

Technical Memorandum BCWA



Date: January 27, 2016
To: Bear Creek Watershed Association
From: Russell N. Clayshulte, Manager

Re: BCWA TM 2015.04 Coyote Gulch

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The Association coordinates with the City of Lakewood a sampling program on Coyote Gulch in the Bear Creek Park (Figure 1 and 2). The monitoring is done at two sampling sites: above the restoration project (Upper Coyote), and at the discharge into the reservoir (Lower Coyote). Beginning in 2013, the Association incorporated the nutrient sampling into the Association monitoring program as part of the P2 Supplemental Monitoring Program. The Association reduced the monitoring frequency to bi-monthly. Nutrient analyses are done at the Association’s contract laboratory GEI Consultants Inc. The Association collects the chemistry data for total phosphorus, total nitrogen, ammonia-nitrogen and nitrate-nitrogen (Table 1). The Association takes bi- monthly flow measurements to determine nutrient loading. The Association also collects data for temperature, pH, specific conductance and Dissolved Oxygen.

Data results are incorporated into the Association annual data summaries (Tables 2, 3, and 4). The Association has pre-construction and post-construction loading data. This monitoring project has established a total phosphorus trade credit for use of the Association membership. Data maintained in the BCWA *MSD11 Coyote Gulch Data Master spreadsheet*.



Figure 1 **Flooded Coyote Gulch**



Figure 2 Coyote Gulch Project and Sample Sites

In September 2013 and May to August 2015, the reservoir became a major flood control structure. The normal pool of about 2,000 ac-ft rose to over 12,000 ac-ft for both periods. In 2013, the flooding only lasted about 30-days, while the 2015 flood event lasted over 90-days. The Coyote Gulch project was completed submerged during both events.

Table 1 Nutrient Data Results

Segment	Site	Location	Date	Total Nitrogen	Nitrogen, ammonia	Nitrate Nitrite	Phosphorus, total
Segment 4a	Site 47a	Upper Coyote	2/17/2015	1677	43	1108	24
			4/20/2015	2005	20	1487	67
			6/15/2015	2668	47	1612	119
			8/11/2015	1505	38	953	102
			10/19/2015	2530			27
			12/7/2015	3936	19	3939	28
	Site 47b	Lower Coyote	2/17/2015	1655	37	1102	25
			4/20/2015	1448	23	2093	97
			6/15/2015				
			8/11/2015	1374	43	826	79
			10/19/2015	2345			15
			12/7/2015	3981	15	3853	35

Table 2 Field Data

Segment	Site	Location	Date	Time	pH	Temp °C	DO (mg/l)	SC (us/cm)	Flow (cfs)	Periphyton Coverage %	Water Clarity
Segment 4a	Site 47a	Upper Coyote	2/17/2015	10:30	8.22	0.60	13.30	1530	0.11	1%	c
			4/20/2015	10:55	8.04	7.20	11.38	977	1.87	20%	c
			6/15/2015	12:00	7.65	15.40	9.47	1215	2.31	20%	sm
			8/11/2015	10:10	7.91	14.90	8.23	1472	1.71	10%	c
			10/19/2015	11:45	7.71	10.00	12.02	1493	0.92	5%	c
			12/7/2015	9:40	8.09	1.50	16.04	1760	0.26	50%	c

Segment	Site	Location	Date	Time	pH	Temp °C	DO (mg/l)	SC (us/cm)	Flow (cfs)	Periphyton Coverage %	Water Clarity	
	Site 47b	Lower Coyote	2/17/2015	10:40	8.31	0.40	15.35	1480	0.31	10%	c	
			4/20/2015	11:00	8.15	7.80	10.29	965	1.44	25%	c	
			6/15/2015									
			8/11/2015	10:15	8.03	16.40	9.93	1429	0.83	15%	c	
			10/19/2015	11:55	7.92	10.40	13.90	1420	0.74	80%	c	
			12/7/2015	9:50	8.11	1.40	17.06	1019	0.18	80%	c	

Table 3 Flow Data

	Jan-Feb	Mar-Apr	May-Jun	Jul-Aug	Sep-Oct	Nov-Dec
cfs						
Upper Coyote	0.11	1.87	2.31	1.71	0.92	0.26
Lower Coyote	0.31	1.44	0.00	0.83	0.74	0.18
Ac-Ft/day						
Upper Coyote	0.218	3.708	4.589	3.391	1.814	0.506
Lower Coyote	0.617	2.856	0.000	1.640	1.467	0.355
Ac-ft/month						
Upper Coyote	13.1	222.5	275.3	203.5	108.9	30.3
Lower Coyote	37.0	174.2	0.0	101.7	89.5	21.7

Table 4 Nutrient Loads

Location	Date	Flow Estimate	Total Nitrogen	Nitrogen, ammonia	Nitrate/Nitrite	Phosphorus, total
Upper Coyote	Jan-Feb	13.1	59.8	1.5	39.5	0.9
	Mar-Apr	222.5	1214.7	12.1	900.9	40.6
	May-Jun	275.3	2000.2	35.2	1208.5	89.2
	Jul-Aug	203.5	833.8	21.1	528.0	56.5
	Sep-Oct	108.9	1166.8	0.0	0.0	8.0
	Nov-Dec	30.3	136.7	1.6	325.4	2.3
Lower Coyote	Jan-Feb	37.0	166.8	3.7	111.0	2.5
	Mar-Apr	174.2	686.8	10.9	992.7	46.0
	May-Jun	0.0	0.0	0.0	0.0	0.0
	Jul-Aug	101.7	380.4	11.9	228.7	21.9
	Sep-Oct	89.5	571.6	0.0	0.0	3.7
	Nov-Dec	21.7	234.7	0.9	227.2	2.1

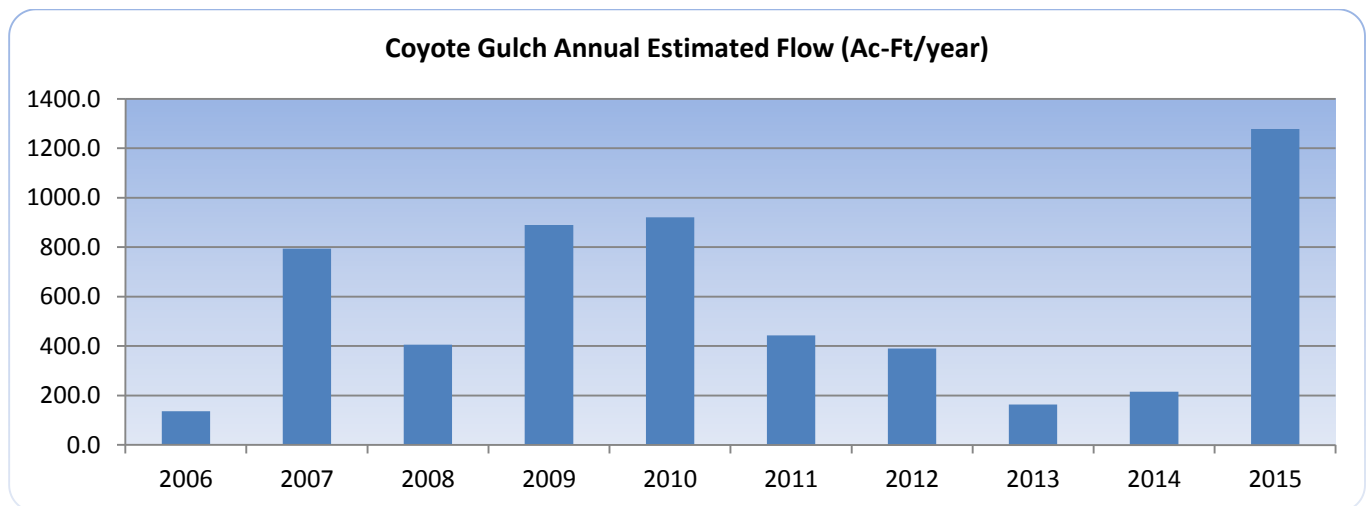


Figure 3 Estimated Annual Flows

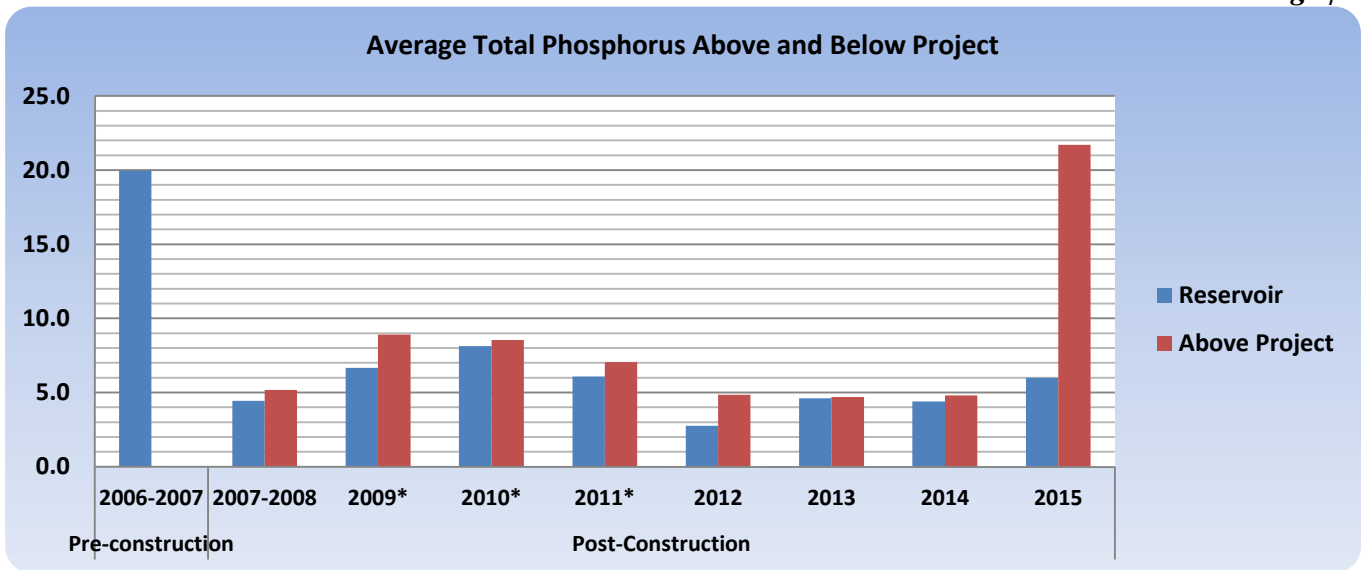


Figure 4 Total Phosphorus Removal by Project

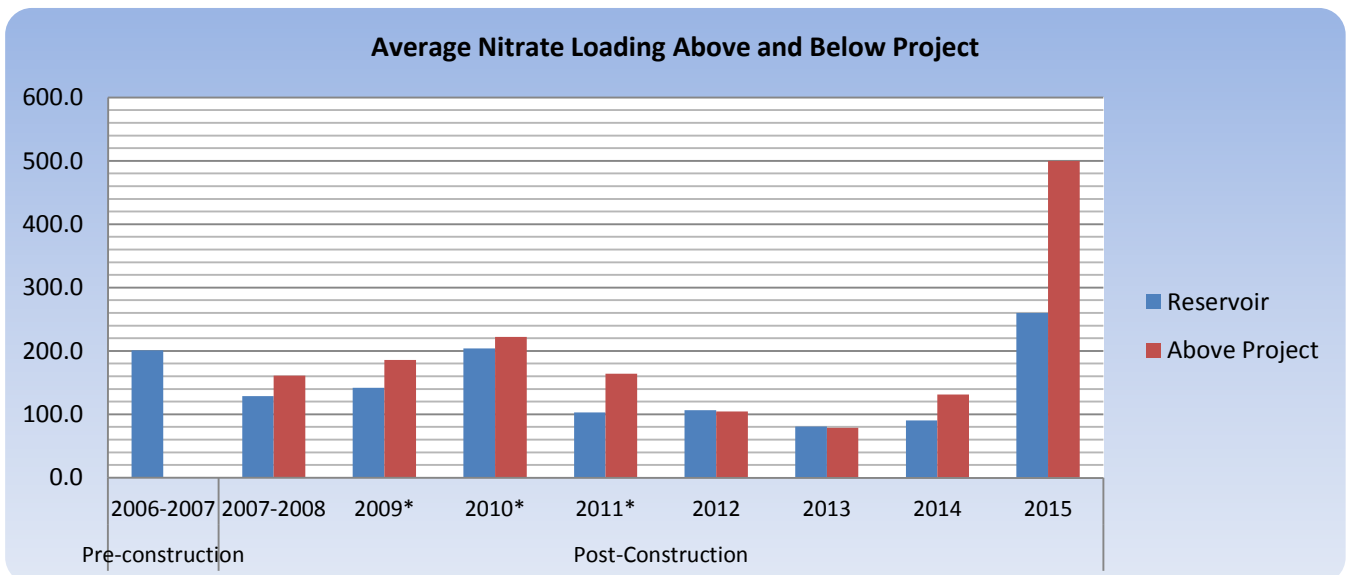


Figure 5 Nitrate-Nitrogen Removal by Project

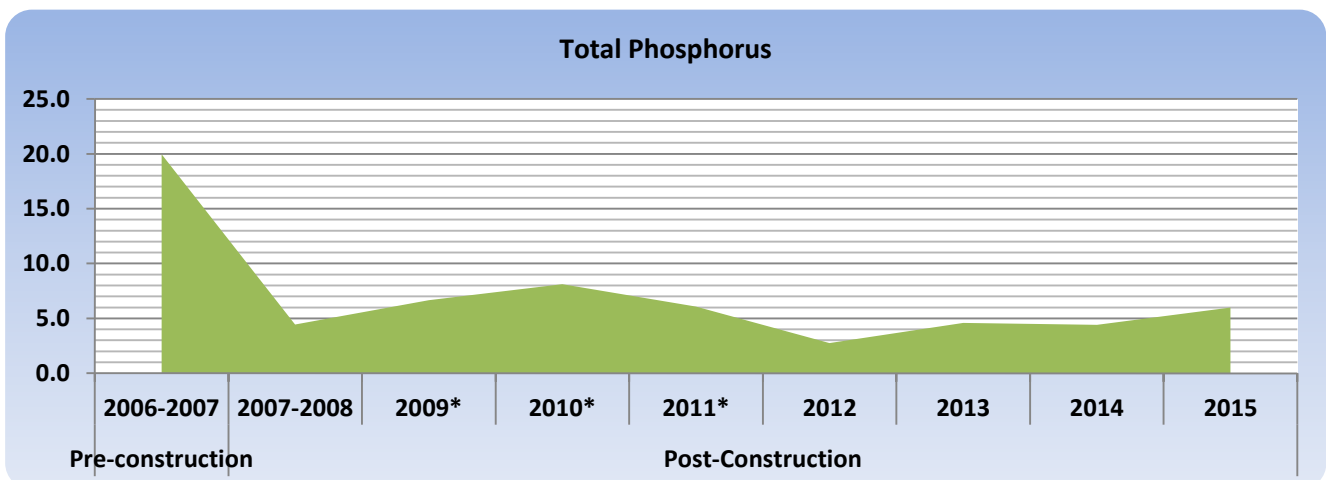


Figure 6 Total Phosphorus Baseload Estimates

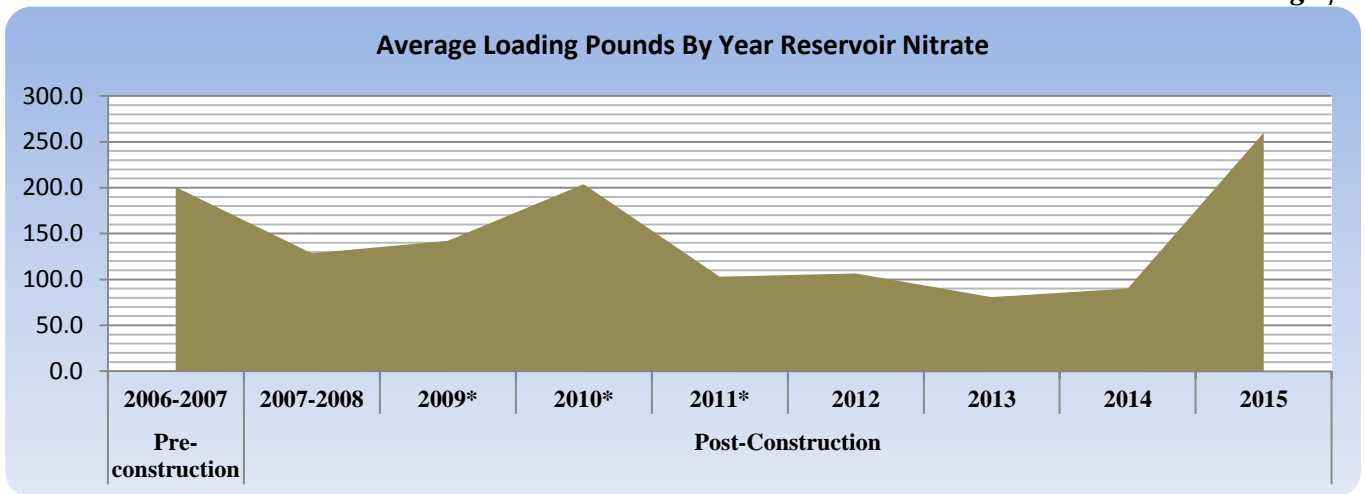


Figure 7 Nitrate-Nitrogen Baseload Estimates

Table 5 Project Average Loading for Trade Estimates

		Average Loading Pounds By Year			
		Reservoir		Above Project	
		Nitrate	T Phos	Nitrate	T Phos
Pre-construction	2006-2007	200.7	20.0		
Post-Construction	2007-2008	128.7	4.4	160.9	5.2
	2009*	142.0	6.7	185.9	8.9
	2010*	203.7	8.1	222.3	8.5
	2011*	103.0	6.1	163.9	7.0
	2012	106.6	2.7	104.4	4.8
	2013	80.6	4.6	78.8	4.7
	2014	90.3	4.4	131.4	4.8
	2015	260	6	500	21.7
			Loading Pounds After Stable		
		Reservoir		Above Project	
		Nitrate	T. Phos	Nitrate	T Phos
Total Pounds		11,167	676	14,463	888
Average		186	11	241	15
Median		91	4	128	5

2009*/2010*/2011/2015 average loadings per year excludes April storm loadings

Table 6 2015 Trade Pound Estimates

Total Phosphorus Trade Pounds				
	Total Base Flow		Trade Ration Pounds	
	Monthly	Annual	Monthly	Annual
Average	5.4	64.6	7.3	87.5
Median	5.3	63.6	7.3	88.0
Monthly TRP=PC Base Load-TBF Monthly Pounds/2				
The base trade ratio is 2:1 for Association Trade Projects				
Base Flows Exclude April Storm Loadings				
Annual Trade Pounds Available = 87.5 pounds Total Phosphorus				