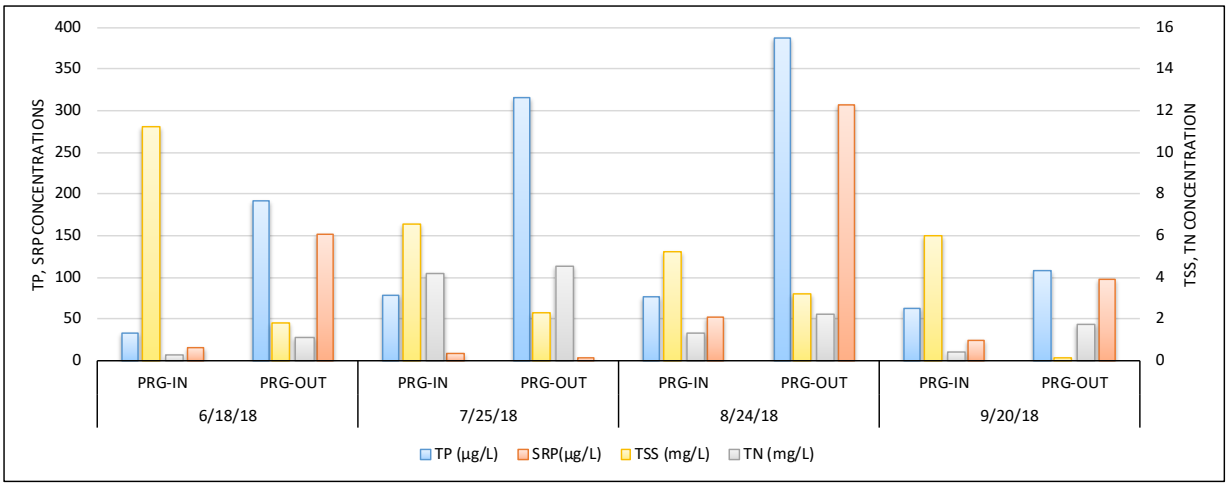

Figure 3.7.2 Concentrations of TP, SRP, TSS and TN for the Ponderosa Rain Garden inlet versus outlet for each sampling occurrence

Table 3.7.1 Summary of average, minimum and maximum concentrations for TP, SRP, TN and TSS at the Ponderosa rain garden for ingoing water and outgoing water for 2017-2018

Year	Site	Ave TP (min-max) µg/L	Ave SRP (min-max) µg/L	Ave TN (min-max) mg/L	Ave TSS (min-max) mg/L
2017	PRG-IN	103 (18 - 156)	39 (8 - 101)	1.3 (0.3 - 2.0)	22 (3.2 - 55)
	PRG-OUT	383 (244 - 586)	309 (164 - 497)	2.0 (1.4 - 3.2)	7.1 (1.7 - 21)
2018	PRG-IN	63 (33 - 77)	25 (9 - 52)	1.6 (0.3 - 4.2)	7.2 (5.2 - 11.2)
	PRG-OUT	251 (107 - 388)	140 (3 - 308)	2.4 (1.1 - 4.6)	1.9 (0.2 - 3.2)

3.7.2. Observations

For the 2nd year, the iron enhanced sand rain garden did not remove TP, SRP or TN but instead increased the concentration as water filtered through the rain garden. Despite the increase in nutrients, the rain garden was effective at removing/filtering sediments. A few observations are listed below.

- Large increases in phosphorus could be attributed to:
    - The soil/compost used in the rain garden may have too high of phosphorus content and therefore releases phosphorus into the water while moving through the rain garden. Soil samples should be tested to determine how much phosphorus is attached to the sediments and how much phosphorus would be released
    - Timing of events/samples: Due to timing of events, samples were not always collected in “first flush.” If samples were during first flush, it is possible the inlet

concentrations would be higher. According to the MPCA Stormwater Manual, the median TP concentration for residential areas is 260 µg/L (MPCA, 2017), which is at least double the concentrations measured in the runoff. The MPCA Stormwater manual also lists the range of TP concentrations from less than 10 to 19,900 µg/L, so there is a wide range of TP concentrations for runoff (MPCA, 2017)

- The rain garden is reducing sediment loading which would be expected since the rain garden acts as a filter for particles
- While there is a decrease in concentration between 2017 to 2018, the ratio of TP in the "In" sample compared to the "Out" sample is similar between the 2 years

4.0 CITATIONS

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5.0 STORMWATER AVERAGE DAILY FLOWS

Average daily flow in cfs for all sites along with precipitation in Plymouth, MN.

Date	BL3-East	BL3-West	ECER	GC-1	Hamel	IP2	NLS	PC2	Peony	PL1	PL2	Precipitation
4/14/18												**0.79**
4/15/18												**0.22**
4/16/18												**0**
4/17/18												**0**
4/18/18												**0**
4/19/18												**0**
4/20/18												**0**
4/21/18												**0**
4/22/18												**0**
4/23/18	**8.711**	**7.368**				**32.315**		**32.352**				**0**
4/24/18	**8.22**	**6.979**	**77.219**	**5.105**	**32.5**	**28.381**		**31.011**				**0**
4/25/18	**6.959**	**5.894**	**63.147**	**3.656**	**28.706**	**22.202**	**5.075**	**27.984**				**0**
4/26/18	**5.832**	**5.015**	**51.355**	**2.388**	**24.9**	**16.589**	**3.718**	**22.631**				**0**
4/27/18	**5.066**	**4.5**	**45.839**	**1.66**	**21.779**	**13.015**	**2.815**	**19.257**			**0.301**	**0**
4/28/18	**4.34**	**3.885**	**38.695**	**1.102**	**19.083**	**10.165**	**2.588**	**15.383**	**20.373**		**0.38**	**0**
4/29/18	**4.195**	**3.635**	**31.168**	**0.998**	**16.222**	**8.073**	**2.278**	**11.948**	**17.405**		**0.317**	**0**
4/30/18	**3.889**	**3.224**	**28.466**	**1.045**	**14.308**	**6.948**	**1.902**	**9.496**	**15.95**	**0.017**	**0.301**	**0.01**
5/1/18	**3.4**	**3.262**	**27.139**	**1.267**	**13.378**	**7.117**	**1.729**	**9.797**	**15.24**	**0.013**	**0.372**	**0.11**
5/2/18	**2.848**	**3.169**	**27.474**	**1.83**	**13.858**	**10.875**	**2.155**	**17.268**	**15.509**	**0.24**	**1.59**	**0.06**
5/3/18	**2.504**	**2.79**	**26.154**	**1.333**	**12.561**	**7.902**	**1.722**	**11.46**	**15.036**	**0.004**	**0.588**	**0**
5/4/18	**2.469**	**2.66**	**23.853**	**1.166**	**11.38**	**6.626**	**1.577**	**8.967**	**14.022**	**0**	**0.365**	**0**
5/5/18	**2.226**	**2.389**	**21.24**	**0.96**	**10.231**	**6.48**	**1.545**	**6.616**	**12.66**	**0**	**0.331**	**0.25**
5/6/18	**2.262**	**2.445**	**20.286**	**0.814**	**9.46**	**7.627**	**1.355**	**6.162**	**11.722**	**0**	**0.275**	**0.01**
5/7/18	**2.208**	**2.358**	**18.45**	**0.658**	**8.107**	**5.696**	**1.636**	**3.889**	**10.685**	**0**	**0.229**	**0**
5/8/18	**1.995**	**1.938**	**16.072**	**0.956**	**7.047**	**4.937**	**1.751**	**3.461**	**9.704**	**0.007**	**0.236**	**0.14**
5/9/18	**2.009**	**1.773**	**16.696**	**1.084**	**7.369**	**6.827**	**3.653**	**4.594**	**10.384**	**0.063**	**0.821**	**0.05**
5/10/18	**1.86**	**1.642**	**15.504**	**0.786**	**6.46**	**5.134**	**2.304**	**3.411**	**9.492**	**0**	**0.247**	**0**
5/11/18	**1.785**	**1.608**	**14.146**	**0.526**	**5.425**	**4.218**	**1.91**	**2.912**	**7.867**	**0**	**0.212**	**0**
5/12/18	**1.736**	**1.54**	**13.118**	**0.562**	**4.542**	**3.81**	**1.001**	**3.712**	**6.711**	**0**	**0.208**	**0**
5/13/18	**1.669**	**1.484**	**11.518**	**0.564**	**3.933**	**3.526**	**0.733**	**2.279**	**5.63**	**0**	**0.226**	**0**

Date	BL3-East	BL3-West	ECER	GC-1	Hamel	IP2	NLS	PC2	Peony	PL1	PL2	Precipitation
5/14/18	1.602	1.434	11.006	0.73	3.572	4.405	1.195	2.282	5.044	0.057	0.59	0.13
5/15/18	1.533	1.495	11.315	0.842	3.387	5.191	1.115	2.764	4.903	0.007	0.538	0
5/16/18	1.317	1.383	9.555	0.671	2.943	4.203	0.453	2.342	4.254	0	0.212	0
5/17/18	1.15	1.178	9.071	0.617	3.148	3.621	0.505	3.748	4.139	0	0.182	0
5/18/18	1.244	1.299	8.763	0.868	2.879	3.099	0.58	1.786	3.868	0.036	0.233	0.14
5/19/18	1.38	1.468	8.687	1.294	2.915	5.033	1.434	3.461	3.774	0.068	0.692	0.02
5/20/18	1.247	1.34	8.328	0.901	2.595	3.139	1.303	3.306	3.621	0	0.103	0
5/21/18	1.021	1.036	7.86	0.566	2.278	2.498	1.373	3.216	3.091	0	0.11	0
5/22/18	0.892	0.93	7.379	0.428	2.046	2.262	1.146	1.317	3.035	0	0.106	0
5/23/18	0.768	0.85	7.276	0.361	2.167	2.054	0.947	2.823	2.996	0	0.12	0
5/24/18	0.719	0.839	7.681	0.484	2.239	2.16	0.787	0.739	2.951	0.017	0.38	0.11
5/25/18	2.003	2.288	16.393	2.102	4.944	13.373	1.606	13.006	8.103	0.834	0.21	0.48
5/26/18	1.893	2.502	14.724	0.841	3.028	6.809	0.174	9.709	5.11	0.005	0.344	0
5/27/18	1.252	1.818	10.089	0.492	2.277	4.069	0.322	5.745	3.422	0.004	0.137	0
5/28/18	1.091	1.58	8.553	0.457	2.605	3.549	1.479	4.962	3.329	0.071	0.334	0.13
5/29/18	1.081	1.59	11.207	1.415	4.405	4.723	2.629	6.017	6.128	0.46	1.652	0.39
5/30/18	1.761	2.324	28.61	3.287	9.18	17.627	3.807	14.618	13.627	0.153	1.763	0.1
5/31/18	1.645	2.143	24.856	1.422	7.256	10.949	1.64	10.821	9.801	0.01	0.509	0
6/1/18	1.544	2.073	16.06	0.872	5.916	7.39	1.563	8.532	8.123	0	0.205	0
6/2/18	1.415	1.975	13.828	0.849	5.339	6.299	2.39	7.194	6.845	0.054	0.406	0.18
6/3/18	1.08	1.678	11.722	1.017	4.531	5.376	1.317	6.289	5.84	0	0.236	0
6/4/18	0.968	1.56	9.492	0.928	3.456	4.05	0.742	4.38	5.416	0	0.241	0
6/5/18	0.887	1.474	8.175	0.752	2.569	3.119	0.495	4.145	3.863	0	0.396	0
6/6/18	0.874	1.475	7.815	1.093	2.576	4.842	1.639	5.563	4.18	0.133	1.103	0.23
6/7/18	0.707	1.288	6.72	1.226	1.909	3.523	0.355	5.183	3.228	0.004	0.428	0
6/8/18	0.682	1.243	5.86	0.746	1.715	2.547	0.914	2.124	2.899	0	0.409	0
6/9/18	0.752	1.285	6.998	1.122	2.587	6.908	3.11	8.319	3.933	0.327	1.774	0.4
6/10/18	0.763	1.339	8.978	1.138	2.092	7.438	1.421	8.088	3.932	0.021	0.533	0
6/11/18	0.877	1.203	7.516	0.814	1.988	4.448	1.757	2.638	3.35	0.047	0.495	0.09
6/12/18	0.908	1.052	7.304	0.728	1.88	4.031	1.128	0.108	3.178	0.002	0.419	0
6/13/18	0.91	1.07	6.16	0.504	1.621	3.204	0.77	0.868	2.956	0	0.335	0
6/14/18	0.797	0.965	5.236	0.394	1.414	2.548	0.315	0.765	2.188	0	0.29	0
6/15/18	0.662	0.822	4.226	0.261	1.254	2.246	0.357	0.648	2.103	0.016	0.293	0.04
6/16/18	0.895	1.009	5.514	1.961	2.652	10.95	3.719	11.608	4.551	0.64	1.916	0.65
6/17/18	1.841	1.911	10.118	2.406	4.668	11.092	2.656	11.353	7.334	1.334	1.395	0.83

Date	BL3-East	BL3-West	ECER	GC-1	Hamel	IP2	NLS	PC2	Peony	PL1	PL2	Precipitation
6/18/18	5.884	5.754	30.676	8.434	20.054	40.728	10.968	48.333	18.694	0.583	4.409	0.46
6/19/18	6.154	6.082	63.624	5.476	18.832	36.628	7.343	36.657	22.016	0.158	2.243	0.23
6/20/18	5.314	5.396	48.899	3.718	14.255	24.43	3.482	24.483	18.253	0.017	0.799	0
6/21/18	4.651	4.907	32.906	2.396	11.016	15.115	1.848	15.661	14.246	0	0.291	0
6/22/18	3.871	4.313	24.941	1.795	9.105	10.414	1.188	11.261	10.992	0	0.242	0
6/23/18	3.014	3.622	19.987	1.432	7.369	7.344	0.649	8.253	8.971	0	0.238	0
6/24/18	2.292	2.795	15.715	1.164	6.023	5.451	0.309	6.407	7.442	0	0.307	0
6/25/18	1.77	2.1	12.855	0.919	4.862	4.285	0.478	5.257	6.136	0	0.221	0
6/26/18	3.899	4.206	31.748	9.377	18.439	38.538	9.068	44.4	21.135	1.034	4.1	1.05
6/27/18	5.114	5.503	44.051	4.757	14.021	24.283	3.234	29.205	17.876	0.052	0.973	0
6/28/18	4.203	4.76	10.461	3.073	9.657	11.928	1.366	15.292	11.708	0.005	0.294	0
6/29/18	3.173	3.75	16.066	2.267	8.255	8.716	0.398	9.793	9.408	0	0.179	0
6/30/18	2.229	2.784	16.944	1.691	7.228	6.568	0.755	6.128	8.168	0.002	0.187	0.02
7/1/18	3.818	4.188	45.768	11.452	27.585	27.933	10.816	33.419	37.553	1.391	5.17	1.24
7/2/18	6.733	6.906	101.507	7.817	51.654	44.551	6.395	51.185	53.783	0.137	1.459	0
7/3/18	5.481	5.97	78.56	4.436	35.555	23.903	2.706	34.994	40.384	0.045	0.7	0.07
7/4/18	4.459	5.022	47.854	3.754	26.64	18.185	2.647	29.235	33.235	0.227	1.027	0.18
7/5/18	3.402	4.035	35.827	2.986	22.47	12.733	2.044	21.734	29.024	0.015	0.368	0
7/6/18	2.542	3.108	30.965	2.251	18.325	8.659	1.256	15.338	22.426	0	0.162	0
7/7/18	1.827	2.259	26.154	1.753	15.287	6.434	0.783	10.108	15.703	0	0.155	0
7/8/18	1.353	1.695	21.006	1.34	12.723	4.912	0.836	6.141	13.305	0	0.122	0
7/9/18	1.043	1.433	17.295	1.081	10.306	3.749	0.611	4.111	10.352	0	0.154	0
7/10/18	0.854	1.205	14.4	0.805	8.552	3.01	0.525	3.716	8.742	0	0.157	0
7/11/18	0.658	1.031	12.278	0.581	7.165	2.514	0.969	0.709	6.983	0	0.102	0.13
7/12/18	0.59	0.969	13.509	1.1	8.399	5.929	5.451	8.107	9.353	0.419	1.169	0.52
7/13/18	1.187	1.582	22.368	1.465	9.837	9.238	3.941	12.17	12.842	0.094	0.91	0.17
7/14/18	1.279	1.684	19.869	0.943	8.227	5.002	1.817	5.262	8.518	0.001	0.172	0
7/15/18	1.095	1.466	15.86	0.615	7.257	3.444	0.951	3.797	6.854	0	0.123	0
7/16/18	0.894	1.241	11.647	0.351	6.275	2.598	0.409	4.703	5.966	0	0.14	0
7/17/18	0.585	0.948	8.724	0.239	4.887	2.051	0.61	3.088	4.603	0	0.153	0
7/18/18	0.404	0.772	6.861	0.157	3.794	1.738	0.553	1.289	3.55	0	0.097	0
7/19/18	0.349	0.697	5.49	0.186	3.268	2.237	0.776	2.005	3.062	0.068	0.305	0.12
7/20/18	0.35	0.647	4.61	0.243	3.058	2.835	1.092	3.591	2.861	0.039	0.353	0.16
7/21/18	0.326	0.666	4.076	0.239	2.81	2.688	0.403	2.8	2.481	0	0.169	0
7/22/18	0.252	0.62	3.534	0.166	2.575	1.718	0.244	1.793	2.083	0	0.133	0

Date	BL3-East	BL3-West	ECER	GC-1	Hamel	IP2	NLS	PC2	Peony	PL1	PL2	Precipitation
7/23/18	0.239	0.586	3.355	0.109	2.4	1.615	0.127	1.564	1.821	0	0.161	0
7/24/18	0.224	0.519	3.481	0.087	2.222	1.557	0.168	2.826	1.76	0	0.109	0
7/25/18	0.253	0.506	3.636	0.275	2.971	5.025	3.959	8.408	1.68	0	0.828	0.67
7/26/18	0.597	0.848	3.622	0.215	2.641	8.024	1.448	5.751	3.177	0	0.237	0.15
7/27/18	0.683	0.821	2.768	0.095	2.042	3.534	0.068	2.944	2.174	0	0.214	0
7/28/18	0.424	0.579	1.98	0.07	1.71	2.692	0.54	1.899	1.667	0	0.156	0.24
7/29/18	0.293	0.416	1.411	0.097	1.519	2.488	0.224	1.46	1.314	0	0.295	0
7/30/18	0.226	0.344	0.689	0.101	1.436	2.008	0.151	1.533	1.309	0	0.235	0
7/31/18	0.188	0.315	0	0.101	1.237	1.672	0.142	1.498	1.031	0	0.236	0
8/1/18	0.189	0.304	0.076	0.113	1.45	2.489	0.546	2.765	1.303	0.013	0.461	0.09
8/2/18	0.167	0.264	0.733	0.11	1.246	2.045	0.127	2.775	1.148	0	0.161	0
8/3/18	0.209	0.295	2.324	0.806	3.158	5.588	4.635	8.8	4.085	0.512	1.176	1.11
8/4/18	1.601	1.578	12.247	1.392	6.114	22.414	7.548	17.669	12.727	0.058	1.306	0.04
8/5/18	1.648	1.639	12.692	0.701	3.889	7.528	2.631	5.992	4.579	0	0.432	0
8/6/18	0.951	1.051	6.418	0.401	3.072	4.595	0.983	3.822	3.039	0	0.227	0
8/7/18	0.563	0.719	5.836	0.358	2.686	3.707	0.875	3.218	2.457	0	0.207	0
8/8/18	0.376	0.519	6.248	0.358	2.39	3.107	0.43	2.423	2.108	0	0.131	0
8/9/18	0.27	0.391	5.292	0.252	2.088	2.548	0.042	2.207	1.676	0	0.138	0
8/10/18	0.206	0.303	3.959	0.136	1.831	2.035	0.115	1.429	1.409	0	0.121	0
8/11/18	0.17	0.229	3.126	0.052	1.635	1.672	0.045	3.05	1.144	0	0.091	0
8/12/18	0.142	0.176	3.137	0.038	1.51	1.422	0.123	1.819	1.074	0	0.105	0
8/13/18	0.146	0.17	2.131	0.044	1.367	1.244	0.275	1.058	0.993	0	0.125	0
8/14/18	0.139	0.18	1.923	0.034	1.264	1.195	0.139	1.582	0.886	0	0.146	0
8/15/18	0.105	0.197	1.806	0.095	1.155	1.265	0.317	4.542	0.825	0	0.069	0
8/16/18	0.079	0.161	1.77	0.165	1.024	1.198	0.234	2.525	0.737	0	0.061	0
8/17/18	0.076	0.112	1.501	0.161	0.917	1.139	0.167	0	0.686	0	0.066	0
8/18/18	0.047	0.105	1.312	0.16	0.955	1.033	0.247	1.043	0.825	0	0.144	0
8/19/18	0.024	0.093	1.078	0.156	1.113	0.701	0.272	2.323	0.824	0	0.167	0
8/20/18	0.027	0.086	1.266	0.184	0.884	1.024	0.519	0.176	0.71	0.195	0.352	0.09
8/21/18	0.03	0.053	1.273	0.223	0.539	1.671	0.151	0.779	0.582	0	0.218	0
8/22/18	0.019	0.039	1.262	0.208	0.455	0.833	0.197	1.703	0.54	0	0.059	0
8/23/18	0.009	0.029	1.166	0.195	0.401	0.095	0.093	2.699	0.474	0	0.053	0
8/24/18	1.487	1.398	9.761	2.193	5.804	23.892	11.728	26.176	17.053	1.027	3.892	1.7
8/25/18	4.803	4.577	22.508	1.607	3.541	30.085	5.853	20.88	9.939	0.011	0.748	0.01
8/26/18	3.32	3.117	11.681	0.997	2.051	11.743	1.551	8.855	3.509	0	0.315	0

Date	BL3-East	BL3-West	ECER	GC-1	Hamel	IP2	NLS	PC2	Peony	PL1	PL2	Precipitation
8/27/18	2.401	2.207	8.543	0.703	1.641	8.169	0.611	6.242	2.291	0.009	0.302	0.06
8/28/18	1.879	1.726	7.696	0.902	2.284	11.325	2.587	8.661	3.213	0.118	0.835	0.27
8/29/18	1.598	1.493	7.715	0.813	1.988	8.864	1.348	5.922	2.968	0.001	0.339	0
8/30/18	1.227	1.176	6.682	0.561	1.525	6.186	0.217	3.499	2.149	0	0.284	0
8/31/18	0.985	1.019	6.134	0.508	1.654	5.086	0.308	2.992	2.12	0.003	0.31	0.06
9/1/18	0.75	0.811	5.85	0.48	1.246	3.938	0.183	2.756	1.589	0	0.292	0
9/2/18	0.64	0.698	4.724	0.371	1.172	3.495	0.309	2.78	1.586	0.016	0.307	0.04
9/3/18	0.519	0.541	3.72	0.305	1.047	2.965	0.309	2.407	1.38	0.001	0.329	0
9/4/18	0.644	0.614	6.451	1.165	2.459	9.811	3.474	9.158	4	0.462	2.234	1.26
9/5/18	1.468	1.424	11.928	1.802	3.315	14.926	5.33	12.415	6.903	0.044	1.67	0.04
9/6/18	1.422	1.34	9.82	0.743	2.09	6.007	0.578	4.742	3.2	0	0.36	0
9/7/18	1.125	1.047	2.124	0.424	1.524	4.24	0	2.973	2.288	0	0.205	0
9/8/18	0.813	0.787	0.645	0.17	1.236	3.457	0.01	2.098	1.71	0	0.149	0
9/9/18	0.564	0.572	1.499	0.269	0.98	2.927	0.02	1.83	1.261	0	0.189	0
9/10/18	0.438	0.449	2.249	0.142	0.857	2.437	0	1.368	1.098	0	0.245	0
9/11/18	0.363	0.343	2.501	0.011	0.812	2.055	0.016	1.059	1.018	0	0.167	0
9/12/18	0.304	0.252	2.733	0	0.753	1.493	0	1.476	0.923	0	0.143	0
9/13/18	0.266	0.077	2.033	0	0.701	1.003	0.071	0	0.841	0	0.184	0
9/14/18	0.226	0.137	1.854	0.081	0.671	0.999	0.004	4.248	0.78	0	0.147	0
9/15/18	0.211	0.11	1.54	0.107	0.644	0.829	0	1.708	0.753	0	0.142	0
9/16/18	0.187	0.142	1.57	0.104	0.607	0.64	0.004	3.692	0.695	0	0.138	0
9/17/18	0.201	0.07	1.934	0.289	1.139	2.262	0.018	3.455	1.191	0.183	0.883	0.57
9/18/18	1.155	1.176	6.707	7.694	10.23	31.684	6.976	38.005	24.927	1.032	4.078	0.81
9/19/18	1.726	1.887	12.047	4.124	5.24	16.147	5.376	17.524	9.594	0.009	0.866	0.01
9/20/18	2.808	2.971	28.082	14.505	18.413	30.342	18.769	52.999	21.507	1.914	9.709	2.47
9/21/18	8.122	8.307	73.021	11.302	30.835	60.582	23.116	46.701	39.216	0.76	2.103	0
9/22/18	5.014	5.207	76.465	2.669	20.466	52.693	15.031	47.007	23.44	0.071	0.97	0
9/23/18	3.966	4.263	39.646	2.669	11.584	40.454	7.502	44.532	13.664	0.005	0.519	0
9/24/18	3.407	3.502	24.581	2.669	9.219	26.859	4.886	39.884	10.709	0.151	0.507	0.17
9/25/18	3.15	3.203	21.315	2.669	9.306	17.111	5.275	37.012	11.37	0.035	0.946	0.07
9/26/18	2.548	2.531	19.146	2.669	8.268	11.409	3.385	31.258	9.852	0	0.349	0
9/27/18	2.133	2.114	16.22	2.641	7.124	9.059	1.255	25.911	7.973	0	0.268	0
9/28/18	1.807	1.826	13.642	2.353	6.02	7.564	0.961	21.327	6.39	0	0.236	0
9/29/18	1.533	1.619	10.998	1.935	4.943	7.792	0.307	17.871	5.497	0	0.225	0
9/30/18	1.398	1.519	9.28	1.637	4.176	8.355	0.241	15.033	4.476	0	0.223	0

Date	BL3-East	BL3-West	ECER	GC-1	Hamel	IP2	NLS	PC2	Peony	PL1	PL2	Precipitation
10/1/18	1.255	1.369	9.047	1.532	4.06	6.646	1.06	13.34	4.329	0.049	0.65	0.16
10/2/18	1.221	1.325	8.001	1.069	4.171	4.924	0.477	11.955	4.429	0	0.364	0.01
10/3/18	1.057	1.211	9.97	1.387	4.096	8.131	1.992	11.581	4.172	0.064	1.262	0.33
10/4/18	0.733	1.196	9.253	1.667	3.953	10.071	0.53	11.739	4.13	0.031	0.845	0.1
10/5/18	1.085	1.265	9.658	1.648	3.922	7.955	1.807	10.624	4.51	0.033	1.106	0.08
10/6/18	1.046	1.155	9.369	1.426	3.736	6.026	1.401	6.933	4.295	0.007	0.407	0.01
10/7/18	0.944	1.097	7.672	1.202	3.289	4.755	0.703	6.022	3.686	0.002	0.294	0.03
10/8/18	1.026	1.203	9.545	1.485	4.056	6.499	5.809	8.504	4.998	0.218	1.03	0.33
10/9/18	1.746	2.058	14.044	3.937	8.805	18.614	15.219	25.912	16.001	0.784	3.18	0.77
10/10/18	4.546	5.168	32.639	7.741	21.181	44.857	12.48	67.283	40.487	0.77	1.196	0.21
10/11/18	4.076	4.734	62.362	4.985	18.377	32.925	5.363	48.158	28.649	0.202	1.279	0
10/12/18	3.31	3.752	38.35	3.648	12.769	20.578	3.183	28.213	18.905	0.063	0.772	0
10/13/18	2.922	3.182	26.262	2.963	10.149	15.097	2.852	21.503	15.062	0.022	0.533	0
10/14/18	2.638	2.667	22.652	2.39	8.778	11.579	2.688	19.269	13.194	0.013	0.425	0.05
10/15/18	2.266	2.186	16.823	2.107	7.737	8.999	1.996	14.282	11.645	0.005	0.457	0
10/16/18	1.975	1.91	15.735	1.786	6.8	6.981	1.385	10.49	9.738	0.002	0.254	0
10/17/18	1.733	1.752	12.719	1.304	5.851	5.718	1.649	7.822	8.641	0.005	0.198	0
10/18/18	1.562	1.761	10.432	1.111	4.954	4.895	0.96	5.762	7.423	0.005	0.191	0
10/19/18	1.588	1.759	10.43	1.074	4.534	4.212	0.76	6.489	6.474	0.005	0.202	0.01
10/20/18	1.453	1.649	9.347	1.046	4.255	3.941	0.38	6.754	5.662	0.005	0.196	0
10/21/18	1.23	1.37	8.713	1.025	3.622	3.865	0.069	3.612	5.457	0.005	0.234	0
10/22/18	1.173	1.235	7.227	0.914	3.309	3.7	0.036	5.066	4.948	0.005	0.171	0
10/23/18	1.063	1.191	4.6	0.77	3.049	3.541	0.031	3.382	4.04	0.005	0.137	0
10/24/18			5.043	0.666	2.968	3.507		1.626	3.966	0.005	0.154	0
10/25/18			5.705		2.93				4.361			0

6.0 STORMWATER SAMPLE DATA

All collected samples from the sites are listed here.

Site	Date	Type	TP (ug/L) (Reporting limit 15 ug/L)	SRP (ug/L) (Reporting limit 6 ug/L)	TN (mg/L) (Reporting limit 0.5 mg/L)	TSS (mgL)	TSS (mg/L) Reported	Cl (mg/L)
BL3-W	1-May-18	GRAB	73.17	9.79	0.94	3.60	<5	
BL3-W	14-May-18	GRAB	57.55	8.71	0.98	10.40	10.40	
BL3-W	25-May-18	COMP	233.30	124.85	3.47	23.60	23.60	
BL3-W	25-May-18	GRAB	60.46	20.10	0.98	2.00	<5	
BL3-W	29-May-18	GRAB	60.73	22.94	1.18	1.00	<5	
BL3-W	30-May-18	COMP	102.70	42.32	1.33	4.40	<5	
BL3-W	11-Jun-18	GRAB	128.80	34.24	1.62	2.40	<5	
BL3-W	18-Jun-18	COMP	167.50	39.02	1.28	6.00	<10	
BL3-W	25-Jun-18	GRAB	188.20	55.14	1.77	3.40	<5	
BL3-W	26-Jun-18	COMP	193.20	68.28	1.83	6.20	6.20	
BL3-W	2-Jul-18	COMP	162.30	93.78	1.39	17.20	17.20	
BL3-W	9-Jul-18	GRAB	208.00	117.88	1.66	2.57	<7	
BL3-W	13-Jul-18	GRAB	151.90	73.40	1.40	3.20	<5	
BL3-W	23-Jul-18	GRAB	128.70	60.98	1.70	7.60	<10	
BL3-W	6-Aug-18	GRAB	45.61	21.88	0.65	4.00	<10	
BL3-W	20-Aug-18	GRAB	317.00	123.77	3.14	10.00	10.00	
BL3-W	24-Aug-18	COMP	206.70	40.91	2.01	18.40	18.40	
BL3-W	4-Sep-18	GRAB	83.58	33.85	1.03	1.47	<3	
BL3-W	5-Sep-18	COMP	92.49	21.27	1.16	5.00	<6	
BL3-W	17-Sep-18	GRAB	158.70	50.30	1.80	2.40	<5	
BL3-W	18-Sep-18	GRAB	113.20	47.90	1.55	3.71	<7	
BL3-W	21-Sep-18	COMP	95.14	32.27	0.94	2.80	<5	
BL3-W	1-Oct-18	GRAB	60.49	25.03	0.77	6.67	<28	
BL3-W	10-Oct-18	COMP	76.05	16.20	0.63	2.75	<6	
BL3-W	15-Oct-18	GRAB	36.63	16.07	0.65	0.77	<4	
ECER	1-May-18	GRAB	98.84	29.83	0.99	4.60	<5	
ECER	14-May-18	GRAB	90.09	34.89	1.10	10.80	10.80	
ECER	25-May-18	COMP	237.20	70.70	1.93	43.20	43.20	
ECER	29-May-18	GRAB	181.50	68.59	1.80	6.40	6.40	
ECER	30-May-18	COMP	262.40	87.34	2.50	43.40	43.40	
ECER	11-Jun-18	GRAB	154.90	82.59	1.16	3.60	<5	
ECER	18-Jun-18	COMP	178.50	96.77	0.98	12.40	12.40	
ECER	25-Jun-18	GRAB	173.30	97.52	1.36	3.00	<5	
ECER	26-Jun-18	COMP	511.20	114.15	1.66	103.20	103.20	
ECER	2-Jul-18	COMP	247.00	169.43	3.76	257.00	257.00	

Site	Date	Type	TP (ug/L) (Reporting limit 15 ug/L)	SRP (ug/L) (Reporting limit 6 ug/L)	TN (mg/L) (Reporting limit 0.5 mg/L)	TSS (mgL)	TSS (mg/L) Reported	Cl (mg/L)
ECER	9-Jul-18	GRAB	439.50	145.71	3.07	10.40	10.40	
ECER	13-Jul-18	GRAB	498.60	167.50	2.44	15.20	15.20	
ECER	23-Jul-18	GRAB	162.90	76.96	1.57	2.20	<5	
ECER	6-Aug-18	GRAB	196.40	110.88	0.88	3.25	<6	
ECER	20-Aug-18	GRAB	356.80	187.74	1.39	2.67	<3	
ECER	24-Aug-18	COMP	475.60	150.94	3.08	186.00	186.00	
ECER	4-Sep-18	GRAB	189.60	136.63	1.19	2.27	<3	
ECER	5-Sep-18	COMP	304.30	104.78	1.57	35.40	35.40	
ECER	17-Sep-18	GRAB	226.40	139.82	1.36	1.47	<3	
ECER	18-Sep-18	COMP	293.80	115.09	1.56	25.20	25.20	
ECER	21-Sep-18	GRAB	328.20	162.83	1.39	166.00	166.00	
ECER	1-Oct-18	GRAB	115.30	71.42	1.07	2.00	<4	
ECER	10-Oct-18	COMP	182.70	84.16	1.12	20.86	20.86	
ECER	15-Oct-18	GRAB	92.86	63.00	0.88	1.54	<4	
GC-1	1-May-18	GRAB	97.27	20.66	0.94	4.60	<5	
GC-1	14-May-18	GRAB	122.10	27.96	1.11	13.40	13.40	
GC-1	25-May-18	COMP	373.30	34.45	1.51	128.67	128.67	
GC-1	29-May-18	GRAB	165.70	76.79	1.22	13.20	13.20	
GC-1	30-May-18	COMP	199.00	64.00	3.82	186.50	186.50	
GC-1	11-Jun-18	GRAB	127.40	57.26	1.22	4.40	<5	
GC-1	18-Jun-18	COMP	154.70		1.60	89.20	89.20	
GC-1	25-Jun-18	GRAB	93.20	54.85	0.88	3.40	<5	
GC-1	26-Jun-18	COMP	570.40	60.76	1.60	283.33	283.33	
GC-1	2-Jul-18	COMP	139.20	77.79	2.64	161.00	161.00	
GC-1	9-Jul-18	GRAB	154.50	83.38	1.07	13.20	13.20	
GC-1	13-Jul-18	COMP	277.10	106.59	1.63	36.00	36.00	
GC-1	23-Jul-18	GRAB	80.75	47.77	0.86	1.40	<5	
GC-1	26-Jul-18	COMP	381.00	88.54	1.68	42.00	42.00	
GC-1	6-Aug-18	GRAB	198.80	56.85	0.83	6.40	<10	
GC-1	20-Aug-18	GRAB	88.93	88.18	0.98	0.33	<4	
GC-1	24-Aug-18	COMP	272.40	72.10	2.74	94.80	94.80	
GC-1	4-Sep-18	GRAB	190.10	66.26	1.28	9.00	9.00	
GC-1	5-Sep-18	COMP	237.30	60.58	1.34	25.25	25.25	
GC-1	17-Sep-18	GRAB	104.60	74.56	1.01	2.53	<3	
GC-1	18-Sep-18	COMP	440.50	51.32	3.46	96.67	96.67	
GC-1	21-Sep-18	COMP	265.80	77.46	1.61	105.33	105.33	
GC-1	1-Oct-18	GRAB	97.06	40.91	0.98	3.80	<5	
GC-1	4-Oct-18	COMP	103.80	26.23	0.88	10.57	10.57	
GC-1	10-Oct-18	COMP	170.40	70.05	1.35	47.20	47.20	
GC-1	15-Oct-18	GRAB	83.57	27.69	0.94	3.60	<5	

Site	Date	Type	TP (ug/L) (Reporting limit 15 ug/L)	SRP (ug/L) (Reporting limit 6 ug/L)	TN (mg/L) (Reporting limit 0.5 mg/L)	TSS (mgL)	TSS (mg/L) Reported	Cl (mg/L)
HAMEL	1-May-18	GRAB	163.40	21.28	1.82	8.80	8.80	
HAMEL	14-May-18	GRAB	128.80	17.53	1.56	12.80	12.80	
HAMEL	29-May-18	GRAB	198.70	49.59	2.15	9.14	9.14	
HAMEL	30-May-18	GRAB	246.30	181.26	2.44	23.20	23.20	
HAMEL	11-Jun-18	GRAB	237.50	67.74	2.22	8.00	8.00	
HAMEL	12-Jun-18	COMP	181.20	72.80	2.03	10.00	10.00	
HAMEL	18-Jun-18	COMP	203.80	91.33	1.75	97.60	97.60	
HAMEL	25-Jun-18	GRAB	236.50	99.76	1.91	8.80	8.80	
HAMEL	2-Jul-18	GRAB	284.10	141.55	2.45	162.40	162.40	
HAMEL	9-Jul-18	GRAB	335.90	183.06	2.64	29.71	29.71	
HAMEL	23-Jul-18	GRAB	259.00	129.51	2.12	9.33	9.33	
HAMEL	6-Aug-18	GRAB	214.30	92.17	1.24	7.60	<10	
HAMEL	20-Aug-18	GRAB	198.60	92.59	1.87	2.75	<6	
HAMEL	24-Aug-18	GRAB	277.30	143.15	1.67	88.00	88.00	
HAMEL	4-Sep-18	GRAB	221.20	91.47	1.68	13.75	13.75	
HAMEL	5-Sep-18	COMP	299.80	87.76	1.49	45.20	45.20	
HAMEL	17-Sep-18	GRAB	188.30	80.94	1.93	2.25	<6	
HAMEL	18-Sep-18	COMP	635.80	112.07	1.99	178.67	178.67	
HAMEL	21-Sep-18	GRAB	276.60	130.89	1.99	59.60	59.60	
HAMEL	1-Oct-18	GRAB	99.39	44.50	1.53	3.75	<6	
HAMEL	10-Oct-18	GRAB	179.30	79.37	1.44	20.75	20.75	
HAMEL	15-Oct-18	GRAB	83.92	23.32	1.31	4.80	<5	
IP2	1-May-18	GRAB	107.00	7.76	1.47	4.80	<5	244.00
IP2	2-May-18	COMP	155.00	12.56	1.81	14.75	14.75	285.00
IP2	14-May-18	GRAB	119.50	5.90	1.60	7.40	7.40	290.00
IP2	25-May-18	COMP	265.30	24.46	2.08	60.50	60.50	396.00
IP2	29-May-18	GRAB	206.90	55.00	2.27	3.80	<5	250.00
IP2	30-May-18	COMP	176.90	94.75	2.51	18.00	18.00	184.00
IP2	11-Jun-18	GRAB	167.50	41.74	1.59	3.40	<5	220.00
IP2	18-Jun-18	COMP	105.40		1.32	35.20	35.20	134.00
IP2	25-Jun-18	GRAB	184.90	63.61	1.56	2.60	<5	160.00
IP2	26-Jun-18	COMP	338.50	31.92	1.34	90.40	90.40	98.00
IP2	2-Jul-18	GRAB		96.67	1.26	8.00	8.00	84.00
IP2	9-Jul-18	GRAB	159.00	92.56	1.24	3.40	<5	146.00
IP2	13-Jul-18	COMP	178.30	67.60	1.73	37.20	37.20	105.97
IP2	23-Jul-18	GRAB	77.69	54.19	1.04	1.00	<5	219.93
IP2	26-Jul-18	COMP	150.10	43.56	1.29	16.40	16.40	197.94
IP2	6-Aug-18	GRAB	127.30	95.23	0.82	1.00	<5	141.96
IP2	20-Aug-18	GRAB	131.10	19.36	1.42	6.00	<10	349.89

Site	Date	Type	TP (ug/L) (Reporting limit 15 ug/L)	SRP (ug/L) (Reporting limit 6 ug/L)	TN (mg/L) (Reporting limit 0.5 mg/L)	TSS (mgL)	TSS (mg/L) Reported	Cl (mg/L)
IP2	24-Aug-18	COMP	235.20	82.44	1.95	113.33	113.33	129.96
IP2	4-Sep-18	GRAB	183.40	59.98	1.46	8.80	8.80	175.95
IP2	5-Sep-18	COMP	224.50	62.85	1.21	27.60	27.60	61.98
IP2	17-Sep-18	GRAB	184.10	31.85	1.85	10.75	10.75	273.92
IP2	18-Sep-18	COMP	176.10	24.97	2.09	14.00	14.00	209.93
IP2	21-Sep-18	COMP	179.60	72.61	1.20	40.80	40.80	49.98
IP2	1-Oct-18	GRAB	84.45	22.22	1.43	1.38	<4	133.96
IP2	4-Oct-18	COMP	163.80	29.73	1.94	39.60	39.60	89.97
IP2	10-Oct-18	GRAB	113.60	61.24	0.83	6.89	6.89	61.98
IP2	15-Oct-18	GRAB	70.97	29.15	1.15	2.53	<3	101.97
NLS	1-May-18	GRAB	80.72	8.22	1.39	3.00	<5	
NLS	2-May-18	COMP	404.30	176.86	3.86	239.00	239.00	
NLS	15-May-18	COMP	416.20	55.60		408.00	408.00	
NLS	25-May-18	COMP	438.70	266.17	2.73	473.00	473.00	
NLS	30-May-18	COMP	543.00	121.69	2.35	165.00	165.00	
NLS	11-Jun-18	GRAB	184.90	26.03	1.74	6.80	6.80	
NLS	18-Jun-18	GRAB	238.70	136.87	1.42	8.00	8.00	
NLS	26-Jun-18	COMP	427.00	76.82	1.51	311.33	311.33	
NLS	23-Jul-18	GRAB	230.10	47.40	2.25	11.14	11.14	
NLS	6-Aug-18	GRAB	186.20	72.14	0.62	2.20	<5	
NLS	20-Aug-18	GRAB	377.70	156.23	3.14	18.00	18.00	
NLS	24-Aug-18	COMP	216.30	117.39	1.40	88.40	88.40	
NLS	4-Sep-18	GRAB	456.70	111.96	3.84			
NLS	5-Sep-18	COMP	401.20	41.47	2.32	77.20	77.20	
NLS	17-Sep-18	GRAB	435.20	159.82	1.93	82.80	82.80	
NLS	18-Sep-18	COMP	1161.00	6.97	6.40	558.00	558.00	
NLS	21-Sep-18	COMP	409.70	231.69	3.71	30.00	30.00	
NLS	15-Oct-18	GRAB	116.20	45.42	2.47	2.67	<3	
PC2	1-May-18	GRAB	94.39	8.48	1.34	6.60	6.60	226.00
PC2	14-May-18	GRAB	98.14	5.41	1.31	11.20	11.20	300.00
PC2	25-May-18	COMP	188.50	32.35	2.32	49.50	49.50	196.00
PC2	29-May-18	GRAB	177.10	64.13	2.07	3.20	<5	256.00
PC2	30-May-18	COMP	159.20	66.85	4.36	17.60	17.60	344.00
PC2	11-Jun-18	GRAB	153.40	40.82	1.52	5.60	5.60	214.00
PC2	18-Jun-18	GRAB	162.10	79.01	1.27	22.00	22.00	118.00
PC2	25-Jun-18	GRAB	162.40	54.38	1.43	6.00	6.00	168.00
PC2	2-Jul-18	GRAB			1.20	9.20	9.20	92.00
PC2	9-Jul-18	GRAB	133.60	38.33	1.02	6.20	6.20	146.00
PC2	13-Jul-18	COMP	147.20	85.89	1.69	32.40	32.40	95.97
PC2	23-Jul-18	GRAB	105.60	34.13	1.04	5.80	5.80	179.94

Site	Date	Type	TP (ug/L) (Reporting limit 15 ug/L)	SRP (ug/L) (Reporting limit 6 ug/L)	TN (mg/L) (Reporting limit 0.5 mg/L)	TSS (mgL)	TSS (mg/L) Reported	Cl (mg/L)
PC2	6-Aug-18	GRAB	146.10	76.04	0.87	5.20	<10	127.96
PC2	24-Aug-18	COMP	213.00	89.91	1.99	65.33	65.33	59.98
PC2	4-Sep-18	GRAB	138.60	50.53	1.13	9.40	9.40	117.96
PC2	5-Sep-18	COMP	140.50	43.17	0.99	18.25	18.25	79.98
PC2	17-Sep-18	GRAB	118.50	58.98	1.19	3.85	3.85	201.94
PC2	18-Sep-18	COMP	218.60	48.96	2.25	37.20	37.20	63.98
PC2	1-Oct-18	GRAB	77.64	67.95	1.06	2.46	<4	127.96
PC2	10-Oct-18	GRAB	87.72	46.33	0.73	7.33	7.33	63.98
PC2	15-Oct-18	GRAB	54.08	23.44	0.94	1.47	<3	109.97
PEONY	1-May-18	GRAB	153.60	39.84	1.54	6.60	6.60	
PEONY	14-May-18	GRAB	183.70	81.94	1.18	7.00	7.00	
PEONY	25-May-18	COMP	389.00	120.54	1.62	180.00	180.00	
PEONY	29-May-18	GRAB	271.60	150.70	1.73	6.80	6.80	
PEONY	30-May-18	COMP	326.20	161.04	1.59	197.00	197.00	
PEONY	11-Jun-18	GRAB	427.40	255.89	1.63	7.20	7.20	
PEONY	12-Jun-18	COMP	364.00	192.87	1.98	10.29	10.29	
PEONY	18-Jun-18	COMP	288.30		1.34	57.60	57.60	
PEONY	25-Jun-18	GRAB	315.60	136.04	1.79	16.60	16.60	
PEONY	26-Jun-18	COMP	1060.00	138.62	2.79	858.00	858.00	
PEONY	2-Jul-18	COMP	197.40	123.66	4.26	1704.00	1704.00	
PEONY	9-Jul-18	GRAB	408.90	193.47	2.85	47.00	47.00	
PEONY	13-Jul-18	COMP	810.30	125.28	1.22	480.00	480.00	
PEONY	23-Jul-18	GRAB	246.20	146.76	1.78	12.69	12.69	
PEONY	26-Jul-18	COMP	441.70	180.05	1.44	76.00	76.00	
PEONY	6-Aug-18	GRAB	396.50	247.58	1.10	9.80	9.80	
PEONY	20-Aug-18	GRAB	198.80	139.22	1.13	7.00	7.00	
PEONY	24-Aug-18	COMP	754.30	136.85	4.99	1626.00	1626.00	
PEONY	4-Sep-18	GRAB	458.80	351.25	1.27	4.75	<6	
PEONY	5-Sep-18	COMP	447.50	281.67	1.47			
PEONY	17-Sep-18	GRAB	332.80	279.66	1.38	4.40	4.40	
PEONY	18-Sep-18	COMP	1439.00	189.60	3.68	515.00	515.00	
PEONY	21-Sep-18	COMP	636.80	145.00	3.65	444.00	444.00	
PEONY	1-Oct-18	GRAB	162.60	112.08	1.39	3.00	<6	
PEONY	4-Oct-18	COMP	273.80	156.03	1.61	56.40	56.40	
PEONY	10-Oct-18	COMP	282.10	141.69	2.12	219.00	219.00	
PEONY	15-Oct-18	GRAB	123.40	73.90	1.19	3.40	<5	
PL1	15-May-18	COMP	636.20	307.34		25.33	25.33	367.00
PL1	25-May-18	COMP	868.00	292.20	4.66	70.00	70.00	24.00
PL1	30-May-18	GRAB	252.50	134.24	2.84	5.00	5.00	58.00
PL1	18-Jun-18	GRAB	166.80	78.76	0.95	13.60	13.60	10.00

Site	Date	Type	TP (ug/L) (Reporting limit 15 ug/L)	SRP (ug/L) (Reporting limit 6 ug/L)	TN (mg/L) (Reporting limit 0.5 mg/L)	TSS (mgL)	TSS (mg/L) Reported	Cl (mg/L)
PL1	26-Jun-18	GRAB	228.50	77.23	1.57	10.75	10.75	28.00
PL1	13-Jul-18	COMP	267.60	115.99	1.99	8.86	8.86	23.99
PL1	24-Aug-18	COMP	335.40	212.59	2.87	10.20	10.20	8.00
PL1	5-Sep-18	COMP	272.00	67.62	1.51	20.00	20.00	19.99
PL1	18-Sep-18	COMP	258.80	72.61	2.04	17.20	17.20	19.99
PL1	21-Sep-18	COMP	208.90	84.44	1.20	20.80	20.80	12.00
PL1	4-Oct-18	COMP	203.00	120.21	1.56	4.20	<5	12.00
PL2	1-May-18	GRAB	80.10	33.29	0.84	2.60	<5	360.00
PL2	2-May-18	COMP	99.92	14.92	1.11	31.20	31.20	340.00
PL2	14-May-18	GRAB	149.70	60.63	1.01	4.40	<5	455.00
PL2	15-May-18	COMP	162.50	46.06		25.20	25.20	310.00
PL2	25-May-18	COMP	175.20	111.63	1.12	65.00	65.00	382.00
PL2	29-May-18	GRAB	216.80	131.26	1.27	7.80	7.80	356.00
PL2	30-May-18	COMP	167.90	51.92	8.52	131.88	131.88	168.00
PL2	11-Jun-18	GRAB	635.60	262.08	2.54	9.60	9.60	60.00
PL2	12-Jun-18	GRAB	183.30	121.34	1.29	1.20	<5	224.00
PL2	18-Jun-18	COMP	151.60		1.17	204.40	204.40	140.00
PL2	25-Jun-18	GRAB	178.80	113.57	1.00	5.20	5.20	130.00
PL2	26-Jun-18	COMP	511.80	75.19	1.77	429.00	429.00	104.00
PL2	2-Jul-18	COMP		64.85	2.19	140.00	140.00	62.00
PL2	9-Jul-18	GRAB	156.40	111.84	0.75	1.80	<5	130.00
PL2	13-Jul-18	COMP	329.40	63.70	2.31	211.60	211.60	89.97
PL2	23-Jul-18	GRAB	177.30	139.29	1.03	3.00	<5	167.95
PL2	26-Jul-18	COMP	260.00	81.59	1.78	74.00	74.00	137.96
PL2	6-Aug-18	GRAB	228.80	87.86	0.84	0.80	<5	149.95
PL2	20-Aug-18	GRAB	271.30	190.72	1.26	4.60	<5	163.95
PL2	24-Aug-18	COMP	398.50	90.77	1.74	117.60	117.60	61.98
PL2	4-Sep-18	GRAB	173.80	39.70	0.98	19.00	19.00	89.97
PL2	5-Sep-18	COMP	209.20	46.34	1.02	50.80	50.80	87.97
PL2	17-Sep-18	GRAB	150.40	126.97	0.77	0.92	<4	113.96
PL2	18-Sep-18	COMP	204.20	35.70	1.58	34.67	34.67	91.97
PL2	21-Sep-18	COMP	171.80	78.32	1.13	13.60	13.60	63.98
PL2	1-Oct-18	GRAB	67.89	53.13	0.86	0.40	<3	81.97
PL2	10-Oct-18	COMP	94.54	51.68	0.93	5.35	5.35	85.97
PL2	15-Oct-18	GRAB	188.50	22.84	1.01	4.60	<5	93.97
PRG-IN	18-Jun-18	GRAB	33.09	16.18	0.27	11.20	11.20	
PRG-IN	25-Jul-18	GRAB	77.47	8.82	4.19	6.57	<7	
PRG-IN	24-Aug-18	GRAB	76.80	51.61	1.31	5.20	5.20	
PRG-IN	20-Sep-18	GRAB	62.78	23.52	0.43	6.00	6.00	
PRG-OUT	18-Jun-18	GRAB	191.50	151.79	1.09	1.80	<5	

Site	Date	Type	TP (ug/L) (Reporting limit 15 ug/L)	SRP (ug/L) (Reporting limit 6 ug/L)	TN (mg/L) (Reporting limit 0.5 mg/L)	TSS (mgL)	TSS (mg/L) Reported	Cl (mg/L)
PRG-OUT	**25-Jul-18**	**GRAB**	**315.60**	**2.71**	**4.56**	**2.29**	**<7**	
PRG-OUT	**24-Aug-18**	**GRAB**	**387.80**	**307.63**	**2.22**	**3.20**	**<3**	
PRG-OUT	**20-Sep-18**	**GRAB**	**107.40**	**96.56**	**1.70**	**0.15**	**<4**	

7.0 LAKE SONDE DATA

Site	Date	Time	Depth (m)	Temp (°C)	Dissolved Oxygen (%)	Dissolved Oxygen (mg/L)	Specific Conductivity (uS/cm)	pH
BASS	**7-May-18**	**11:18:36 AM**	**0.000**	**15.724**	**126.5**	**12.54**	**543.0**	**8.05**
BASS	**7-May-18**	**11:19:25 AM**	**1.000**	**15.643**	**126.9**	**12.60**	**543.0**	**8.15**
BASS	**7-May-18**	**11:20:26 AM**	**2.000**	**12.296**	**117.9**	**12.60**	**550.0**	**8.12**
BASS	**7-May-18**	**11:21:10 AM**	**3.000**	**10.309**	**104.4**	**11.68**	**558.0**	**8.04**
BASS	**7-May-18**	**11:21:54 AM**	**4.000**	**8.294**	**79.7**	**9.36**	**598.0**	**7.93**
BASS	**7-May-18**	**11:23:41 AM**	**5.000**	**5.236**	**19.5**	**2.46**	**900.0**	**7.67**
BASS	**7-May-18**	**11:24:18 AM**	**6.000**	**4.814**	**7.0**	**0.89**	**1060.0**	**7.60**
BASS	**7-May-18**	**11:24:47 AM**	**7.024**	**4.748**	**3.4**	**0.44**	**1170.0**	**7.52**
BASS	**21-May-18**	**8:56:00 AM**	**0.000**	**18.902**	**103.5**	**9.60**	**559.0**	**8.46**
BASS	**21-May-18**	**8:56:45 AM**	**1.000**	**18.896**	**103.5**	**9.61**	**559.0**	**8.46**
BASS	**21-May-18**	**8:57:07 AM**	**2.000**	**18.888**	**103.5**	**9.61**	**559.0**	**8.45**
BASS	**21-May-18**	**9:00:25 AM**	**3.000**	**15.335**	**102.8**	**10.27**	**564.0**	**8.30**
BASS	**21-May-18**	**9:01:06 AM**	**4.000**	**9.626**	**84.6**	**9.61**	**613.0**	**7.90**
BASS	**21-May-18**	**9:02:31 AM**	**5.000**	**6.600**	**7.6**	**0.93**	**813.0**	**7.37**
BASS	**21-May-18**	**9:03:11 AM**	**6.000**	**5.784**	**4.5**	**0.56**	**967.0**	**7.21**
BASS	**21-May-18**	**9:03:49 AM**	**7.012**	**5.516**	**3.3**	**0.41**	**1066.0**	**7.19**
BASS	**4-Jun-18**	**9:00:31 AM**	**0.000**	**21.474**	**98.6**	**8.70**	**575.0**	**8.36**
BASS	**4-Jun-18**	**9:01:02 AM**	**1.000**	**21.440**	**98.4**	**8.69**	**575.0**	**8.36**
BASS	**4-Jun-18**	**9:01:25 AM**	**2.000**	**21.351**	**97.4**	**8.61**	**577.0**	**8.35**
BASS	**4-Jun-18**	**9:01:51 AM**	**3.000**	**21.262**	**94.7**	**8.39**	**577.0**	**8.32**
BASS	**4-Jun-18**	**9:03:04 AM**	**4.000**	**12.994**	**52.8**	**5.56**	**642.0**	**7.63**
BASS	**4-Jun-18**	**9:05:22 AM**	**5.000**	**8.171**	**5.4**	**0.63**	**821.0**	**7.18**
BASS	**4-Jun-18**	**9:06:08 AM**	**6.000**	**6.575**	**2.8**	**0.34**	**951.0**	**7.05**
BASS	**4-Jun-18**	**9:06:41 AM**	**7.000**	**6.174**	**2.2**	**0.27**	**992.0**	**7.07**
BASS	**4-Jun-18**	**9:07:37 AM**	**7.410**	**6.187**	**1.8**	**0.23**	**1011.0**	**7.17**
BASS	**18-Jun-18**	**9:05:10 AM**	**0.000**	**24.394**	**104.8**	**8.74**	**577.0**	**8.55**
BASS	**18-Jun-18**	**9:06:00 AM**	**1.000**	**24.388**	**104.4**	**8.71**	**579.0**	**8.54**
BASS	**18-Jun-18**	**9:06:18 AM**	**2.000**	**24.388**	**103.7**	**8.65**	**579.0**	**8.52**
BASS	**18-Jun-18**	**9:07:29 AM**	**4.000**	**18.091**	**9.7**	**0.92**	**647.0**	**7.60**
BASS	**18-Jun-18**	**9:08:28 AM**	**5.000**	**10.649**	**4.0**	**0.44**	**845.0**	**7.20**
BASS	**18-Jun-18**	**9:09:10 AM**	**6.000**	**7.882**	**2.7**	**0.32**	**933.0**	**7.10**
BASS	**18-Jun-18**	**9:09:34 AM**	**7.000**	**7.007**	**2.4**	**0.29**	**975.0**	**7.06**

Site	Date	Time	Depth (m)	Temp (°C)	Dissolved Oxygen (%)	Dissolved Oxygen (mg/L)	Specific Conductivity (uS/cm)	pH
BASS	18-Jun-18	9:10:24 AM	7.535	6.900	2.1	0.25	1002.0	7.03
BASS	2-Jul-18	9:14:51 AM	0.000	25.119	91.3	7.52	581.0	8.08
BASS	2-Jul-18	9:16:00 AM	1.000	25.089	90.6	7.47	581.0	8.18
BASS	2-Jul-18	9:17:13 AM	2.000	24.927	87.9	7.26	579.0	8.22
BASS	2-Jul-18	9:18:19 AM	3.000	24.818	79.7	6.60	582.0	8.20
BASS	2-Jul-18	9:19:32 AM	4.000	18.690	4.1	0.38	652.0	7.96
BASS	2-Jul-18	9:20:31 AM	5.000	11.227	5.2	0.56	860.0	7.81
BASS	2-Jul-18	9:21:34 AM	6.000	8.152	1.4	0.16	942.0	7.65
BASS	2-Jul-18	9:22:40 AM	7.000	7.339	0.8	0.09	970.0	7.53
BASS	2-Jul-18	9:23:27 AM	7.459	7.274	0.5	0.07	973.0	7.43
BASS	16-Jul-18	9:23:37 AM	0.000	27.047	98.4	7.82	569.0	8.76
BASS	16-Jul-18	9:24:56 AM	1.000	27.048	98.5	7.83	569.0	8.53
BASS	16-Jul-18	9:25:14 AM	2.000	27.033	97.9	7.79	569.0	8.51
BASS	16-Jul-18	9:25:50 AM	3.000	25.779	8.6	0.70	589.0	8.29
BASS	16-Jul-18	9:26:17 AM	4.000	20.213	4.3	0.39	664.0	8.08
BASS	16-Jul-18	9:26:32 AM	5.000	13.512	3.0	0.31	826.0	7.98
BASS	16-Jul-18	9:26:47 AM	6.000	9.728	2.3	0.26	911.0	7.96
BASS	16-Jul-18	9:27:07 AM	7.000	8.521	1.8	0.21	952.0	7.79
BASS	16-Jul-18	9:27:52 AM	7.324	8.486	1.7	0.20	956.0	7.71
BASS	30-Jul-18	9:30:49 AM	0.000	23.972	140.8	11.84	575.0	8.87
BASS	30-Jul-18	9:31:20 AM	1.000	23.769	130.1	10.98	577.0	8.82
BASS	30-Jul-18	9:32:24 AM	2.000	23.365	61.5	5.23	589.0	8.34
BASS	30-Jul-18	9:33:46 AM	3.000	22.603	20.3	1.75	594.0	7.96
BASS	30-Jul-18	9:35:13 AM	4.000	21.043	4.3	0.38	632.0	7.72
BASS	30-Jul-18	9:36:09 AM	5.000	13.932	3.0	0.31	851.0	7.36
BASS	30-Jul-18	9:36:41 AM	6.000	10.377	2.6	0.29	932.0	7.27
BASS	30-Jul-18	9:37:26 AM	7.024	8.682	2.3	0.26	988.0	7.09
BASS	13-Aug-18	9:05:20 AM	0.000	26.587	101.3	8.12	557.0	7.95
BASS	13-Aug-18	9:06:09 AM	1.000	26.564	99.6	7.99	558.0	8.25
BASS	13-Aug-18	9:06:44 AM	2.000	26.454	90.4	7.27	560.0	8.31
BASS	13-Aug-18	9:07:28 AM	3.000	24.146	10.4	0.87	576.0	8.00
BASS	13-Aug-18	9:07:48 AM	4.000	20.761	6.7	0.60	635.0	7.78
BASS	13-Aug-18	9:08:11 AM	5.000	16.084	5.0	0.49	783.0	7.54
BASS	13-Aug-18	9:08:33 AM	6.000	11.932	4.0	0.43	906.0	7.35
BASS	13-Aug-18	9:08:46 AM	7.000	9.727	3.7	0.42	963.0	7.20
BASS	13-Aug-18	9:09:11 AM	7.095	9.593	3.5	0.40	974.0	7.13
BASS	27-Aug-18	9:10:48 AM	0.000	22.999	87.0	7.45	560.0	8.36
BASS	27-Aug-18	9:11:18 AM	1.000	22.949	86.3	7.40	560.0	8.35
BASS	27-Aug-18	9:11:49 AM	2.000	22.890	83.2	7.14	561.0	8.29
BASS	27-Aug-18	9:12:26 AM	3.000	22.763	73.1	6.29	562.0	8.14

Site	Date	Time	Depth (m)	Temp (°C)	Dissolved Oxygen (%)	Dissolved Oxygen (mg/L)	Specific Conductivity (uS/cm)	pH
BASS	27-Aug-18	9:13:38 AM	4.000	22.013	21.7	1.89	576.0	7.57
BASS	27-Aug-18	9:14:20 AM	5.000	17.021	4.7	0.45	753.0	7.26
BASS	27-Aug-18	9:15:12 AM	6.000	12.421	2.5	0.27	886.0	7.07
BASS	27-Aug-18	9:16:01 AM	7.069	10.749	1.7	0.19	949.0	6.97
BASS	10-Sep-18	9:16:10 AM	0.000	21.140	75.1	6.67	589.0	8.18
BASS	10-Sep-18	9:16:54 AM	1.000	21.122	74.5	6.62	589.0	8.18
BASS	10-Sep-18	9:17:43 AM	2.000	21.067	75.5	6.72	589.0	8.20
BASS	10-Sep-18	9:18:08 AM	3.000	21.016	74.3	6.61	589.0	8.19
BASS	10-Sep-18	9:19:04 AM	4.000	20.926	69.6	6.20	591.0	8.11
BASS	10-Sep-18	9:20:10 AM	5.000	19.112	7.8	0.72	671.0	7.44
BASS	10-Sep-18	9:20:58 AM	6.000	12.859	4.7	0.49	939.0	7.11
BASS	10-Sep-18	9:21:44 AM	7.000	10.351	3.5	0.39	1035.0	7.03
BASS	10-Sep-18	9:22:09 AM	7.429	10.452	3.2	0.36	1031.0	7.04
BASS	24-Sep-18	1:11:52 PM	0.000	18.371	68.4	6.41	607.0	7.69
BASS	24-Sep-18	1:12:50 PM	1.000	18.337	67.5	6.34	608.0	7.68
BASS	24-Sep-18	1:13:30 PM	2.000	18.295	66.4	6.24	607.0	7.66
BASS	24-Sep-18	1:14:00 PM	3.000	18.170	63.7	6.00	607.0	7.64
BASS	24-Sep-18	1:14:51 PM	4.000	17.984	58.2	5.50	607.0	7.59
BASS	24-Sep-18	1:15:38 PM	5.000	17.835	52.6	4.99	607.0	7.53
BASS	24-Sep-18	1:16:43 PM	6.000	17.737	46.2	4.39	608.0	7.48
BASS	24-Sep-18	1:18:00 PM	7.000	12.772	7.6	0.80	1018.0	6.86
BASS	24-Sep-18	1:20:25 PM	7.450	12.423	2.9	0.31	1075.0	6.74
BASS	8-Oct-18	9:15:27 AM	0.000	11.404	72.0	7.85	606.0	7.86
BASS	8-Oct-18	9:16:12 AM	1.000	11.395	68.0	7.42	606.0	7.76
BASS	8-Oct-18	9:16:44 AM	2.000	11.385	67.1	7.32	605.0	7.73
BASS	8-Oct-18	9:17:09 AM	3.000	11.373	66.5	7.26	605.0	7.72
BASS	8-Oct-18	9:17:41 AM	4.000	11.325	66.2	7.23	605.0	7.71
BASS	8-Oct-18	9:18:05 AM	5.000	11.309	66.0	7.22	605.0	7.70
BASS	8-Oct-18	9:18:31 AM	6.000	11.276	65.4	7.15	605.0	7.70
BASS	8-Oct-18	9:19:14 AM	6.820	11.295	42.1	4.60	609.0	7.23
POM	7-May-18	10:16:55 AM	0.000	17.351	106.6	10.22	442.6	7.63
POM	7-May-18	10:18:53 AM	1.000	16.334	111.1	10.87	442.7	7.78
POM	7-May-18	10:19:32 AM	2.000	10.276	108.8	12.19	443.8	7.83
POM	7-May-18	10:20:52 AM	3.000	7.257	72.1	8.69	464.0	7.68
POM	7-May-18	10:22:06 AM	4.000	5.747	28.0	3.50	510.0	7.54
POM	7-May-18	10:22:46 AM	5.000	4.839	6.9	0.88	567.0	7.43
POM	7-May-18	10:23:28 AM	6.000	4.705	2.6	0.33	614.0	7.31
POM	7-May-18	10:24:06 AM	6.341	4.771	1.5	0.20	642.0	7.08
POM	21-May-18	9:39:59 AM	0.000	18.647	103.6	9.67	453.2	8.34
POM	21-May-18	9:40:28 AM	1.000	18.638	103.3	9.65	453.3	8.33

Site	Date	Time	Depth (m)	Temp (°C)	Dissolved Oxygen (%)	Dissolved Oxygen (mg/L)	Specific Conductivity (uS/cm)	pH
POM	21-May-18	9:41:15 AM	2.000	16.383	71.2	6.97	457.4	7.81
POM	21-May-18	9:41:37 AM	3.000	9.478	68.8	7.86	483.6	7.71
POM	21-May-18	9:43:23 AM	4.000	6.152	15.0	1.85	529.0	7.31
POM	21-May-18	9:44:08 AM	5.000	5.345	5.4	0.68	580.0	7.20
POM	21-May-18	9:44:40 AM	6.000	5.109	3.5	0.45	619.0	7.14
POM	21-May-18	9:45:14 AM	6.217	5.126	2.8	0.35	617.0	7.15
POM	4-Jun-18	9:49:37 AM	0.000	21.084	70.8	6.29	453.4	7.81
POM	4-Jun-18	9:50:13 AM	1.000	20.833	68.9	6.15	453.7	7.79
POM	4-Jun-18	9:51:44 AM	2.000	20.286	32.1	2.90	461.6	7.46
POM	4-Jun-18	9:54:15 AM	3.000	11.594	72.8	7.91	473.4	7.42
POM	4-Jun-18	9:55:36 AM	4.000	7.618	16.2	1.94	517.0	7.24
POM	4-Jun-18	9:57:00 AM	5.000	5.979	3.6	0.45	575.0	7.15
POM	4-Jun-18	9:58:18 AM	6.000	5.561	2.0	0.25	615.0	7.00
POM	4-Jun-18	9:58:54 AM	6.112	5.558	1.7	0.22	614.0	6.89
POM	18-Jun-18	3:26:10 PM	0.000	24.353	92.6	7.74	441.7	8.09
POM	18-Jun-18	3:26:37 PM	1.000	24.088	74.0	6.21	443.7	7.95
POM	18-Jun-18	3:26:57 PM	2.000	22.079	73.2	6.38	461.8	7.89
POM	18-Jun-18	3:27:23 PM	3.000	15.570	51.2	5.09	482.8	7.68
POM	18-Jun-18	3:28:08 PM	4.000	9.524	21.7	2.48	523.0	7.47
POM	18-Jun-18	3:28:53 PM	5.000	6.820	7.9	0.96	577.0	7.30
POM	18-Jun-18	3:29:48 PM	6.000	5.908	3.9	0.48	656.0	7.18
POM	18-Jun-18	3:30:22 PM	6.514	5.949	3.1	0.38	649.0	7.22
POM	2-Jul-18	10:04:49 AM	0.000	24.500	78.1	6.50	441.9	7.60
POM	2-Jul-18	10:05:37 AM	1.000	24.147	69.3	5.81	441.9	7.60
POM	2-Jul-18	10:06:28 AM	2.000	22.714	20.5	1.77	468.4	7.45
POM	2-Jul-18	10:07:14 AM	3.000	16.450	15.4	1.51	481.8	7.43
POM	2-Jul-18	10:07:53 AM	4.000	10.233	6.1	0.68	524.0	7.43
POM	2-Jul-18	10:08:17 AM	5.000	7.150	2.6	0.32	580.0	7.39
POM	2-Jul-18	10:08:40 AM	6.000	6.261	1.7	0.20	648.0	7.23
POM	2-Jul-18	10:12:40 AM	6.808	6.327	0.8	0.10	681.0	7.14
POM	16-Jul-18	2:06:36 PM	0.000	27.720	99.6	7.83	447.4	8.19
POM	16-Jul-18	2:07:43 PM	1.000	26.832	86.0	6.86	445.5	8.07
POM	16-Jul-18	2:08:46 PM	2.000	24.137	14.0	1.17	456.8	7.81
POM	16-Jul-18	2:10:11 PM	3.000	16.267	16.1	1.58	482.4	7.70
POM	16-Jul-18	2:10:42 PM	4.000	10.684	6.0	0.67	522.0	7.69
POM	16-Jul-18	2:11:19 PM	5.000	8.028	2.2	0.26	577.0	7.56
POM	16-Jul-18	2:11:43 PM	6.000	6.937	1.6	0.19	645.0	7.40
POM	30-Jul-18	10:19:20 AM	0.000	23.600	92.1	7.81	454.7	7.81
POM	30-Jul-18	10:20:46 AM	1.000	23.417	86.4	7.35	454.7	7.70
POM	30-Jul-18	10:21:51 AM	2.000	22.564	17.1	1.48	461.2	7.53

Site	Date	Time	Depth (m)	Temp (°C)	Dissolved Oxygen (%)	Dissolved Oxygen (mg/L)	Specific Conductivity (uS/cm)	pH
POM	30-Jul-18	10:23:04 AM	3.000	16.880	6.5	0.62	497.0	7.38
POM	30-Jul-18	10:24:15 AM	4.000	11.320	3.1	0.34	527.0	7.27
POM	30-Jul-18	10:25:22 AM	5.000	7.961	2.5	0.30	601.0	7.06
POM	30-Jul-18	10:26:12 AM	6.000	6.835	2.3	0.28	689.0	6.87
POM	30-Jul-18	10:26:52 AM	6.475	6.665	2.1	0.26	724.0	6.72
POM	13-Aug-18	1:57:50 PM	0.000	27.166	99.5	7.89	448.2	8.23
POM	13-Aug-18	1:58:52 PM	1.000	26.072	83.6	6.77	449.7	8.11
POM	13-Aug-18	1:59:27 PM	2.000	23.927	45.6	3.84	457.9	7.97
POM	13-Aug-18	2:01:06 PM	3.000	18.407	10.5	0.99	485.9	7.68
POM	13-Aug-18	2:01:31 PM	4.000	12.356	8.1	0.86	533.0	7.67
POM	13-Aug-18	2:01:50 PM	5.000	8.889	5.1	0.59	603.0	7.51
POM	13-Aug-18	2:02:03 PM	6.000	7.349	4.2	0.51	679.0	7.31
POM	13-Aug-18	2:02:57 PM	6.488	7.275	3.3	0.39	729.0	7.06
POM	27-Aug-18	10:01:43 AM	0.000	22.661	73.2	6.31	435.6	7.68
POM	27-Aug-18	10:02:35 AM	1.000	22.623	72.2	6.23	435.7	7.67
POM	27-Aug-18	10:03:25 AM	2.000	22.573	69.6	6.01	435.9	7.65
POM	27-Aug-18	10:04:20 AM	3.000	20.178	8.0	0.72	446.2	7.25
POM	27-Aug-18	10:04:46 AM	4.000	14.075	4.3	0.44	517.0	7.18
POM	27-Aug-18	10:05:16 AM	5.000	9.508	2.7	0.31	586.0	7.08
POM	27-Aug-18	10:05:41 AM	6.000	7.860	2.2	0.26	667.0	7.11
POM	27-Aug-18	10:06:05 AM	6.671	7.603	1.9	0.23	697.0	7.10
POM	10-Sep-18	2:16:17 PM	0.000	21.721	96.5	8.48	457.0	8.03
POM	10-Sep-18	2:16:59 PM	1.000	21.182	98.4	8.73	456.9	8.02
POM	10-Sep-18	2:17:18 PM	2.000	20.520	89.7	8.06	457.7	7.92
POM	10-Sep-18	2:18:13 PM	3.000	19.341	28.8	2.66	469.8	7.41
POM	10-Sep-18	2:19:16 PM	4.000	16.783	8.3	0.81	503.0	7.22
POM	10-Sep-18	2:19:37 PM	5.000	9.713	5.7	0.65	631.0	7.10
POM	10-Sep-18	2:20:14 PM	6.000	8.173	4.2	0.49	717.0	7.14
POM	10-Sep-18	2:20:34 PM	6.671	7.637	3.8	0.45	760.0	6.98
POM	24-Sep-18	1:49:29 PM	0.000	17.880	81.6	7.74	455.6	7.77
POM	24-Sep-18	1:49:59 PM	1.000	17.847	81.3	7.71	455.6	7.74
POM	24-Sep-18	1:50:39 PM	2.000	17.824	81.3	7.72	455.5	7.73
POM	24-Sep-18	1:51:17 PM	3.000	17.360	74.3	7.12	459.3	7.64
POM	24-Sep-18	1:52:21 PM	4.000	16.172	28.5	2.80	470.7	7.29
POM	24-Sep-18	1:53:24 PM	5.000	11.165	8.3	0.91	598.0	6.94
POM	24-Sep-18	1:54:00 PM	6.000	8.590	5.5	0.64	730.0	6.75
POM	24-Sep-18	1:55:10 PM	6.906	8.189	3.8	0.45	746.0	6.82
POM	8-Oct-18	2:05:31 PM	0.000	11.453	62.0	6.76	467.1	7.70
POM	8-Oct-18	2:06:07 PM	1.000	11.415	57.5	6.27	467.3	7.62
POM	8-Oct-18	2:07:11 PM	3.000	11.377	54.9	5.99	467.1	7.58

Site	Date	Time	Depth (m)	Temp (°C)	Dissolved Oxygen (%)	Dissolved Oxygen (mg/L)	Specific Conductivity (uS/cm)	pH
POM	8-Oct-18	2:08:17 PM	4.000	11.294	52.3	5.72	467.6	7.54
POM	8-Oct-18	2:08:44 PM	5.000	11.110	28.0	3.07	512.0	7.33
POM	8-Oct-18	2:09:33 PM	6.000	9.633	12.7	1.45	689.0	6.90
POM	8-Oct-18	2:10:05 PM	6.156	9.518	8.3	0.95	701.0	6.85

8.0 LAKE SAMPLE DATA

Site	Date	TP (ug/L) (Reporting limit 15 ug/L)	SRP (ug/L) (Reporting limit 6 ug/L)	TN (mg/L) (Reporting limit 0.5 mg/L)	Chl-a (ug/L) Measured	Chl-a Reported Value (ug/L)	Secchi (m)
BASS	7-May-18	32.20	6.01	0.80	6.99	6.99	2.18
BASS	7-May-18	41.76	14.53				
BASS	7-May-18	68.18	10.29				
BASS	21-May-18	34.05	3.32	0.63	6.30	6.30	2.47
BASS	21-May-18	59.18	9.30				
BASS	21-May-18	82.86	7.10				
BASS	4-Jun-18	41.73	3.20	0.97	12.25	12.30	3.68
BASS	4-Jun-18	57.51	22.56				
BASS	4-Jun-18	167.80	47.74				
BASS	18-Jun-18	46.55	10.27	1.07	37.85	37.80	0.97
BASS	18-Jun-18	32.13	17.01				
BASS	18-Jun-18	271.30	10.28				
BASS	2-Jul-18	73.06	3.11	1.20	50.40	50.40	0.92
BASS	2-Jul-18	50.75	8.00				
BASS	2-Jul-18	470.10	104.75				
BASS	16-Jul-18	65.96	23.12	1.78	57.09	57.09	0.84
BASS	16-Jul-18	67.07	19.80				
BASS	16-Jul-18	538.60	15.89				
BASS	30-Jul-18	70.11	6.40	1.27	69.43	69.43	0.45
BASS	30-Jul-18	78.68	2.28				
BASS	30-Jul-18	697.50	6.87				
BASS	13-Aug-18	63.81	2.43	1.18	43.43	43.43	0.59
BASS	13-Aug-18	71.70	2.60				
BASS	13-Aug-18	514.70	13.66				
BASS	27-Aug-18	66.43	3.95	1.45	55.09	55.09	0.79
BASS	27-Aug-18	76.32	2.04				
BASS	27-Aug-18	368.80	22.46				
BASS	10-Sep-18	50.96	3.94	1.22	24.22	24.22	0.73
BASS	10-Sep-18	49.70	4.15				
BASS	10-Sep-18	797.00	10.14				
BASS	24-Sep-18	64.28	11.92	1.29	22.58	22.58	1.42
BASS	24-Sep-18	90.18	6.25				
BASS	24-Sep-18	62.11	5.36				

Site	Date	TP (ug/L) (Reporting limit 15 ug/L)	SRP (ug/L) (Reporting limit 6 ug/L)	TN (mg/L) (Reporting limit 0.5 mg/L)	Chl-a (ug/L) Measured	Chl-a Reported Value (ug/L)	Secchi (m)
BASS	**8-Oct-18**	**74.86**	**5.80**	**1.01**	**18.43**	**18.43**	**1.87**
BASS	**8-Oct-18**	**65.30**	**6.08**				
BASS	**8-Oct-18**	**196.50**	**4.65**				
POM	**7-May-18**	**35.89**	**5.85**	**1.04**	**5.38**	**5.38**	**2.07**
POM	**7-May-18**	**54.14**	**1.40**				
POM	**7-May-18**	**161.80**	**12.53**				
POM	**21-May-18**	**34.83**	**4.01**	**0.85**	**9.26**	**9.30**	**2.15**
POM	**21-May-18**	**60.41**	**10.10**				
POM	**21-May-18**	**176.60**	**9.74**				
POM	**4-Jun-18**	**43.31**	**5.70**	**1.05**	**3.80**	**<5**	**3.20**
POM	**4-Jun-18**	**50.21**	**7.65**				
POM	**4-Jun-18**	**176.00**	**36.41**				
POM	**18-Jun-18**	**30.66**	**0.23**	**0.85**			**2.38**
POM	**18-Jun-18**	**83.06**	**11.03**				
POM	**18-Jun-18**	**96.91**	**50.39**				
POM	**2-Jul-18**	**45.47**	**3.62**	**1.04**	**11.70**	**11.70**	**2.36**
POM	**2-Jul-18**	**76.62**	**22.31**				
POM	**2-Jul-18**	**178.10**	**24.91**				
POM	**16-Jul-18**	**42.53**	**11.00**	**1.57**	**15.08**	**15.08**	**1.79**
POM	**16-Jul-18**	**82.11**	**7.95**				
POM	**16-Jul-18**	**115.00**	**20.38**				
POM	**30-Jul-18**	**36.62**	**4.97**	**0.81**	**10.67**	**10.67**	**1.97**
POM	**30-Jul-18**	**60.40**	**4.84**				
POM	**30-Jul-18**	**462.60**	**6.60**				
POM	**13-Aug-18**	**33.44**	**0.54**	**0.82**	**7.10**	**<9**	**2.16**
POM	**13-Aug-18**	**47.98**	**2.14**				
POM	**13-Aug-18**	**610.70**	**11.40**				
POM	**27-Aug-18**	**31.80**	**2.06**	**0.99**	**7.70**	**7.70**	**2.83**
POM	**27-Aug-18**	**39.35**	**7.87**				
POM	**27-Aug-18**	**633.40**	**11.60**				
POM	**10-Sep-18**	**40.87**	**5.09**	**0.97**	**8.28**	**8.28**	**2.43**
POM	**10-Sep-18**	**60.13**	**5.46**				
POM	**10-Sep-18**	**957.00**	**10.83**				
POM	**24-Sep-18**	**95.33**	**13.20**	**0.89**	**5.52**	**5.52**	**3.35**
POM	**24-Sep-18**	**85.87**	**17.52**				
POM	**24-Sep-18**	**1512.00**	**81.38**				
POM	**8-Oct-18**	**49.98**	**15.36**	**1.09**	**3.92**	**<9**	**2.50**
POM	**8-Oct-18**	**54.63**	**14.69**				
POM	**8-Oct-18**	**682.90**	**18.96**				