

Technical Memorandum BCWA



Date: February 8, 2017
To: Bear Creek Watershed Association
From: Russell N. Clayshulte, Manager
Re: BCWA TM 2016.07 Barr Milton TMDL Summary

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Figure 1 BCWA Site 45 is located below the Weir in the Outfall Trace



Figure 2 BCWA Site 45 Sampling Location below Weir.

The Bear Creek Watershed is in the defined “data” shed for the BMW pH/DO TMDL. The Bear Creek Watershed boundary is defined in *BCWA Policy 13 Watershed Boundary*. Discharge from Bear Creek Reservoir is identified as a “point” source and input to the BMW pH/DO TMDL and model. As such, the BCWA site 45 is identified as a source that contributes about 1.8 % of the external load of Total Phosphorus (See Table 1). The BMW pH/DO TMDL defines the contribution of Total Phosphorus from Bear Creek for both Barr Lake and Milton Reservoir at 1,167 kg/year or 2,672.7 pounds/year. In the period from 2000 through 2016, the average Total Phosphorus at BCWA site 45 was 2,786 pound/year (Table 2).

Problematic years are 2007, 2013, 2015 and 2016. In 2007, the flow predictions were used for the downstream Sheridan gage (Table 2 and Figure 3). Although the Association believes the actual flow at site 45 was less than measured at Sheridan, the total load would still exceed the target of 2,672.7 pound/year.

In September 2013, an exceptional flood event occurred within Bear Creek Watershed and the reservoir became a major flood control structure. The rains began in earnest on September 9, 2013 in the upper watershed. The U.S. Army Corps of Engineers shut the outflow gates on Bear Creek Reservoir on September 13, 2013. The pool rose from 1,817 acre-feet to about 15,000 acre-feet (5 trillion gallons) on September 22, 2013. The surface area was about 500 acres or 70% of surface acre capacity. Although Bear Creek Reservoir returned to normal pool by the end of October, the water quality in the reservoir may be altered for years to come. As a result of the flooding event, the reservoir received a massive nutrient load from the watershed flushing. A substantial amount of nutrients was discharged into lower Bear Creek during operational flood discharges from Bear Creek Reservoir. During the 45-day event, 5,026 pounds of total phosphorus and 36,500 pound of total nitrogen was released from the reservoir. The Association estimates 10,000 pounds of total phosphorus was retained within the reservoir and incorporated into the massive sediment deposits.

The average inflow into Bear Creek Reservoir from both Turkey Creek & Bear Creek (1987-2014) was 27,100 acre-feet per year. In 2015, 118,925 acre-feet flowed through the reservoir. In 2016, 39,577 acre-feet flowed through the reservoir.



Figure 3 Sediment and Nutrient Load Associated with 2016 Flows

The Total Phosphorus load target at BCWA site 45 was met in 11 out of 17 years of reviewed data. The target Total Phosphorus listed in the BMW pH/DO TMDL can be met under most hydrologic conditions and within the expectations of the BCWA management program. The BMW pH/DO TMDL expects any reduction in this target Total Phosphorus load will occur by in-canal treatment in the Barr-Milton Watershed prior to discharge into those waterbodies.

Since nitrogen is an issue, the Association estimated the nitrate loading at BCWA site 45 from 2000-2016 and Total Nitrogen from (2011-2016). Figure 5 and 6, and Table 2 shows the Nitrate-Nitrogen and Total Nitrogen loading at BCWA site 45.

The Association maintains a spreadsheet (*BCWA MSD06 Site 45 Data Summary*) for BCWA site 45 that contains water quality data and nutrient loading estimates (Summary data is shown in Table 3, spreadsheet available upon request). The Association will collect Total Nitrogen/ Total Phosphorus pairs for 12 months/year (unless no flow

or completely frozen) at BCWA site 45. There is a state DNR staff gage above the weir, which allows the Association to monitor flow at the monitoring station.

Table 1 Model Prediction Compared with BCWA Data

Source	Average Conc (ug/l)	Total TP TML Load		Barr Load		% Total Load	Milton		% Total Load
		Kg/yr	Pounds/Year	Kg/yr	Pounds/Year		Kg/yr	Pounds/Year	
Model Bear Creek Site 45	32-80	1,167	2,673	1,091	2,505	1.60%	76	167.5	0.20%
BCWA Bear Creek Site 45	40	1219	2,687						

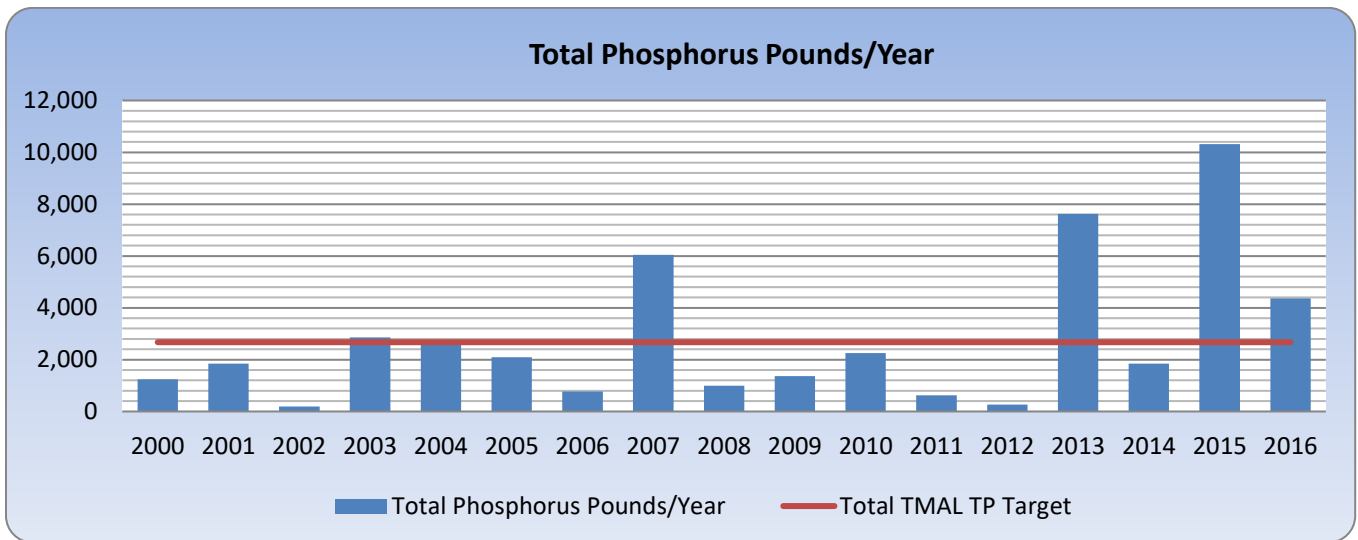


Figure 4 Total Phosphorus Trend

Table 2 Phosphorus and Nitrogen Load Estimates Per Year

	Total Phosphorus Pounds/Year	Nitrate Pounds/Year	Total Nitrogen Pounds/year
2000	1,243	23,146	
2001	1,847	17,736	
2002	187	3,182	
2003	2,856	2,856	
2004	2,667	3,569	
2005	2,094	22,936	
2006	776	6,837	
2007	6,047	57,496	
2008	991	16,470	
2009	1,361	18,576	
2010	2,259	32,148	
2011	624	3,467	10,632
2012	260	4,315	7,897
2013	7,627	22,576	80,028
2014	1,841	27,821	63,229
2015	10,320	84,081	172,116
2016	4,369		84,580
Average	2,786	21,701	66,780

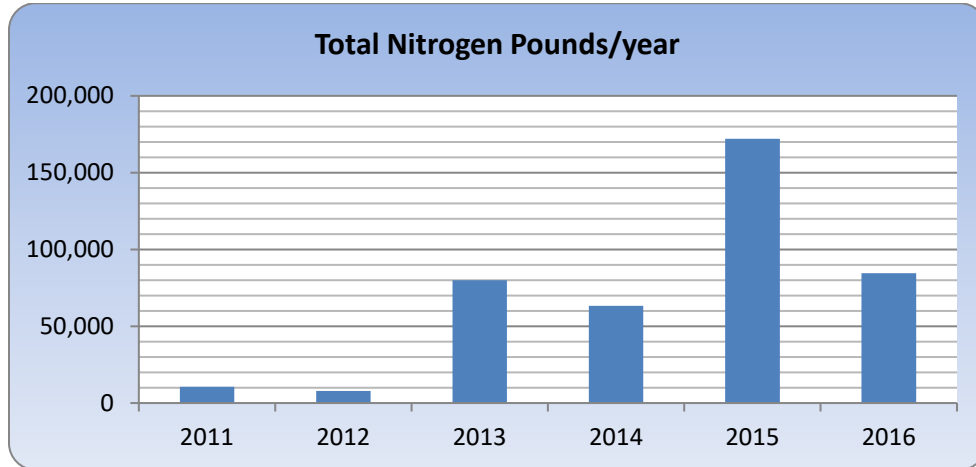


Figure 5 Total Nitrogen Trend

Table 3 Summary Data 2010-2016

	Avg	Median	Maximum	Standard Deviation	Minimum
Temperature, °C	13.7	14.6	24.1	6.9	1.3
Total Suspended Solids, mg/L	8.5	6.6	94.7	8.9	0.0
Specific Conductance us/cm	386.0	371.3	724.0	134.5	147.0
Fecal Coliforms, colonies per 100 ml (Geo Mean)	7				
E. coli cts/100 ml (Geo Mean)	2				
Dissolved Oxygen, mg/L	9.2	9.0	15.5	2.0	3.3
pH	8.3	8.3	9.4	0.4	7.0
Total ammonia-nitrogen, ug/L	55.2	39.9	403.0	55.7	3.0
Nitrate-nitrogen, ug/L	268.9	187.9	1700.2	254.1	0.0
Soluble Reactive Phosphorus (SRP), ug/l	12.5	6.6	76.4	14.0	0.1
Total Dissolved Phosphorus (TDP), ug/l	19.0	13.6	96.0	16.5	2.0
Total Particulate Phosphorus (TPP), ug/l	17.3	12.4	136.8	19.2	2.6
Total Phosphorus (Total P), ug/l	38.3	29.7	259.0	32.0	2.0
Total Nitrogen, ug/l	720.1	641.5	2241.0	287.6	342.0

Table 4 E. coli Geometric Mean Summary

BCWA Site 45 E. Coli Geometric mean cts/100ml

	J-F	M-A	M-J	J-A	S-O	N-D	Annual
2004-2014							3
2012						1	
2013	1	6	2	9	2	1	2
2014	2	2	5	2	1	14	3
2015	3	3	8	2	1	6	3
2016	1	2	2	9	6	7	3

LBCW Site BCL5 E. coli (MPN/100ml)

	J-F	M-A	M-J	J-A	S-O	N-D	Annual
2013			62	36	54		46