

Bear Creek Watershed Association

2013 Annual Report



Bear Creek Watershed Association
1529 South Telluride St
Aurora, CO 80017

Manager: Russell N Clayshulte
303-751-7144

rclayshulte@earthlink.net
www.bearcreekwatershed.org

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*The Bear Creek Watershed Association protects & restores water & environmental quality
within the Bear Creek Watershed from the effects of land use*

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I. WQCC Summary

The Bear Creek Watershed is a specific geographic area identified in the Bear Creek Watershed State Control Regulation (Regulation #74, 5 CCR 1002-74) that requires special water quality management. The Bear Creek Watershed Association is the local water quality agency responsible for implementation of monitoring and tracking water quality in the Bear Creek Watershed.

The Control Regulation identifies the Association's annual reporting requirements for presentation to the Water Quality Control Commission (WQCC). The Bear Creek Watershed Association Annual Report includes five reporting requirements as listed in the control regulation: 1) Summarize status of water quality in the watershed for the previous calendar year. 2) Provide information on the wastewater treatment facilities loading and compliance with permit limitations. 3) Nonpoint source loading and appropriate best management practices. 4) Demonstrate through in-stream and reservoir data analyses the status of water quality goals and standards for the watershed. 5) Characterize any active phosphorus trading programs.

1. Status Of Water Quality

The total estimated annual discharge into Bear Creek Reservoir was about 49,973 acre-feet with about 45,726 acre-feet flow through and 4,246 acre-feet of evaporation and infiltration. Most of the 2013 flow came from a single large flood event in September (>31,000 ac-ft.). This flood washed fine sediment relatively high in total phosphorus into the reservoir, along with debris and organic matter. This may increase the internal phosphorus loading issue in late summer to early fall. The internal loading problem with Bear Creek Reservoir has not diminished over the last 6-years. The total phosphorus deposition into reservoir bottom sediments is about 10,450 pounds since 2008. The reservoir continues to experience late summer phytoplankton blooms (2013 peak density of *Microcystis aeruginosa* was > 233,750 cells/ml). A major phytoplankton bloom occurred prior to the September flooding.

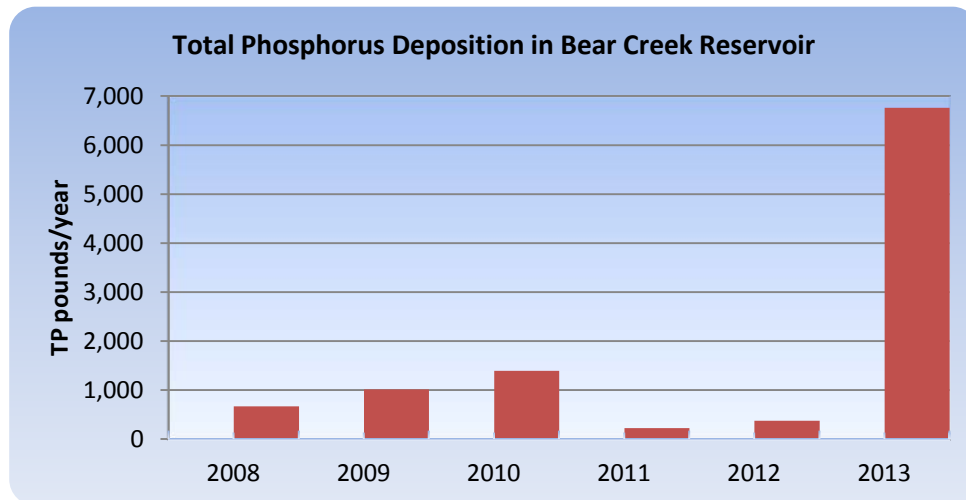


Figure 1 Annual Total Phosphorus Deposition into Bear Creek Reservoir Bottom Sediments

The total phosphorus load from the watershed comes from a combination of wastewater treatment plant point source loads, un-regulated point sources, and nonpoint sources, including stormwater runoff. The estimated total phosphorus load in 2013 from all sources reaching the reservoir was 14,387 pounds (97% from Bear Creek) at a flow of about 49,973 acre-feet. There was about 94,110 pounds of total nitrogen loading into the reservoir with 90% derived from the Bear Creek drainage.

The Association monitored watershed nutrients beginning near Mt. Evans following the September 2013 flood event. From a water quality perspective, the watershed showed remarkable resilience. 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. The peak flood chemistry showed a total phosphorus load in excess of 13,000 pounds, a total nitrogen load of 82,000 pounds and the total suspended sediment load of about 1.7 million pounds. Bed-load may have exceeded a 1/2 million tons. About 70% of the nutrient load flushed through the reservoir, with 90% of the sediment load retained in the reservoir basin. The Association estimates between 3,000 and 5,000 pounds of total phosphorus may be contained in the 0.5 to 1 acre-feet of sediment deposited in this single flood event.

A massive nutrient loading occurred in Evergreen Lake. Evergreen Lake received about 20,650 ac-ft of runoff. The peak flood chemistry showed a total phosphorus load in excess of 1,650 pounds, a total nitrogen load of 22,550 pounds and the suspended sediment load was about 900 tons (750 cubic-yards) with an estimated bedload of about 13,500 tons (11,200 cubic-yards). This sediment loading affect water supply storage rights. As such, a portion of Evergreen Lake will be dredged to reduce this massive sediment load.

Bear Creek peak stage (UDFCD) was 3,200 cfs in Morrison. Highest September flows in 113-year record. Flows in Evergreen above Evergreen Lake exceeded 1,300 cfs. Bear Creek jumped its channel in many locations and caused flood damage throughout the urban corridor. The stream morphology is altered and habitats are changed at most monitoring sites. The Association is applying an adaptive management process to adjust monitoring, strategies and options, and redefine restoration projects throughout the watershed.

2. Wastewater Treatment Facilities Loading and Compliance

In 2013, wastewater dischargers reduced waste load contributions to just 1,138 pounds annually. There were no significant permit compliance problems. Some of the smallest dischargers are finding it difficult to consistently meet the total phosphorus permit limit of 1.0 mg/l, but they do meet their annual wasteload allocations.

Regulation 85 also took effect in 2013, requiring nutrient monitoring of all BCWA member wastewater dischargers. Most larger WWTFs chose to participate in BCWA watershed level Reg 85 sampling and reporting in conjunction with stream sampling for data comparability.

In August, the Town of Morrison completed a major WWTF upgrade that reduced total phosphorus in effluent discharge from over 0.5 mg/L to less than 0.1 mg/L. This will be particularly helpful during drought periods when diverters dewater Bear Creek through Bear Creek Park, increasing the proportional flow derived from Morrison WWTF effluent that enters Bear Creek Reservoir.

3. Nonpoint Source Loading

Throughout 2013, BCWA was also involved in a CSU dissertation case study project in nutrient management. This resulted in the development of an online system to assist in further addressing nutrient loading the watershed. The project also developed detailed information on septic systems, horse properties and pastures, and unpaved roads to include in screening level analysis in EPA BASINS GWLF-E to estimate non-point source contributions. Preliminary results and watershed data from the last three years indicate the annual nonpoint phosphorus base-flow load from all sources in the watershed ranges from 5,000 to 6,000 pounds, annually. A single major flood event in the watershed can generate 1,000 to 12,000 pounds of total phosphorus. Clearly, only a fraction of this load transports to the Bear Creek Reservoir (Table 1). The point source load of total phosphorus in 2013

(Table 1) was 1,138 pounds (8%), while the nonpoint source load reaching Bear Creek Reservoir was about 13,250 pounds (92 %). This is not typical for nonpoint source phosphorus loading.

Table 1 Point Source versus Nonpoint Source Phosphorus Loading, Bear Creek Reservoir

Total Phosphorus Loading				
	Total Load	PS	NPS	%NPS
Turkey Creek Drainage	372	8	365	98%
Bear Creek Drainage	14,014	1,130	12,884	92%
Discharged into Reservoir	14,387	1,138	13,249	92%
Site 45 Outflow BCR	7,627			
BCR Total Phosphorus Deposition	6,759			

The Association online system is a permanent management policy (BCWA Policy 21, December 2013). Watershed plan and administration policies were developed by the Association in 2013, related to: priority zones, park latrines, plan development, watershed boundaries, data collection, nonpoint source loading and strategies, membership, recycling, illegal dumping, trading eligibility, and reservoir management strategies. Association policies are an essential component of the Association’s interactive online *watershed plan* and are used to continually improve watershed-planning efforts and provide tools to understand watershed dynamics.

4. Status Of Water Quality Goals and Standards

The Association has 32-years of active service to the watershed in Clear Creek, Jefferson and Park Counties. The Association has 28-years of data and studies to support good science. During this time, the Association has removed or immobilized about 327 tons of phosphorus in the watershed. The 75.7 volunteer-years of effort by Association membership has helped waters in the watershed meet standards and classified uses.

Average seasonal total phosphorus of 112 µg/L in Bear Creek Reservoir exceeds the 32 µg/L goal-standard. Average seasonal chlorophyll-a of 26 µg/L also exceeds the 10 µg/L standard. The trophic status of the reservoir remains at the Eutrophic-Hypertrophic boundary based on Carlson and Walker indices. Seasonal average reservoir temperature generally remained below 22° Celsius. There was 1 exceedance of the *Weekly Average Temperature* (WAT) and 11 exceedances of the *Daily Maximum Temperature* (DM). Lake aeration maintained dissolved oxygen levels at or above 6 mg/L throughout the growing season and recreational fishing remained strong.

In Bear Creek and Turkey Creek segments, there were a limited number of temperature compliance problems in both the warm and cold seasons. The only water chemistry exceedances of standards measured in the 2013 occurred at the site-specific Summit Lake pollution plume.

The Colorado 303(d) list includes Swede Gulch as a low priority for E. coli. There were no exceedances of the E. coli standard. The Association recommends de-listing this segment on the 303(d) list for E. coli. The Association is also monitoring nitrogen and phosphorus, flow and standard field parameters.

5. Phosphorus Trading Program

There was no active total phosphorus trading by Association membership in 2013. The Association has established three trading policies to improve future trading programs. The Association Coyote Gulch restoration project has established the annual available total phosphorus trade pounds consistent with the Association trade program at 81.7 pounds.

II. Bear Creek Watershed Association Program

The Bear Creek Watershed (Figure 2) is a specific geographic area identified in the Bear Creek Watershed State Control Regulation (Regulation #74, 5 CCR 1002-74) (Control Regulation) requiring special water quality management. The watershed includes all tributary water flows that discharge into Bear Creek Reservoir. The watershed extends from the Mount Evans Wilderness on the western end to the Town of Morrison on the eastern end. The two major tributaries are Bear Creek and Turkey Creek. The goal of the Control Regulation is to attain site-specific water quality standards and classifications through control of total phosphorus and chlorophyll. The Bear Creek Watershed Association (Association) oversees implementation of the Control Regulation.

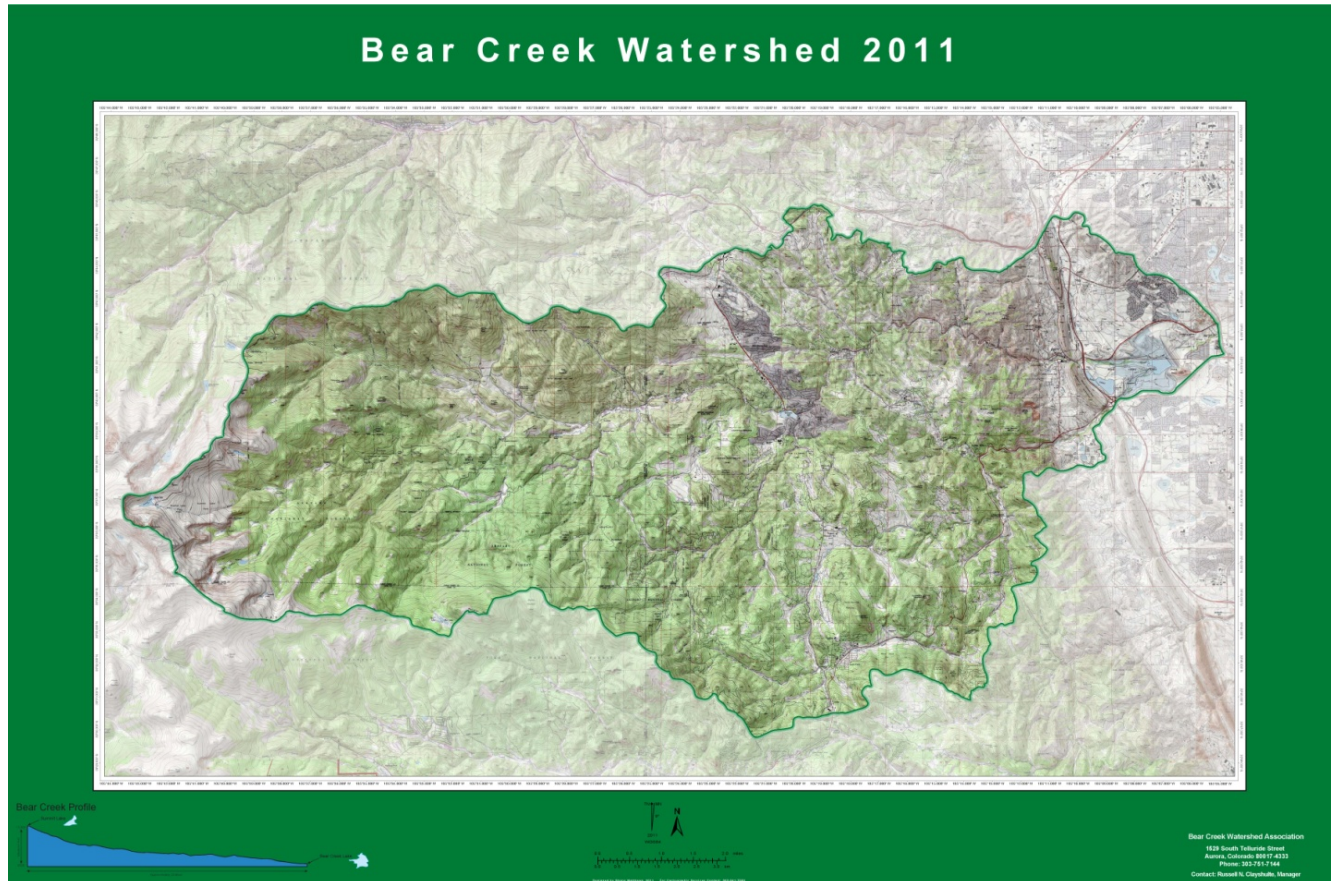


Figure 2 Bear Creek Watershed

The Association is the local water quality agency responsible for implementation of monitoring and tracking water quality in the Bear Creek Watershed (*BCWA Policy 13 Watershed Boundary*). The Association membership includes counties, local general-purpose governments, special districts (wastewater dischargers), associate agencies, and local citizen groups (Table 2). The Association membership monitors point sources and tracks nonpoint source practices, programs and loadings within the watershed. The Association management and implementation programs are at a watershed level.

The Association provides watershed reporting as posted on the Association website www.bearcreekwatershed.org, which serves to keep federal, state, and local governments and others informed on the state of the watershed. The Control Regulation defines specific reporting requirements, which helps the Association keep the Water Quality Control Commission and Water

Quality Control Division staff updated on progress of the Association in implementing the Control Regulation.

Table 2 Association Membership, Dischargers and Participation

Members and Associates	Wastewater Discharger	2013 Program Participation
<u>Counties</u>		
Jefferson County		Active
Clear Creek County		Active
<u>City and Towns</u>		
City of Lakewood		Active
Town of Morrison	Yes	Active
<u>Water & Sanitation Districts</u>		
Aspen Park Metropolitan District	Yes	Dues Paid, Not Active
Bear Creek Cabins	Yes	Active
Brook Forest Inn	Yes	Active
Conifer Sanitation Association	Yes	Dues Paid, Not Active
Conifer Metropolitan District	Yes	Dues Paid, Not Active
Evergreen Metropolitan District	Yes	Active
Forrest Hills Metropolitan District	Yes	Dues Paid, Not Active
Genesee Water & Sanitation District	Yes	Active
Geneva Glen	Yes	Dues Paid, Not Active
Jefferson County School District	Yes	Active
Kittredge Water & Sanitation District	Yes	Active
Singing River Ranch	Yes	Dues Paid, Not Active
The Fort Restaurant	Yes	Dues Paid, Not Active
Tiny Town Foundation, Inc.	Yes	Active
West Jefferson County Metropolitan District	Yes	Active
<u>Participant Agencies</u>		
Denver Water Department		Active
Denver Health/ Parks & Recreation		Active
Evergreen Trout Unlimited		Active
U.S. Army Corps of Engineers		Active
CDOT		Attended
Jefferson County Health Department		Attended
Jefferson Conservation District		Attended
U.S. Forest Service		Attended
WQCD		Attended

III. Status of Water Quality in the Reservoirs and Watershed

Monitoring Program Update

The BCWA monitoring plan details the 2013 reservoir and watershed monitoring programs as approved by the BCWA Board and submitted to the Water Quality Control Division staff (WQCD). This monitoring plan serves as a supplement to the adopted Association Quality Assurance Project Plan (Bear Creek Watershed Association, 2006). The 2013 monitoring program (version 2013.01) details changes, updates, major continuation studies and monitoring program elements. The *BCWA Policy 14*

Data Collection in the Bear Creek Watershed defines expectations for other groups or agencies that conduct overlapping monitoring activities within the watershed.

The routine monitoring program (P1) focuses on Turkey Creek drainage and Bear Creek drainage inputs, and discharge from Bear Creek Reservoir into lower Bear Creek with a central pool characterization of the reservoir near the dam (Figure 3; BCWA site 40). The outlet structure is near BCWA site 41 with Bear Creek inflow near BCWA site 44 and Turkey Creek inflow near BCWA site 43. The reservoir chemistry and biological characterization monitoring occurs at BCWA site 40. Vertical probe samples for specific conductance, temperature, dissolved oxygen, and pH measured at 1/2 and 1-meter intervals at all reservoir sites. The current monitoring program optimizes data generation to evaluate reservoir inflow loading, chemical and biological changes within the reservoir, and reservoir outflow, while minimizing monitoring cost. The aeration sites are visible in Figure 3. Figure 4 shows all monitoring stations within Bear Creek Park. The Association maintains maps of recent sampling sites and wastewater treatment plant locations on the Association web site.



Figure 3 Reservoir Monitoring Stations; Site 2 is the Routine P1 Station



Figure 4 Monitoring Station in Bear Creek Park

Watershed Studies

Stream Flow Studies

The BCWA obtains stream flow data at multiple stations throughout the watershed. Manual flows measured with most watershed-sampling events. For watershed sites, manual flows measured at up to 17 sites during the May to November timeframe. Year-round flows measured at the Kerr-Swede sites and P1 sites. The Association installed stream staff gages and involves members to help gather daily/weekly stream data at selected sites. Five sites have flow curves. The Association also conducts tributary stream flow studies.

Hydrology

The BCWA evaluates the basin hydrology. In 2013, the total estimated annual discharge into Bear Creek Reservoir was about 49,973 acre-feet (Figure 5) with about 45,726 acre-feet flow through and 4,246 acre-feet of evaporation and infiltration. Most of the 2013 flow came from a single large flood event in September (BCWA Fact Sheet 16). In Bear Creek Reservoir, the estimated flood event inflow was about 31,000 ac-ft. Bear Creek peak stage (UDFCD) was 3,200 cfs in Morrison. Highest September flows in 113-year record. Figure 6 shows the total reservoir inflow trend from 1987-2013.

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 over 15,000 acre-feet on September 22, 2013. The surface area was about 500 acres or 70% of surface acre capacity. Bear Creek within Bear Creek Park ran at about 40 cubic feet per second on September 1, 2013, which was about 20 cfs over expected conditions (caused by an earlier single heavy rainfall event). By September 11, Bear Creek was up to 400 cfs and soon after the gaging station in the park washed away. Bear Creek jumped its channel in many locations and caused flood damage throughout the urban corridor. The stream morphology was extensively altered and habitats are changed at most monitoring sites. The flood damage has affected the watershed hydrology and the BCWA water quality program.

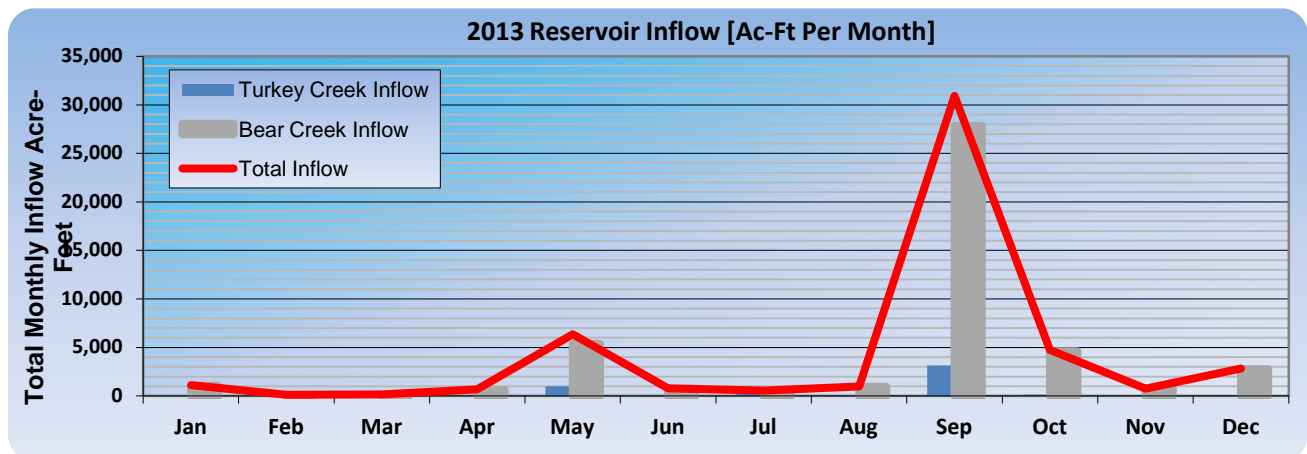


Figure 5 In-Flow Estimates by Month into Bear Creek Reservoir

Bear Creek flow diverts at the Harriman Ditch in Morrison, and a portion of the Turkey Creek flow diverts for water uses. Bear Creek flow diverts into the Arnett-Harriman during the irrigation season. The Arnett-Harriman ditch reduces flows in lower Bear Creek below 10 cfs in the operational season about 35% of the time. The ditch systems can completely dewatered lower Bear Creek for periods of up to 15 consecutive days. In 2013, lower Bear Creek was dewatered (<5 cfs flow) for 100 days or 27% of the time.

The reservoir inflow represents flows below the water diversions and is not representative of the total watershed water flows. Figure 4 compares the 2013 reservoir monthly inflow estimates from Bear Creek (91%) and Turkey Creek (9%). Peak spring runoff occurred in May 2013. The increased Bear Creek flows in September and October came from a large flood event in the watershed. Figure 6 shows the Bear Creek in-flow estimates (1987-2013) above Bear Creek Reservoir, in Bear Creek Park. Figure 7 shows the flow estimates at the Evergreen station.

Comparing in-flow estimates at the Morrison gaging station (2013, 49,421 ac-feet) and at the BCWA site in Bear Creek Park (2013, 45,090 ac-feet) provide an estimate of the amount of water diverted from the watershed by the Arnett-Harriman Canal. For example, in 2013 the Bear Creek water use diversion reduced flow to the reservoir by about 4,331 ac-ft (-9 %). Additionally, the longer time trends shown in Figures 6 and 7 depict a basic linear trend of declining flow in Bear Creek.

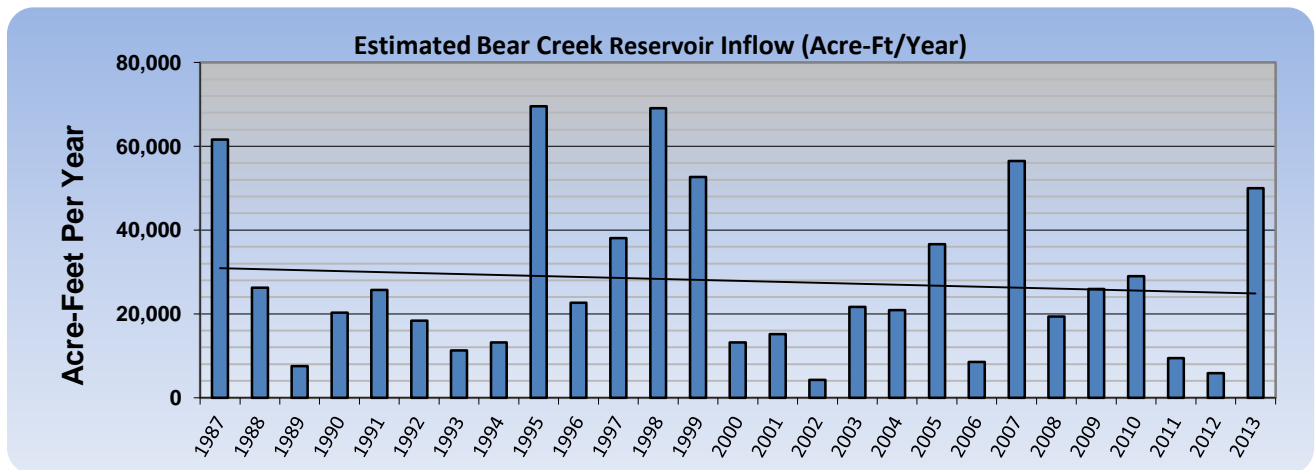


Figure 6 Annual Flows into Bear Creek Reservoir

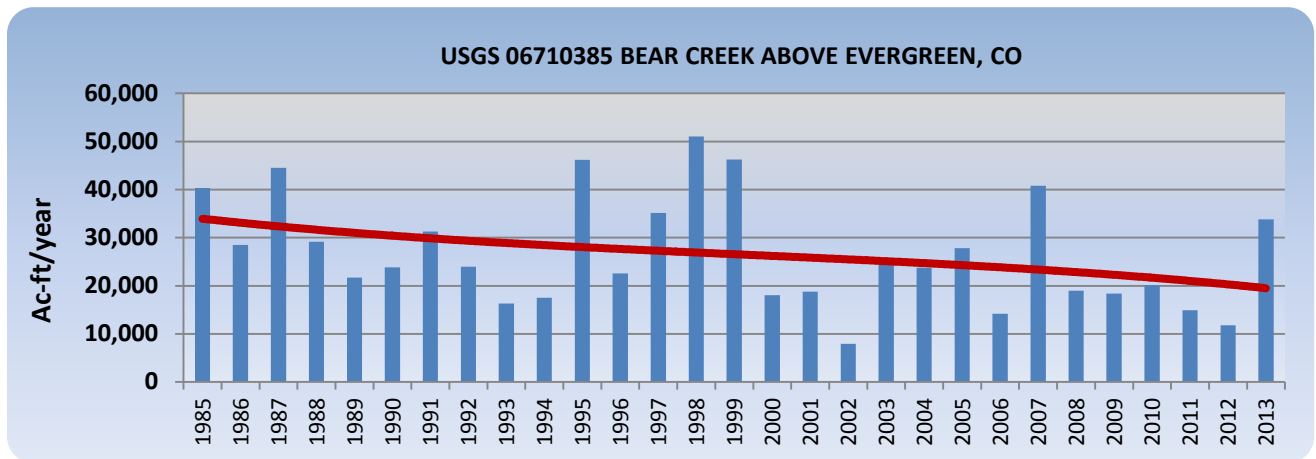


Figure 7 Bear Creek above Evergreen Annual Acre-feet/year Flow

Water Quality Studies

The BCWA summarizes its watershed-monitoring program in a data report (Bear Creek Watershed Association Data Report, May 2014). The BCWA collects annual water quality data from multiple sampling locations throughout the watershed. The watershed-monitoring program has three major water quality and environmental data generating elements, as defined in the *Water Monitoring Program and Sample Analyses Plan Version 2013.01, BCWA February 2013, and subsequent annual updates*:

1. Bear Creek Watershed surface water characterizations during selected months beginning at the headwaters of both Bear Creek and Turkey with a primary focus on nutrients and base field parameters,
2. Bear Creek Watershed surface water temperature characterization by major stream segments for both the cold and warm seasons, which is also defined in the *Water Monitoring Program and Sample Analyses Plan Version 2013.01, BCWA February 2013, and subsequent annual updates.*
3. Special water quality characterization and analyses studies completed on a site-specific basis.

The 2013 P1 data results are contained in the *2013 Bear Creek Master Spreadsheet* posted on the Association website monitoring page and a specific watershed spreadsheet for the temperature data. Monthly summary reports provided to the Association Board with data files posted to the website.

Stream and lake sampling and monitoring data, including pH, Temperature, Dissolved Oxygen, Specific Conductance, Ammonia, Nitrate +Nitrite, Total Inorganic Nitrogen (calculated), Total Nitrogen, Dissolved Phosphorus, Total Phosphorous, and Total Suspended Solids were collected from July through September, at 22 sites including the special pollution study sites in Mount Evans Wilderness Area. Stream and lake temperature data-loggers placed at 28 sites, including the Evergreen Lake profile station, and the Bear Creek Reservoir profile station, excluding the five WWTPs. Eight selected sites collected data logger temperatures from January through December. The remaining sites collected temperature data from April through September and May through October. Some data-loggers were lost during the flood event and others were pulled from the stream early.

Table 3 lists the 2013 middle watershed seasonal average chemistry results (full results shown in 2013 Master Spreadsheet). BCWA Technical Memorandum 2013.06 summarizes the middle watershed data. Table 4 lists the upper watershed chemistry results (full results shown in 2013 Master Spreadsheet). BCWA Technical Memorandum 2013.01 summarizes the Summit lake data.

Table 3 Middle Watershed Chemistry

	Site ID	Site Location by Stream Segment	Seasonal Average			
			TN Ug/l	NO3-NO2 Ug/l	Ammonia Ug/l	T Phos Ug/l
Segment 1a	Site 58	Bear Creek above Singing River Ranch	295.3	95.0	23.0	14.0
	Site 2a	Golden Willow Road UBC	277.4	68.0	27.3	20.0
	Site 3a	Above Evergreen Lake at CDOW Site	278.3	65.4	29.9	30.6
Segment 3	Site 25	Vance Creek (Mt. Evans Wilderness drainage)	200.8	25.8	29.2	16.4
Segment 1e	Site 5	Above EMD WWTP, CDOW downtown site	361.6	110.7	41.1	21.4
	Site 8a	Bear Creek Cabins at CDOW Site	487.6	258.7	34.0	23.6
	Site 9	O'Fallon Park, west end at CDOW Site	454.8	199.9	39.1	29.1
	Site 12	Lair o' the Bear Park, at CDOW site	630.3	324.2	33.6	38.6
	Site 13a	Below Idledale, Shady Lane at CDOW site	592.7	299.3	31.1	36.1
	Site 14a	Morrison Park west, CDOW Site	564.1	284.2	28.3	34.0
Segment 4a	Site 34	Mt Vernon Drainage, Morrison	1141.8	744.9	37.1	22.8
Segment 5	Site 35	Cub Creek, Upstream @ Brookforest Inn	415.5	221.8	27.5	24.7
	Site 50	Cub Creek, Upstream of Cub Creek Park	474.3	230.2	27.8	24.5
	Site 64	Troublesome at Culvert above West Jeff	721.2	334.3	33.6	65.0
	site 32	Troublesome Mouth	1377.4	709.2	65.6	203.7
Segment 6a	Site 18	South Turkey Creek Aspen Park	611.0	28.1	29.7	28.0
Segment 6b	Site 19	North Turkey Creek Flying J Ranch Bridge	544.6	276.3	32.9	25.2

Table 4 Upper Watershed (Summit Lake) Chemistry

Site	Parameter	19-Jun	24-Jul	28-Aug	26-Sep	Average
BCWA Segment Sample Sites						
36 - Outlet Summit Lake	Total Nitrogen, ug/l	289	260	351	345	311
36 - Outlet Summit Lake	Nitrate/Nitrite as N, dissolved, ug/l	52	75	127	165	105
36 - Outlet Summit Lake	Nitrogen, ammonia, ug/l	46	9	63	16	34
36 - Outlet Summit Lake	Phosphorus, total, ug/l	16	2	40	6	16
65 - Between Pond #1 & #2	Total Nitrogen, ug/l	229	517	458	283	372
66 - Between Pond #1 & #2	Nitrate/Nitrite as N, dissolved, ug/l	74	76	251	167	142
67 - Between Pond #1 & #2	Nitrogen, ammonia, ug/l	43	25	9	14	23
68 - Between Pond #1 & #2	Phosphorus, total, ug/l	16	2	63	8	22
37 - Upper Bear Creek	Total Nitrogen, ug/l	219	327	421	338	326
37 - Upper Bear Creek	Nitrogen, ammonia, ug/l	32	32	51	15	33
37 - Upper Bear Creek	Nitrate/Nitrite as N, dissolved, ug/l	86	101	228	169	146
37 - Upper Bear Creek	Phosphorus, total, ug/l	7	2	12	6	7
Summit Plume Discharge						
63- Est Bottom Plume	Phosphorus, total, ug/l	4112	1798	208	1087	1801
63- Est Bottom Plume	Total Dissolved Phosphorus, ug/l			39	22	31
63- Est Bottom Plume	Ortho-Phosphorus, ug/l			22	29	26
63- Est Bottom Plume	Total Nitrogen, ug/l	1722	3108	121	925	1469
63- Est Bottom Plume	Nitrogen, ammonia, ug/l	49	42	83	32	52
63- Est Bottom Plume	Nitrate/Nitrite as N, dissolved, ug/l	4	3	2	2	3

Kerr/Swede Gulch E. coli Study

The Colorado 303(d) list includes Swede Gulch as a low priority for E. coli. The mainstem is Kerr/Swede Gulch with the western gulch upstream of the upper confluence as Kerr Gulch and the eastern tributary as Swede Gulch (Figure 8). The Division and Association agree this area maybe a good candidate to understand the contribution of nutrients from septic systems to the water quality in tributaries. The Division and Association agree there is a water quality problem that requires further investigation.

The Association completed the 4th year of a 5-year monitoring program to evaluate E. coli and nutrients on Kerr/Swede Gulch (confluence with Bear Creek, below confluence of Swede Gulch and just upstream of confluence on Kerr Gulch) and lower Swede Gulch. The Association monitors E. coli at 4-sites (Figure 8) from January (provided winter flows) through December.

The Association also collects data for temperature, pH, specific conductance and Dissolved Oxygen using the field probe and nutrient samples for laboratory analyses. The Association is conducting the E. coli analyses.

Table 5 shows the 2013 data summary for Kerr/Swede Gulch sample sites. Table 6 shows the Geometric means for E. coli. The E. coli standard is 126/100ml (Measured as a geometric mean of data). There were no exceedances of the E. coli standard. The Association recommends this segment for de-listing from the 303(d), since the 4-year data set shows no E. coli problem. The Association is also monitoring nitrogen and phosphorus, flow and standard field parameters.

Technical Memorandum 2013.02 (BCWA, January 2013) summarizes all 2013 data for this special study.

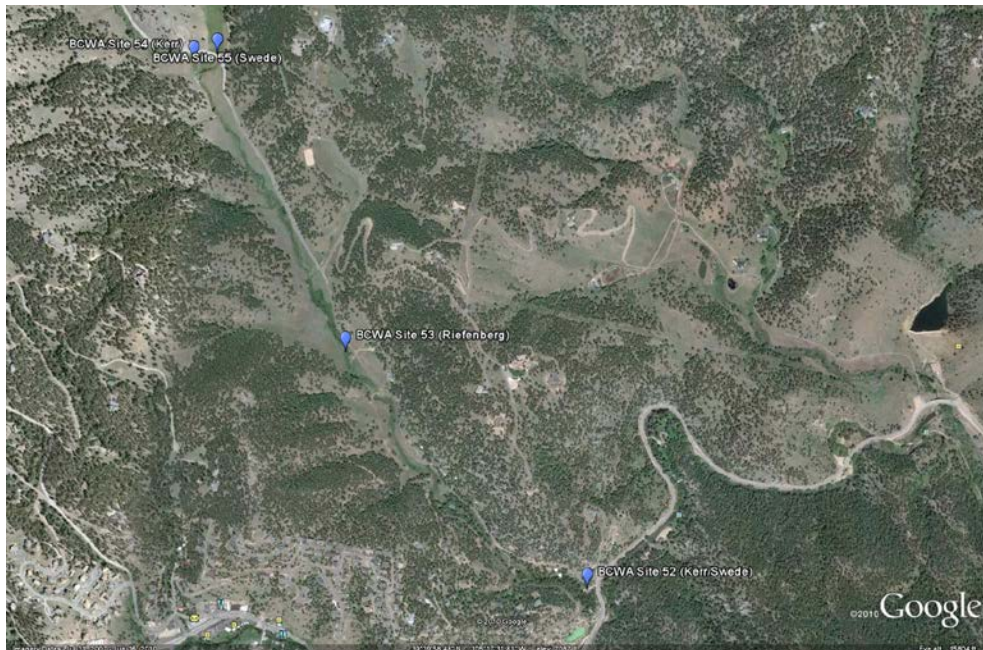


Figure 8 Kerr/Swede Gulch Sample Sites

Table 5 Kerr/Swede Gulch Data Summary

BCWA Site	Time	Temp (C)	pH	SC (ms/cm)	DO (mg/l)	E. Coli (Cells/100ml)-
1/22/2013						
Site 52 - Confluence	1:13	0	8.49	0.946	10.42	1
Site 53 - Riefenberg	1:26	0.5	7.95	0.98	10.31	1
Site 54 - Kerr	1:41	0	8.76	0.918	10.5	5
Site 55 - Swede	1:38	0	8.82	0.883	12	6
2/19/2013						
Site 52 - Confluence	1:36	0.2	8.66	0.862	12.3	1
Site 53 - Riefenberg	1:54	0.2	8.71	0.84	12.43	1
Site 54 - Kerr	2:09	0.1	8.34	0.812	11.21	1
Site 55 - Swede	2:06	0.08	8.27	0.672	11.77	4
3/25/2013						
Site 52 - Confluence	12:48	0	8.3	0.809	13.15	1
Site 53 - Riefenberg	1:01	0.2	7.97	0.793	12.16	1
Site 54 - Kerr	1:21	0.1	7.75	0.813	8.66	1
Site 55 - Swede	1:16	0.1	7.96	0.759	8.93	1
4/25/2013						
Site 52 - Confluence	10:45	2.9	7.89	0.93	11.48	1
Site 53 - Riefenberg	10:16	1.7	8.4	0.97	13.12	1
Site 54 - Kerr	10:30	3.6	7.94	0.803	11.2	1
Site 55 - Swede	10:26	2.9	7.74	1.13	10.87	4
5/20/2013						
Site 52 - Confluence	10:35	9.2	7.93	0.572	11.42	1
Site 53 - Riefenberg	10:47	10.3	7.91	0.83	9.8	1
Site 54 - Kerr	11:01	12.1	7.43	0.79	9.06	12
Site 55 - Swede	10:58	12	7.82	0.65	9.2	4
6/17/2013						
Site 52 - Confluence	10:48	11.4	7.87	0.128	12.07	21
Site 53 - Riefenberg	11:01	12.4	8.16	0.86	10.91	27
Site 54 - Kerr	11:15	13.6	8.17	0.83	10.1	66
Site 55 - Swede	11:11	13.2	8.16	0.94	10.7	17
7/22/2013						
Site 52 - Confluence	11:14	14.5	8.01	0.88	8.63	11

BCWA Site	Time	Temp (C)	pH	SC (ms/cm)	DO (mg/l)	E. Coli (Cells/100ml)-
Site 53 - Riefenberg	11:26	15.3	8.26	0.91	8.24	37
Site 54 - Kerr	11:40	17.4	8.13	0.67	6.67	60
Site 55 - Swede	11:36	16.6	8.26	1	7.88	6
8/26/2013						
Site 52 - Confluence	11:17	14.65	8.47	0.914	8.17	10
Site 53 - Riefenberg	11:36	15.48	8.29	0.919	7.27	9
Site 54 - Kerr	11:51	16.52	8.17	0.917	6.25	10
Site 55 - Swede	11:46	17.28	8.32	0.871	7.21	2
9/24/2013						
Site 52 - Confluence	9:45	8.9	8.62	1.02	10.54	1
Site 53 - Riefenberg	10:05	8.3	8.46	1.01	10.38	1
Site 54 - Kerr	10:22	9	8.36	1	9.95	1
Site 55 - Swede	10:20	9.5	8.36	1.02	9.42	1
10/21/2013						
Site 52 - Confluence	10:15	3.3	8.23	1.02	12.79	1
Site 53 - Riefenberg	10:28	2.8	8.06	1.01	12.77	1
Site 54 - Kerr	10:45	2.8	8	0.97	11.78	15
Site 55 - Swede	10:40	3.6	8.02	1.02	11.93	1
11/18/2013						
Site 52 - Confluence	1:10	2.9	8.21	1.01	11.6	1
Site 53 - Riefenberg	1:31	3.2	8.1	0.97	11.65	1
Site 54 - Kerr	1:48	4.1	7.95	0.95	11.74	5
Site 55 - Swede	1:43	5.7	7.99	0.99	10.08	2
12/16/2013						
Site 52 - Confluence	12:52	1	8.14	1.01	10.28	1
Site 53 - Riefenberg	1:05	1.4	8.1	0.93	11.23	9
Site 54 - Kerr	1:18	0.1	8.07	0.902	11.33	9
Site 55 - Swede	1:13	0.4	7.92	0.93	12.1	15

Table 6 Kerr/ Swede Gulch E. Coli Geometric Mean Summary

E. coli Summary, Geometric Mean									
BCWA Site	2010		2011						
	May-Dec	J-D (Annual)	Jan-Feb	Mar-Apr	May-Jun	Jul-Aug	Sep-Oct	Nov-Dec	May-Oct
	n=36	n=48	n=8	n=8	n=8	n=8	n=8	n=8	n=24/6
Sites 52-53			14	2	6	5	6	2	6
Site 52 - Confluence	10	6							15
Site 53 - Riefenberg	13	4							9
Site 54 - Kerr	16	5							3
Site 55 - Swede	11	3							2
2012									
Sites 52-53		5	3	1	11	26	10	3	13
Site 52 - Confluence		3							6
Site 53 - Riefenberg		4							9
Site 54 - Kerr		10							32
Site 55 - Swede		3							13
2013									
Sites 52-53		3	2	1	9	14	1	3	5
Site 52 - Confluence		2							4
Site 53 - Riefenberg		2							5
Site 54 - Kerr		6							14
Site 55 - Swede		3							3

Reservoirs

Bear Creek Reservoir and Inflow Nutrients

The watershed-monitoring program characterizes nutrient loading into Bear Creek Reservoir from two primary drainages: Bear Creek and Turkey Creek. The Association monitors for total phosphorus, dissolved phosphorus, nitrate-nitrite nitrogen, and total nitrogen on a monthly basis. The Association has established preferred management strategies for Bear Creek Reservoir (*BCWA Policy 20*).

The total phosphorus load from the watershed comes from a combination of wastewater treatment plant point source loads, un-regulated point sources, and nonpoint sources, including runoff. There are over 15,000 septic systems in the watershed. The estimated total phosphorus load in 2013 from all sources reaching the reservoir was 14,387 pounds at a flow of about 49,973 acre-feet. Bear Creek drainage contributed 97% of the load (Figure 9). The peak flood chemistry showed a Total Phosphorus load in excess of 14,000 pounds. In comparison, the entire total phosphorus load in 2012 was 700 pounds. More total phosphorus was loaded into the reservoir in September than measured from 2007-2012. Although the point source discharges of total phosphorus were about 1,138 pounds, the water diversions above the reservoir and natural stream vegetation uptake are removing a portion of this phosphorus load and inflow water before it reaches the reservoir.

The nitrate loading (51,020 pounds) was much higher than past flow conditions due to flood loadings (Figure 10) with 87% of the load coming from Bear Creek. Figure 11 estimates the total nitrogen loading into Bear Creek Reservoir. There was about 94,110 pounds of total nitrogen loading with 90% derived from the Bear Creek drainage. Figure 12 shows the 2013 total phosphorus concentrations at the routine watershed monitoring stations. The management program targets reduction of total phosphorus reaching the reservoir on an annual basis. Figure 13 shows the total phosphorus reservoir trend. Figure 14 shows the nitrate concentrations at routine watershed monitoring stations. Figure 15 shows the total nitrogen trends. The reservoir nitrogen data shows a general reduction over the years (Figure 16).

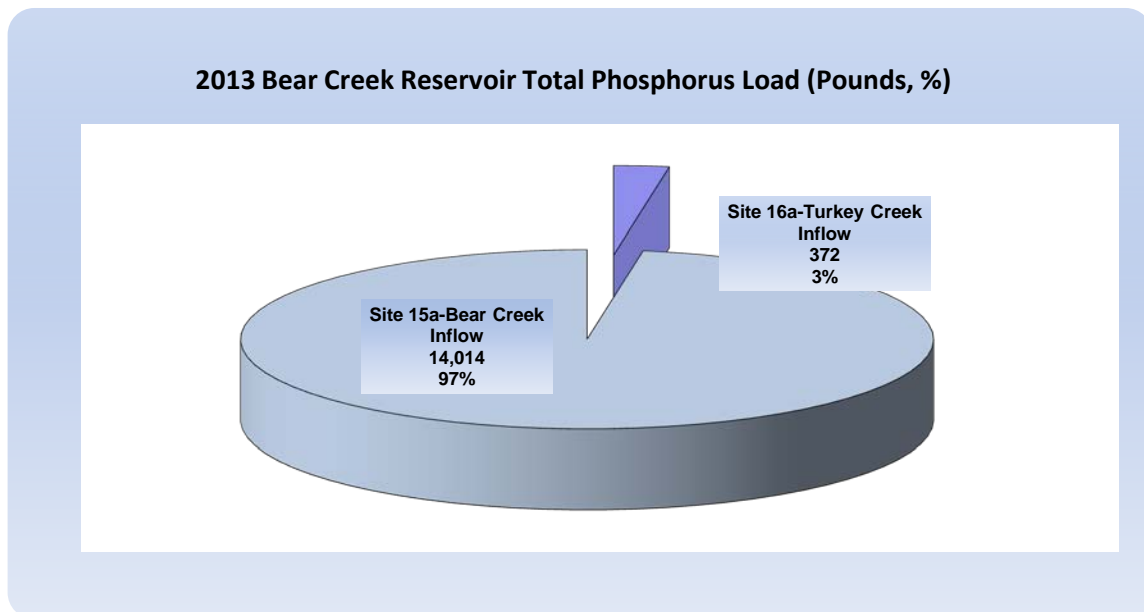


Figure 9 Estimated Total Phosphorus loading into Bear Creek Reservoir

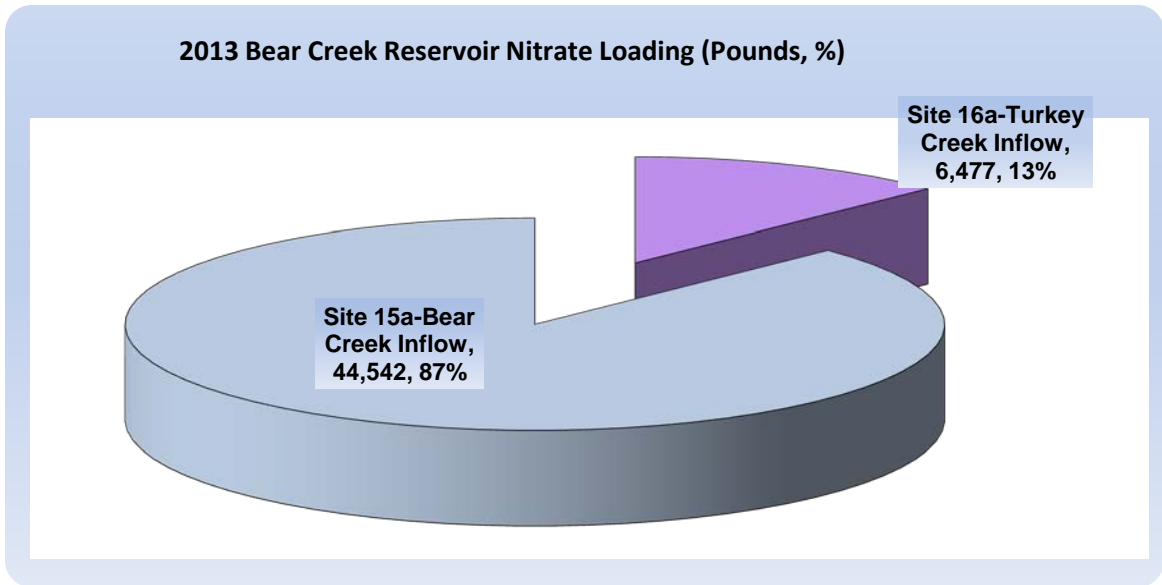


Figure 10 Estimated Nitrate loading into Bear Creek Reservoir

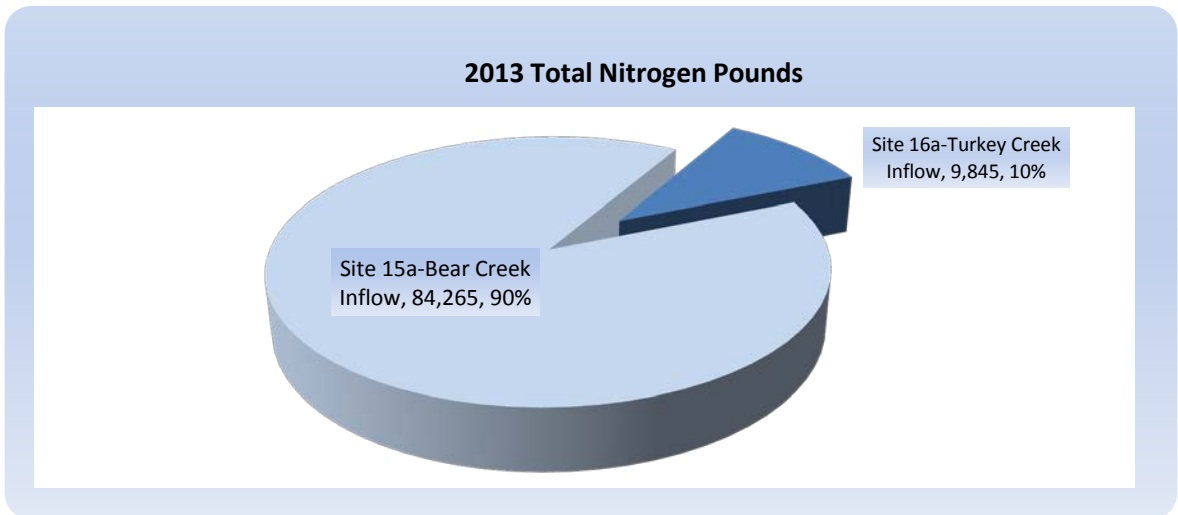


Figure 11 Estimated Total Nitrogen Loading into Bear Creek Reservoir

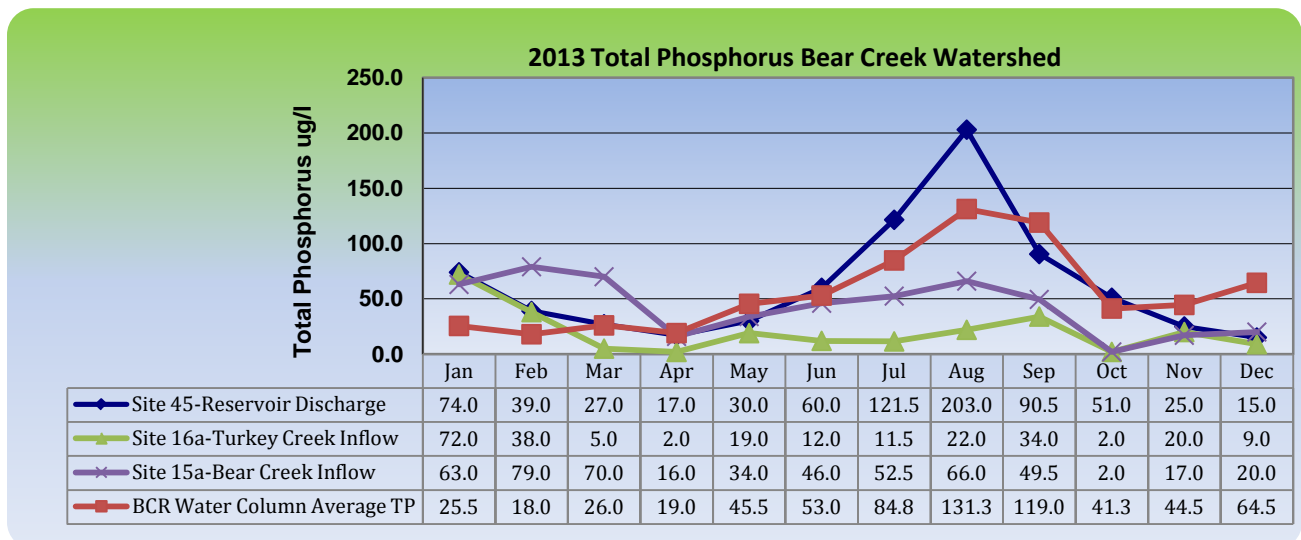


Figure 12 Total Phosphorus Annual Trend at Bear Creek Reservoir

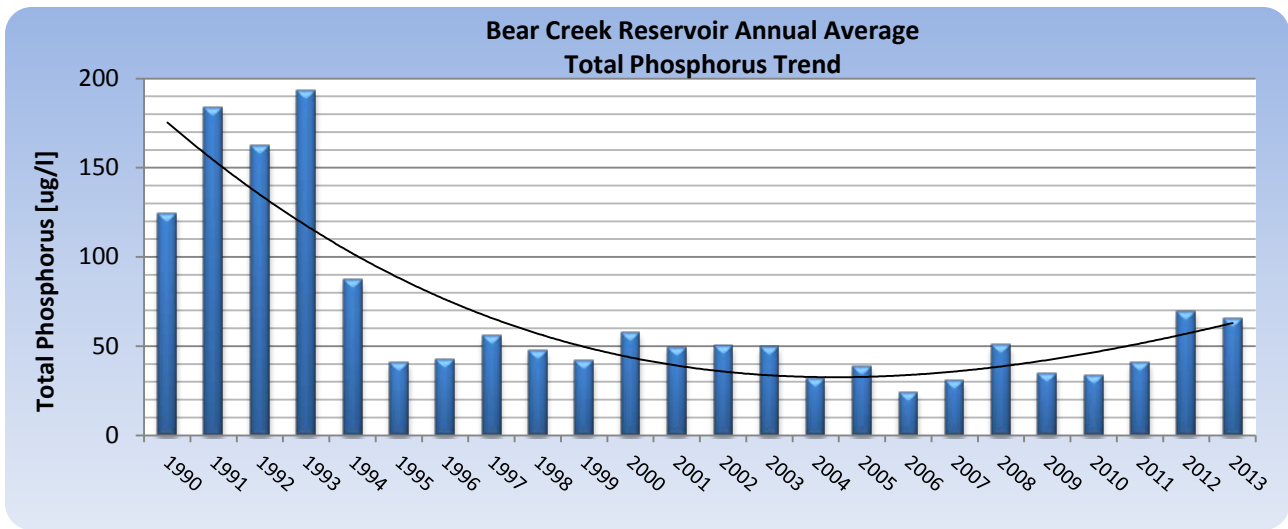


Figure 13 Annual Total Phosphorus Bear Creek Reservoir

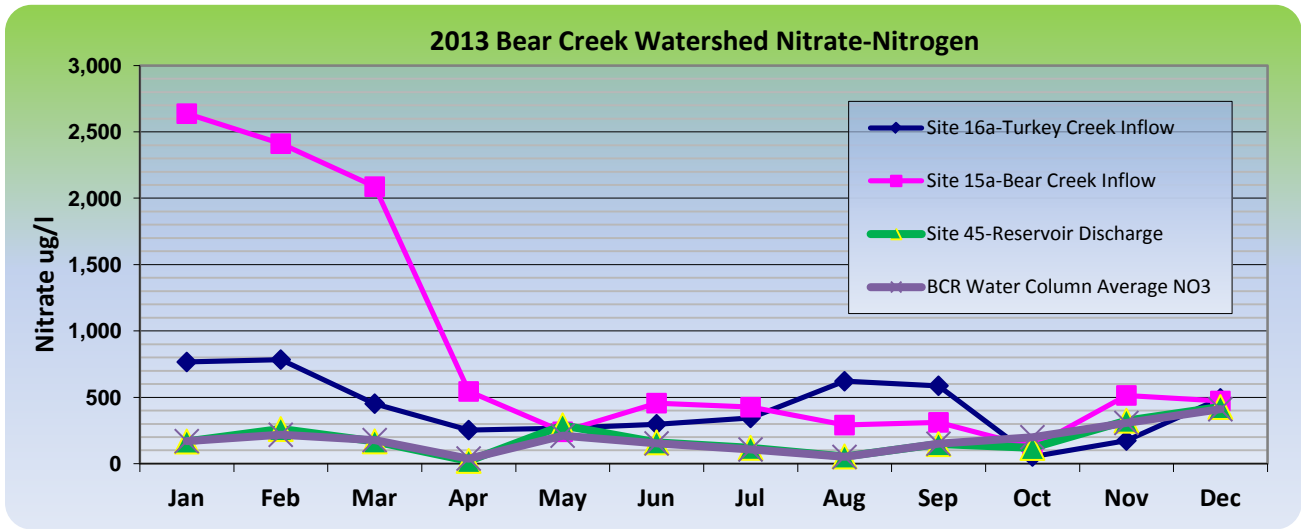


Figure 14 Bear Creek Reservoir Nitrate-Nitrogen Concentrations

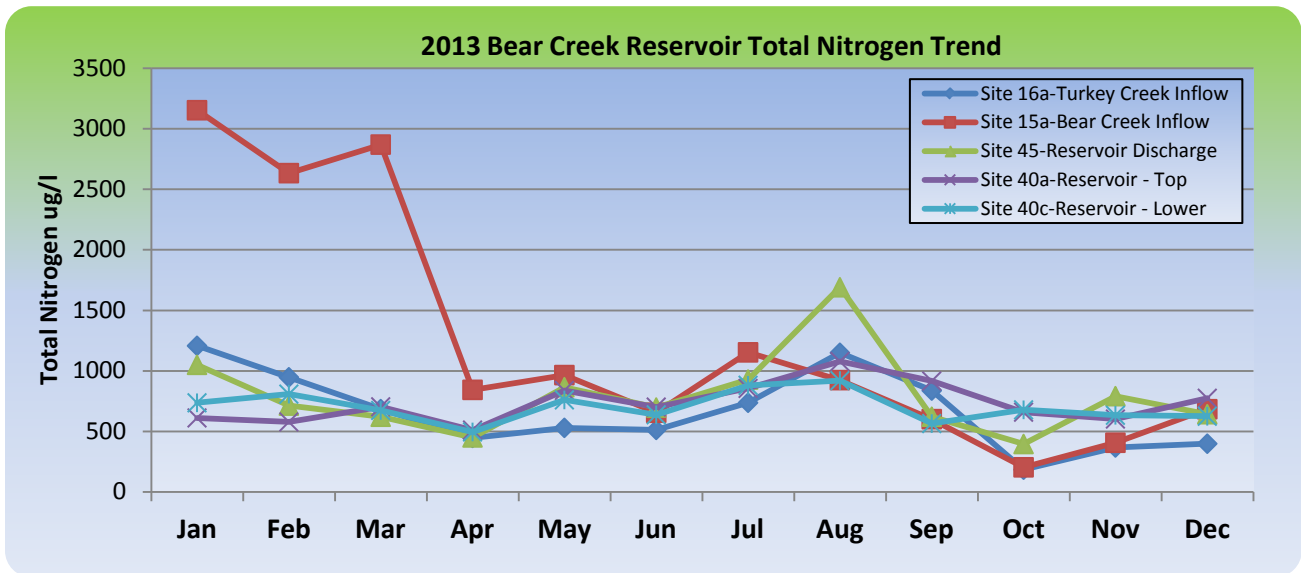


Figure 15 Total Nitrogen Bear Creek Reservoir

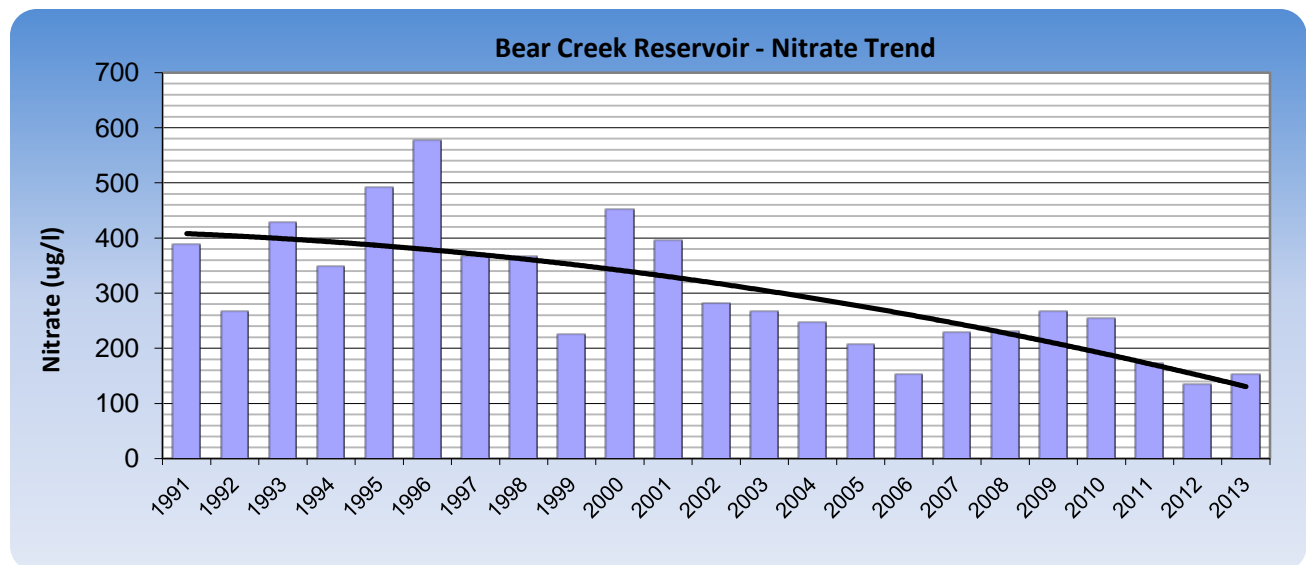


Figure 16 Annual Bear Creek Reservoir Nitrate Trend

Bear Creek Reservoir Indicator Trend Variables

The Association’s reservoir monitoring program collects samples to analyze nutrient (nitrogen and phosphorus) concentrations, chlorophyll-a, total suspended sediments, dissolved oxygen, pH, specific conductance, Secchi depth, and phytoplankton population dynamics as trend variables. Table 7 lists the summary statistics for the monitoring variables. Table 8 summarizes the reservoir loading data. Table 9 compares 2013 data with the long-term patterns from 1991 through 2013. Overall, 2013 water quality is similar to historic trends. Table 10 summarizes the phytoplankton data. Figure 17 shows the phytoplankton total density during summer sampling period and Figure 18 depicts the Biovolume of the functional groups. Figure 19 shows the general clarity trend in the water column using Secchi measurements. March and April had the poorest clarity caused by runoff.

Table 7 Bear Creek Reservoir Summary Statistics (July September)

Reservoir Monitoring Parameters	Reservoir
Chlorophyll (Site 40)	
Average Growing Season Chlorophyll-a [ug/l (-1m)]	26.4
Average Annual Chlorophyll-a [ug/l (-1m)]	14.6
Peak Chlorophyll-a [ug/l]	54.3
Phosphorus	
Annual Total Phosphorus [ug/l]: Water Column Average	65.6
Average Annual Total Phosphorus [ug/l] -1m	71.4
Average Annual Total Phosphorus [ug/l] -10m	59.8
Growing Season Total Phosphorus [ug/l]: Water Column Average	111.7
Growing Season Total Phosphorus [ug/l]: -1m	128.8
Growing Season Total Phosphorus [ug/l]: -10m	94.5
Peak Annual Total Phosphorus [ug/l] Water Column Average	166.0
Annual Ortho Phosphorus ug/l] Water Column Average	32.1
Growing Season Ortho Phosphorus [ug/l] Water Column Average	59.7
Peak Annual Ortho Phosphorus [ug/l] Water Column Average	108.0
Nitrogen	
Annual Nitrate-Nitrogen [ug/l] Water Column Average	153
Growing Season Nitrate-Nitrogen [ug/l] Water Column Average	103
Peak Annual Nitrate-Nitrogen [ug/l] Water Column Average	316
Average Annual Total Nitrogen [ug/l]: Water Column Average	752
Average Total Nitrogen [ug/l]: -1m	782

Reservoir Monitoring Parameters	Reservoir
Average Total Nitrogen [ug/l]: -10m	721
Growing Season Total Nitrogen [ug/l]: Water Column Average	869
Growing Season Total Nitrogen [ug/l]: -1m	950
Growing Season Total Nitrogen [ug/l]: -10m	788
Clarity (All Profiles)	
Average Annual Secchi Depth (meters)	1.86
Growing Season Average Secchi Depth (meters)	1.14
Total Suspended Sediments	
Annual Average Total Suspended Sediments [mg/l]	8.9
Growing Season Average Total Suspended Sediments [mg/l]	9.5
Peak Total Suspended Sediments [mg/l]	39.8
Dissolved Oxygen (site 40 Profile)	
Annual Average at -1/2m - 2m [mg/l]	9.0
Annual Minimum at -1/2m - 2m [mg/l]	5.8
Seasonal Average at -1/2 - 2m [mg/l]	7.4
Seasonal Minimum at -1/2 - 2m [mg/l]	5.8
pH	
Annual Average at -1/2m - 2m [mg/l]	8.28
Annual Maximum at -1/2m - 2m [mg/l]	9.06
Seasonal Average at -1/2 - 2m [mg/l]	8.49
Seasonal Maximum at -1/2 - 2m [mg/l]	8.98
Specific Conductance	
Annual Average at -1/2m - 2m [uS/cm]	0.408
Annual Minimum at -1/2m - 2m [us/cm]	0.704
Seasonal Average at -1/2 - 2m [us/cm]	0.335
Seasonal Minimum at -1/2 - 2m [us/cm]	0.397
Phytoplankton Species	
Phytoplankton Co-dominant Species - Site 40 (July-September 2013)	Aphanizomenon flos-aquae
	Microcystis aeruginosa
	Cryptomonas erosa
	Rhodomonas minuta
	Achnanthes minutissima
	Cocconeis placentula
	Cymbella minuta
	Melosira ambigua
	Melosira granulata
	Stephanodiscus niagarae
	Synedra cyclopus
	Glenodinium sp.
	Chlamydomonas sp.
Ankistrodesmus falcatus	
Peak Phytoplankton	
<i>Aphanizomenon flos-aquae</i>	Density cells/ml = 3,341
<i>Aphanizomenon flos-aquae</i>	Peak Biovolume (um ³ /mL) = 5,261,667

Table 8 Annual Bear Creek Reservoir Load Estimates

Loading - Annual Pounds	
Total Nitrogen -Total Load In to BCR	94,110
Total Nitrogen -Total Load From BCR	80,203
Total Nitrogen -Total Deposition into BCR	13,907
Total Phosphorus -Total Load In to BCR	14,387
Total Phosphorus -Total Load From BCR	7,622

Loading - Annual Pounds	
Total Phosphorus -Total Deposition into BCR	6,765
TSS -Total Load In to BCR	2,103,350
TSS -Total Load From BCR	1,611,815
TSS -Total Deposition into BCR	491,535

Table 9 Bear Creek Reservoir Select Trend Parameters

Parameter		2013	91-2013 Mean	91-2013 Median
Chlorophyll-a (ug/L)	Top	15	14	15
Total Nitrogen ug/l	Top	782	637	637
	Bottom	721	619	619
	Water Column Average	752	628	628
Nitrate-Nitrogen (ug/L)	Top	161	313	289
	Bottom	144	285	244
	Water Column Average	153	299	266
Total Phosphorus (ug/L)	Top	71	59	40
	Bottom	60	83	60
	Water Column Average	66	67	50
Total Suspended Solids (mg/L)	Top	7	7	6
	Bottom	11	11	10
	Water Column Average	9	8	8
Secchi Depth (m)	Top	2	2	2

Table 10 Bear Creek Reservoir Phytoplankton Summary Data

	8-Jul	22-Jul	5-Aug	26-Aug	9-Sep	23-Sep
Total Density (#/mL):	2,581	4,036	2,446	173	17,657	461
Total Biovolume (um³/mL):	3,512,071	6,140,359	3,224,164	310,383	3,580,368	1,136,298
Trophic State Index:	55	63	58	41	59	51

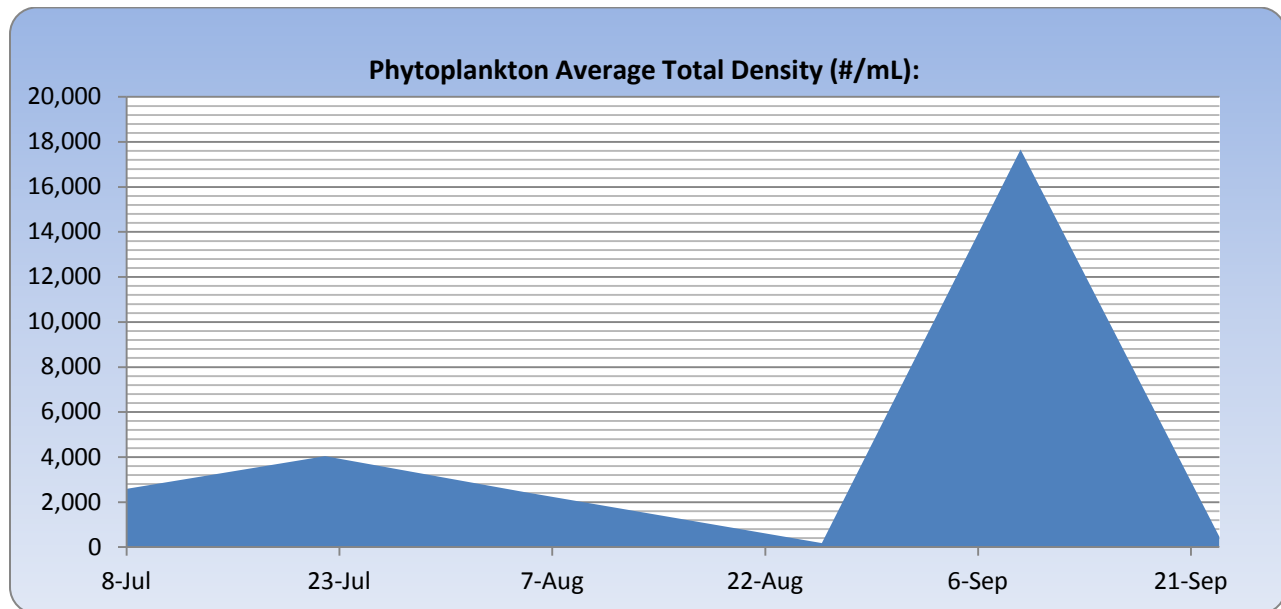


Figure 17 Bear Creek Reservoir Phytoplankton Summer Total Density

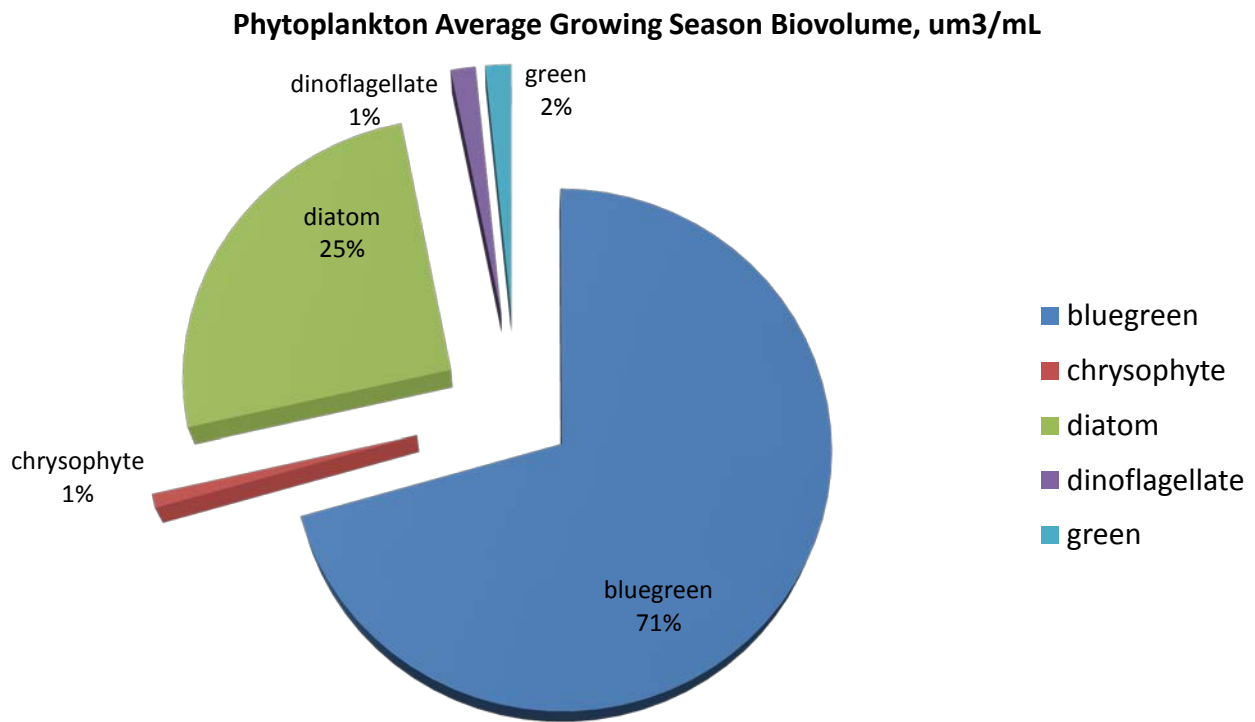


Figure 18 Phytoplankton Average Biovolume by Functional Group

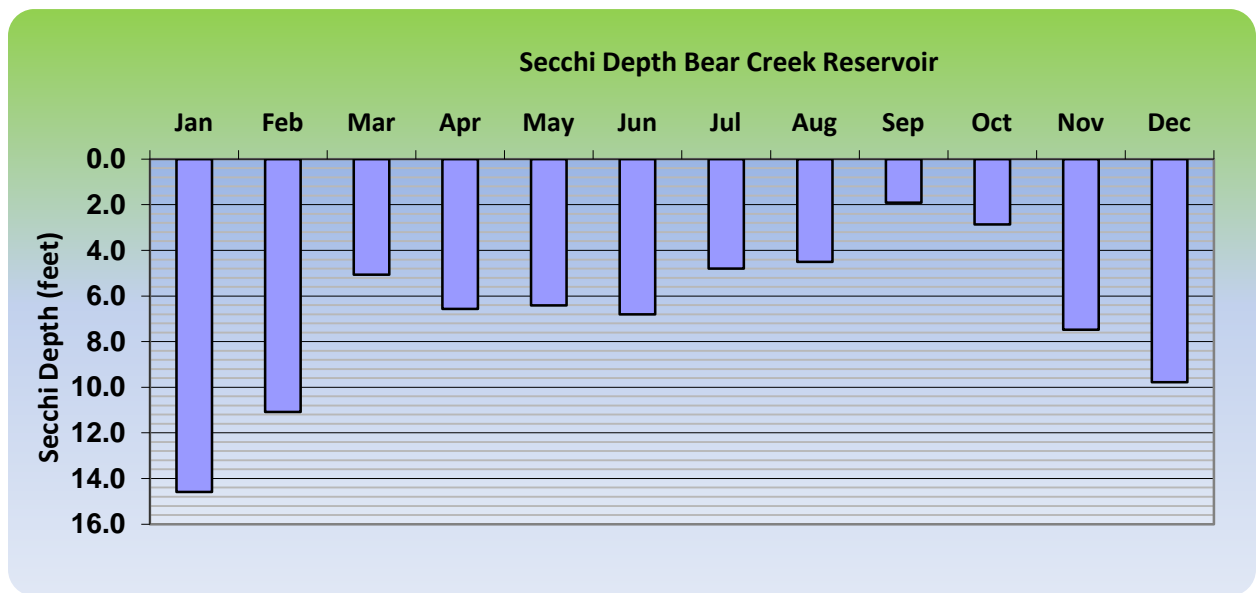


Figure 19 Secchi Depth Bear Creek Reservoir

The reservoir had several algal blooms in 2013 as evidenced by the peak September chlorophyll concentration of 54.3 $\mu\text{g}/\text{l}$ (Figure 20). The peak phytoplankton Biovolume was 1,686,888 $\mu\text{m}^3/\text{mL}$ caused by a blue-green phytoplankton species. Historically, blue-green phytoplankton species are associated with major blooms in the reservoir.

Generally, the reservoir trophic state was eutrophic (Walker Index, Figure 21). The Carlson Index shows a similar eutrophic trend. Although external nutrient loads were lower than historic trends, the

reservoir continues to have an internal nutrient loading problem, which causes eutrophic water quality conditions.

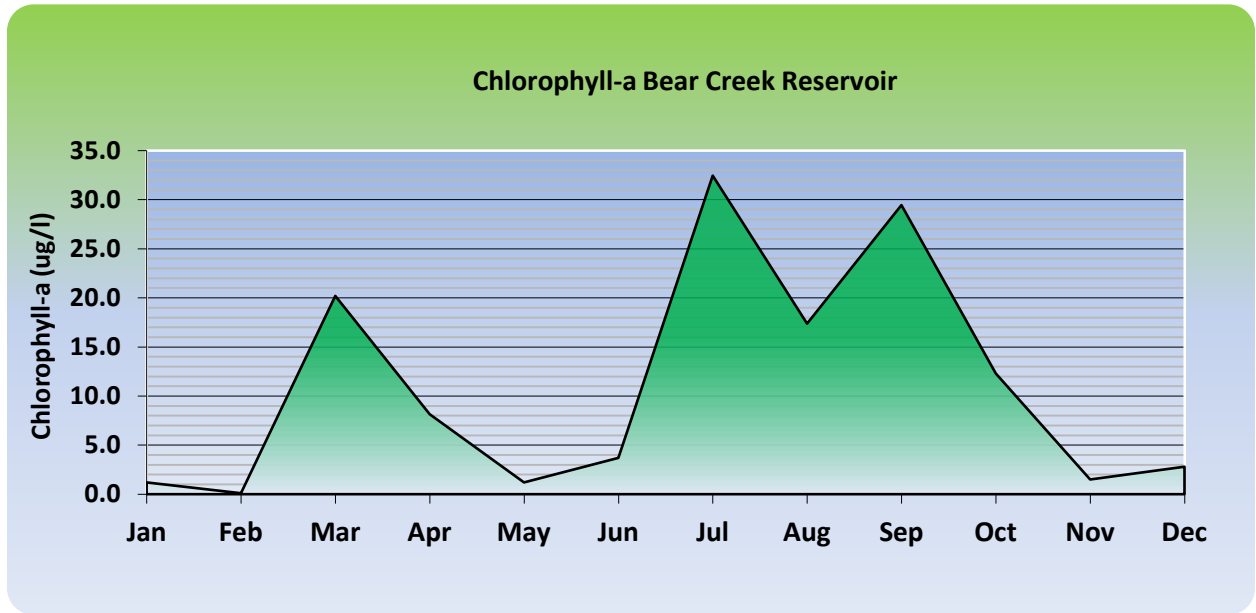


Figure 20 Bear Creek Reservoir Chlorophyll Trend

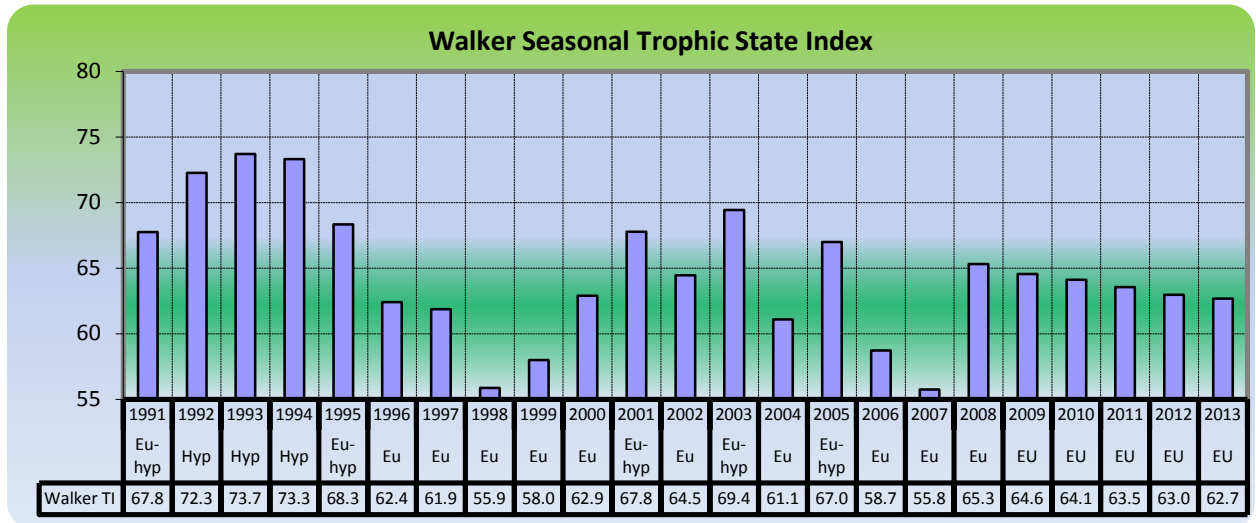


Figure 21 Walker Trophic Index Trend Bear Creek Reservoir

Bear Creek Reservoir Aeration Practice Manages Summer Dissolved Oxygen

The reservoir aeration system reduces chlorophyll productivity, possibly through the partial control of internal nutrient loading that can trigger algal blooms (*BCWA Policy 8 Bear Creek Reservoir Aeration*). The Association adopted a Policy 8 that makes the reservoir aeration system a permanent reservoir management tool. The Association determined through ongoing monitoring that the de-stratifying aeration system in Bear Creek Reservoir is a necessary and long-term or permanent management practice necessary to protect the quality reservoir fishery (Figure 22) and prevent Dissolved Oxygen standard exceedances during summer months of June 1-September 30.

Reservoir aeration is also a necessary management tool in low flow conditions. The current aeration system has been operational since the summer of 2002 and uses a fine-bubble diffusion system with aerators distributed across the hypolimnion. In 2013, the Association and Lakewood operated the aeration system to assure oxygen transfer during phased on-off cycling (Figure 23), with the aeration

system phased primarily on in the growing season. The aeration system can increase the Dissolved Oxygen concentrations throughout the water column by about 2 mg/l within a two-week period. The aeration system was damaged when the reservoir flooded and will be assessed by Lakewood and the BCWA in 2014.



Figure 22 Fishing Very Popular on Bear Creek Reservoir, Both Winter and Summer

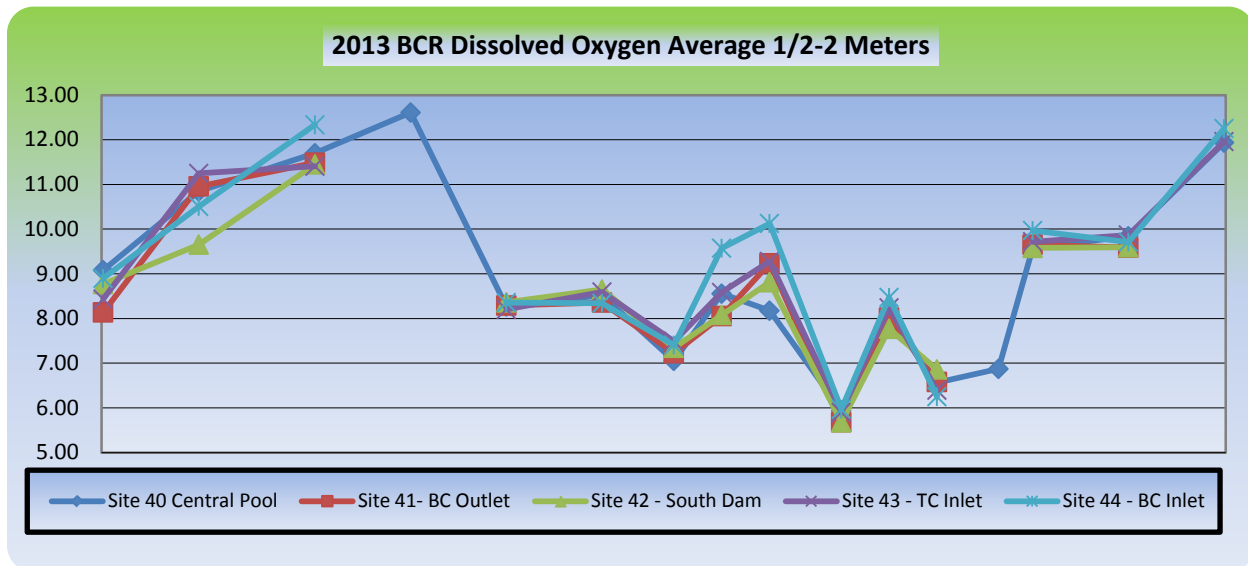


Figure 23 Bear Creek Reservoir Dissolved Oxygen Trend

Bear Creek Reservoir Sediment Study

The total suspended sediment load in the reservoir has been generally constant over the historic monitoring period with periodic storm events dumping large volumes of sediment into the reservoir. Bottom sediments are a mixture of fine sand, silt and mud. The September flood event introduced extremely large amounts of sediments. The sediment-sampling event scheduled for September was canceled due to the flood and reservoir volume.

The BCWA has no reliable method to determine the total amount of sediment transported by the 2013 floods. The BCWA made some best guesses on the amounts deposited into Evergreen Lake (Table 11) and Bear Creek Reservoir (Table 12). It is very apparent that storm waters moved millions of pounds

of sediments. There was extensive erosion throughout the watershed. Streambanks were lost and channels configurations were altered throughout the segment 1e.

Table 11 Estimated Sediment Load into Evergreen lake

Evergreen Reservoir			
Sep-13		Oct-13	
TSS Based (SSL Load)		TSS Based (SSL Load)	
Tons/month	Cubic Yards/Month	Tons/month	Cubic Yards/Month
905	745	28	23
Estimated Bedload		Estimated Bedload	
Tons/month	Cubic Yards/Month	Tons/month	Cubic Yards/Month
13,582	11,179	142	117

Table 12 Estimated Sediment Load into Bear Creek Reservoir

Bear Creek Reservoir			
Sep-13		Oct-13	
TSS Based (SSL Load)		TSS Based (SSL Load)	
Tons/month	Cubic Yards/Month	Tons/month	Cubic Yards/Month
40,933	33,690	1,587	1,306
Estimated Bedload		Estimated Bedload	
Tons/month	Cubic Yards/Month	Tons/month	Cubic Yards/Month
1,023,331	842,248	7,933	6,529

Evergreen Lake Study

Evergreen Lake (Segment 1d) is a small reservoir constructed in 1927 and serves as a major direct use water supply for the Evergreen community. The lake is an important year-round recreational facility with fishing and winter ice activities. The Evergreen Park & Recreation District provides maintenance around Evergreen Lake. These efforts aid in maintaining good water quality. The District maintains the wetlands located on the west end of the lake, retaining walls and rocks structure that support the road and walking paths, maintains erosion control features of the area and periodically removes rooted vegetation located along the shoreline and in the lake. In recent years, the Association has increased monitoring efforts to better characterize the reservoir and help protect the quality (Table 13). The Association has established preferred management strategies for Evergreen Lake (*BCWA Policy 20*).

In last few years, the dissolved oxygen concentrations in the water column were becoming very low with periodic bottom waters having less than 5 mg/l DO. The Evergreen Metropolitan District in cooperation with the recreation district installed an aeration system near the dam outlet area to help maintain elevated DO levels throughout the lake. The districts in cooperation with the Colorado Department of Parks and Wildlife introduced Grass Carp into the reservoir with the first release of about 100 fish at 20 inches length. This program reduces some of the excess Elodea algal (introduced invasive species) growth that contributes to the depressed DO problem. The combination of the aeration system and grass carp program resulted in DO compliance in 2013 monitoring program (Table 13). The Association monitoring program data to supports the designation of Evergreen Lake as a direct use water supply.

Table 13 Water Quality Data Summary for Evergreen Lake

Site	Parameter (ug/l)	20-May	17-Jun	22-Jul	26-Aug	24-Sep	9-Oct	21-Oct	Average
EGL 4a	Total Nitrogen	477	243	392	451	401	183	247	342
	Nitrate/Nitrite as N, dissolved	46	12	35	3	106	118	104	61
	Nitrogen, ammonia	34	49	62	50	22	31	7	36
	Phosphorus, total	31	15	4	26	26	16	2	17

Site	Parameter (ug/l)	20-May	17-Jun	22-Jul	26-Aug	24-Sep	9-Oct	21-Oct	Average
	Total Dissolved Phosphorus	6	4	2	4	8	2	2	4
	Residue, Non-Filterable (TSS) mg/l	8	5	7	14	8	10	4	8
	Chlorophyll a, Average ug/l	2	4	8	25	0	1	1	6
	Chlorophyll a	2	3	8	24	0	2	2	6
	Chlorophyll a	2	5	7	27	0	1	1	6
EGL 4e	Total Nitrogen	446	253	422	253	382	186	224	309
	Nitrate/Nitrite as N, dissolved	44	10	29	4	106	114	104	59
	Nitrogen, ammonia	47	56	64	45	21	28	9	39
	Phosphorus, total	21	20	3	26	31	43	2	21
	Total Dissolved Phosphorus	10	3	2	5	8	2	6	5
	Residue, Non-Filterable (TSS)	10.2	8.4	8.0	15.2	12.8	26.2	4.0	12
Parameter Summary		5/20	6/17	7/22	8/26	9/24	10/9	10/21	
Water Column	Dissolved Oxygen 1/2-2m	9.95	9.03	6.39	7.80	10.17	8.69	12.11	
	Temperature (C) 1/2-2m	9.05	15.76	19.98	16.42	8.18	6.53	3.15	
	pH water column	7.44	8.03	8.06	7.74	8.08	8.11	7.97	
	Specific Conductance (us/m)	0.068	0.056	0.063	0.064	0.082	0.083	0.085	
	Bear Creek In-Flow (cfs)	74.0	30.0	26.0	37.0	264.0	93.0	62.0	

IV. Meeting Water Quality Goals and Standards for the Watershed

Dissolved Oxygen Compliance in Bear Creek Reservoir

The Association takes multiple profile readings at five profile stations in the reservoir to determine Dissolved Oxygen compliance. The Association Dissolved Oxygen data set from 2003-2013 for Bear Creek Reservoir shows over 99% compliance with the standard for the upper water column (surface through the mixed layer). The monthly Dissolved Oxygen values in the mixed layer in 2013 were greater than 6 mg/l (Table 14, Figure 24). Data collected in the 2013 growing season shows the aeration system adds a maximum of 2.5 mg/l dissolved oxygen to the water column when under normal operation. Generally, the aeration system increases water column dissolved oxygen by about 1 mg/l, which results in dissolved oxygen compliance within the mixed layer.

Table 14 DO Compliance in Bear Creek Reservoir

Reservoir Site 40	2013 DO Compliance Bear Creek Reservoir															
	Jan	Feb	Mar	Apr	May	Jun	Jul	Jul	Aug	Aug	Sep	Sep	Oct	Oct	Nov	Dec
Total Depth Profile (m)	10.2	10.5	10.5	10.8	11.0	10.7	10.6	10.5	10.5	10.6	10.5	25.8	15.3	10.8	10.5	7.2
Average 1/2-2m (mg/l)	9.08	10.85	11.70	12.6	8.3	8.5	7.1	8.6	8.2	5.9	8.1	6.6	6.9	9.6	9.8	11.9
Profile Average (mg/l)	7.10	7.98	10.94	11.2	6.7	8.0	6.4	7.6	8.1	5.4	7.6	6.7	6.7	9.6	9.4	11.2

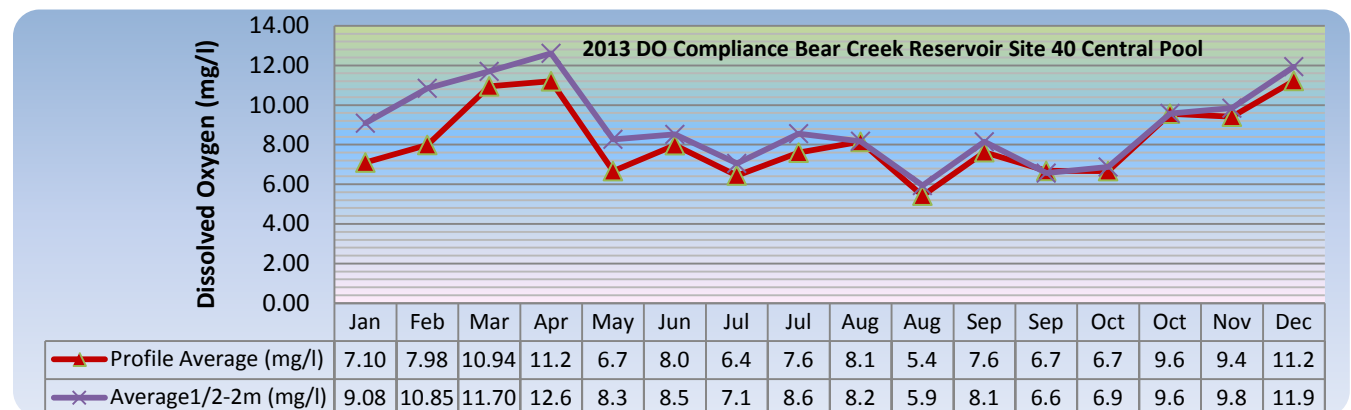


Figure 24 DO Compliance Bear Creek Reservoir

Temperature Standards Bear Creek Watershed

Table 15 shows the adopted temperature standards by segment for the watershed.

Table 15 Temperature Standards in Bear Creek Watershed

Segment	Segment	Standard	Month	STANDARD (°C)		Month	STANDARD (°C)	
				(MWAT)	(DM)		(MWAT)	(DM)
1a	Mainstem of Bear Creek from the boundary of the Mt. Evans Wilderness area to the inlet of Evergreen Lake	T=TVS(CS-I) °C	June-Sept	17.0	21.2	Oct-May	9.0	13.0
1b	Mainstem of Bear Creek from Harriman Ditch to the inlet of Bear Creek Reservoir	T=TVS(CS-II) °C, April-Oct; T(WAT)=19.3 oC	April-Oct	19.3	23.8	Nov-March	9.0	13.0
1c	Bear Creek Reservoir.	T=TVS(CLL) °C; April-Dec; T(WAT)=23.3oC	April-Dec	23.3	23.8	Jan-Mar	9.0	13.0
1d	Evergreen Lake.	T=TVS(CLL) °C	April-Dec	18.2	23.8	Jan-Mar	9.0	13.0
1e	Mainstem of Bear Creek from the outlet of Evergreen Lake to the Harriman Ditch.	T=TVS(CS-II) °C; April-Oct; T(WAT)=19.3 oC	April-Oct	19.3	23.8	Nov-March	9.0	13.0
2	Mainstem of Bear Creek from the outlet of Bear Creek Reservoir to the confluence with the South Platte River.	T=TVS(WS-II) °C	March-Nov	27.5	28.6	Nov-March	13.7	14.3
3	All tributaries to Bear Creek, including all wetlands, from the source to the outlet of Evergreen Lake, Except for specific listings in Segment 7.	T=TVS(CS-I) °C	June-Sept	17.0	21.2	Oct-May	9.0	13.0
4a	All tributaries to Bear Creek, including all wetlands, from the outlet of Evergreen Lake to the confluence with the South Platte River, except for specific listings in Segments 5, 6a, and 6b.	T=TVS(WS-I) °C	March-Nov	24.2	29	Dec-Feb	12.1	14.5
5	Swede, Kerr, Sawmill, Troublesome, and Cold Springs Gulches, and mainstem of Cub Creek from the source to the confluence with Bear Creek.	T=TVS(CS-II) °C	April-Oct	18.2	23.8	Nov-March	9.0	13.0
6a	Turkey Creek system, including all tributaries and wetlands, from the source to the inlet of Bear Creek Reservoir, except for specific listings in Segment 6b.	T=TVS(CS-II) °C	April-Oct	18.2	23.8	Nov-March	9.0	13.0
6b	Mainstem of North Turkey Creek, from the source to the confluence with Turkey Creek.	T=TVS(CS-I) °C	June-Sept	17.0	21.2	Oct-May	9.0	13.0
7	Mainstem and all tributaries to Bear Creek, including wetlands, within the Mt. Evans Wilderness Area.	T=TVS(CS-I) °C	June-Sept	17.0	21.2	Oct-May	9.0	13.0
8	Lakes and reservoirs in the Bear Creek system from the sources to the boundary of the Mt. Evans Wilderness area.	T=TVS(CL) °C	April-Dec	17.0	21.2	Jan-Mar	9.0	13.0
9	Lakes and reservoirs in the Bear Creek system from the boundary of the Mt. Evans Wilderness area to the inlet of Evergreen Lake.	T=TVS(CL) °C	April-Dec	17.0	21.2	Jan-Mar	9.0	13.0
10	Lakes and reservoirs in drainages of Swede Gulch, Sawmill Gulch, Troublesome Gulch, and Cold Springs Gulch from source to confluence with Bear Creek.	T=TVS(CL) °C	April-Dec	17.0	21.2	Jan-Mar	9.0	13.0
11	Lakes and reservoirs in the Bear Creek system from the outlet of Evergreen Lake to the confluence with the South Platte River, except as specified in Segments 1c, 10, and 12; includes Soda Lakes.	T=TVS(CL) °C	April-Dec	17.0	21.2	Jan-Mar	9.0	13.0
12	Lakes and reservoirs in the Turkey Creek system from the source to the inlet of Bear Creek Reservoir	T=TVS(CL) °C	April-Dec	17.0	21.2	Jan-Mar	9.0	13.0

Bear Creek Reservoir Temperature Compliance

The Association takes multiple profile readings at five profile stations in the reservoir and has a temperature data-logger set at site 40 to determine temperature compliance. Figure 25 show temperature standards and the monthly sampling compliance record for Bear Creek Reservoir. The temperature probe string at site 40 measures temperature in the top 2m of the water column (-1/2m, -

1m, -1.5m, and 2m). Table 16 summarizes the temperature record. The reservoir exceeded the WAT 1-times and the daily maximum 11 times.

Table 16 Temperature Compliance Summary Bear Creek Reservoir

All Temperatures in °C	30-Min Temp. Warm Season	Apr 1-Oct 31 Stream Std. WAT (19.3°C)	Apr 1-Oct 31 2-HR Avg. Temp.	Apr 1-Oct 31 Stream DM (23.8°C)
Min	6.9	7.7	6.9	7.6
Max	25.2	23.4	24.8	24.8
Avg	16.4	16.6	16.4	16.9
Measurements	38512	112	9628	804
# 23.3°C WAT exceeded		1		
% Compliance WAT		99%		
# 23.8°C DM exceeded				11
% Compliance DM				99%

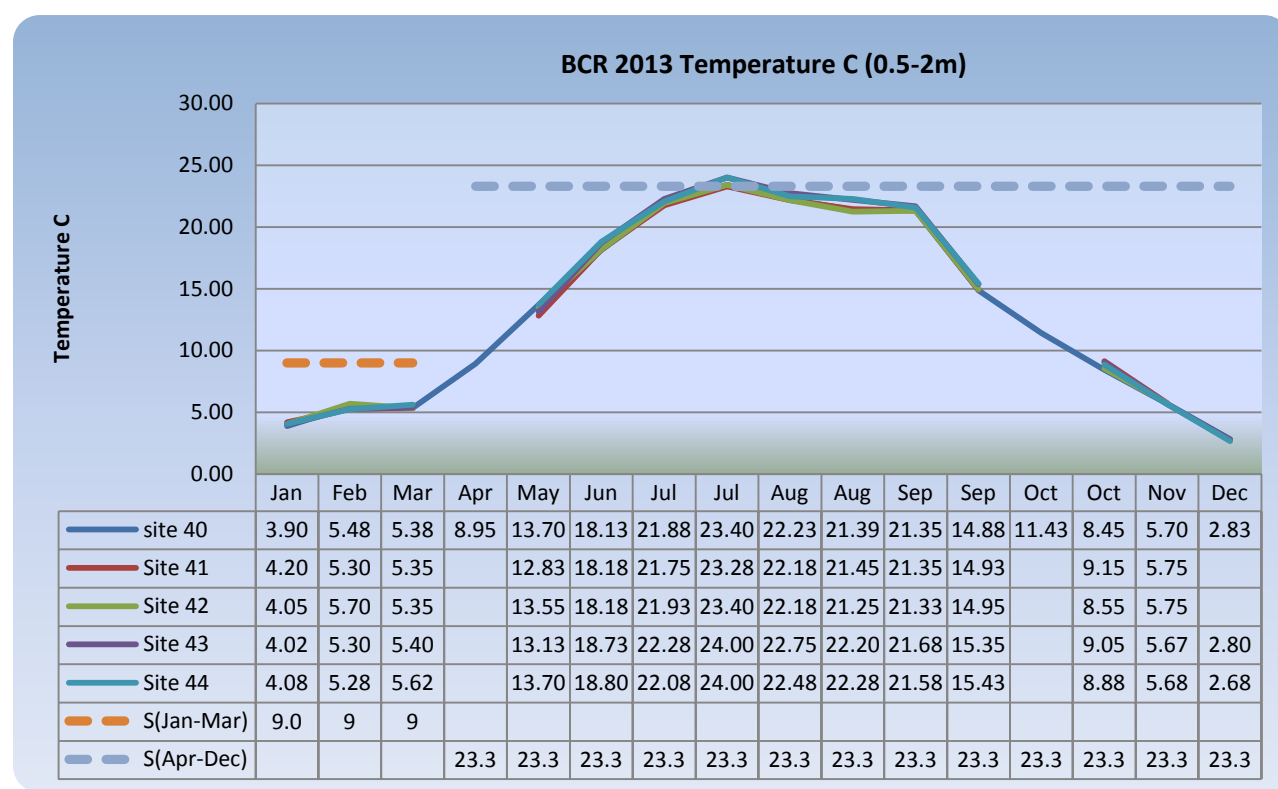


Figure 25 Temperature Compliance Bear Creek Reservoir

Watershed Stream and Lake Compliance

The Association conducts special stream monitoring programs within the Bear Creek Watershed including Bear Creek, and a portion of the Turkey Creek Drainage (North and South Turkey Creek). The monitoring year divides into a warm-season period with more intense sampling and a cold-season period, designed to provide minimal winter and spring data. The Association 2013 Data Report summarizes temperature and water quality monitoring data, sampling results obtained from in-stream locations, and data from five-wastewater treatment plant effluents. The complete water quality data set is an electronic data report.

There were 249,995 individual temperature data points obtained from the 28 data logger sites within the watershed (excluding the WWTP data). Some date-loggers were lost during the flood event and no

or limited data obtained. The warm-season and cold-season temperature compliance summary is shown in Table 17. A limited number of temperature compliance problems occurred in both the warm and cold seasons.

Table 17 Watershed Temperature Compliance Summary Warm/ Cold Seasons

	Cold-season		Warm Season	
Segment 3	9°C WAT	13°C DM	17°C WAT	21.2°C DM
# Exceedances	0	5	0	1
% Compliance	100%	80%	100%	98%
Segment 1a	9°C WAT	13°C DM	17°C WAT	21.2°C DM
# Exceedances	0	5	0	0
% Compliance	100%	98%	100%	100%
Segment 1d	9.0°C WAT	13.0°C DM	18.2°C WAT	23.8°C DM
# Exceedances			20	0
% Compliance			77%	100%
Segment 1e	9°C WAT	13°C DM	19.3°C WAT	23.8°C DM
# Exceedances	0	0	1	0
% Compliance	100%	100%	99%	100%
Segment 1b	9°C WAT	13°C DM	19.3°C WAT	23.8°C DM
# Exceedances	0	0	0	0
% Compliance	100%	100%	100%	100%
Segment 5	9°C WAT	13°C DM	18.2°C WAT	23.8°C DM
# Exceedances	0	0	6	1
% Compliance	100%	100%	93%	100%
Segment 6a	9°C WAT	13°C DM	18.2°C WAT	23.8°C DM
# Exceedances	2	0	0	0
% Compliance	97%	100%	100%	100%
Segment 6b	9°C WAT	13°C DM	17°C WAT	21.2°C DM
# Exceedances	0	3	0	0
% Compliance	100%	98%	100%	100%
Segment 2	13.7°C WAT	14.3°C DM	27.5°C WAT	28.6°C DM
# Exceedances	0	0	0	1
% Compliance	100%	100%	100%	99%
Segment 1c	9°C WAT	13°C DM	24.0°C WAT	26.0°C DM
# Exceedances			1	11
% Compliance			99%	99%

Stream and lake sampling and monitoring data, including pH, Temperature, Dissolved Oxygen, Specific Conductance, Ammonia, Nitrate+Nitrite, Total Inorganic Nitrogen (calculated), Total Nitrogen and Total Phosphorous was collected from July through September (Table 18). Stream and lake temperature dataloggers located at 28 Sites, including the Evergreen Lake profile station and Bear Creek Reservoir profile station, excluding the five-wastewater treatment plants. Manual flows measured at 22 sites during the July to October timeframe. An aeration system was installed and operational for Evergreen Lake. The only water chemistry exceedances of standards measured in the 2013 watershed-monitoring program occurred at Summit Lake.

Table 18 Water Quality Compliance at Watershed Monitoring Sites

	Stream Std. pH (6.5-9 SU)	Stream Std. DO (6.0 mg/L 2-meter avg.)	Stream Std. NH3-N ug/L (TVS)	Stream Std. NO3-N (10,000ug/L)*	Proposed Stream Std Total Phosphorous(110 ug/L)
Segment 8					
# Exceedances	0	0	0	0	0
# Measurements	4	4	4	4	4
% Compliance	100%	100%	100%	100%	100%

	Stream Std. pH (6.5-9 SU)	Stream Std. DO (6.0 mg/L 2-meter avg.)	Stream Std. NH3-N ug/L (TVS)	Stream Std. NO3-N (10,000ug/L)*	Proposed Stream Std Total Phosphorous(110 ug/L)
Segment 7					
# Exceedances	2	3	0	0	4
# Measurements	12	12	12	12	12
% Compliance	83%	75%	100%	100%	67%
Segment 3					
# Exceedances	0	0	0	0	0
# Measurements	5	5	5	5	5
% Compliance	100%	100%	100%	100%	100%
Segment 1a					
# Exceedances	0	0	0	0	1
# Measurements	20	20	20	20	20
% Compliance	100%	100%	100%	100%	95%
Segment 1d					
# Exceedances	0	0	0	0	0
# Measurements	60	24	12	12	12
% Compliance	100%	100%	100%	100%	100%
Segment 1e					
# Exceedances	0	0	0	0	1
# Measurements	54	54	54	54	54
% Compliance	100%	100%	100%	100%	98%
Segment 1b					
# Exceedances	0	0	0	0	0
# Measurements	15	15	15	15	15
% Compliance	100%	100%	100%	100%	100%
Segment 5					
# Exceedances	0	0	0	0	11
# Measurements	78	78	78	78	78
% Compliance	100%	100%	100%	100%	86%
Segment 6a					
# Exceedances	0	0	0	0	0
# Measurements	9	9	9	9	23
% Compliance	100%	100%	100%	100%	100%
Segment 6b					
# Exceedances	0	0	0	0	0
# Measurements	9	9	9	9	9
% Compliance	100%	100%	100%	100%	100%
Segment 4a					
# Exceedances	0	0	0	0	0
# Measurements	9	9	9	9	9
% Compliance	100%	100%	100%	100%	100%
Segment 2					
# Exceedances	0	0	0	0	4
# Measurements	15	15	15	15	15
% Compliance	100%	100%	100%	100%	73%

*- Samples were analyzed for NO3+NO2-N but compared to the Nitrate water quality standard of 10 mg/L.

303(d) Listing

Table 19 shows the stream segments in the Bear Creek Watershed that are on the Colorado 303(d) list. The Association is evaluating potential causes and water quality problems in these listed segments. The Association suspects' road (both dirt and paved) and parking lot sand/silt and debris runoff has localized affects on stream quality. These fine sediments cause sections of the streambed to become embedded with fine sands and silts, which reduces habitat for macroinvertebrates and may result in poor MMI scores in segments 1e and 2. The Association has designed a project to address this problem and is actively seeking funding for the project(s).

Table 19 303(d) List Bear Creek Watershed

WBID	Segment Description	Portion	Colorado's Monitoring & Evaluation	Clean Water Act Section 303(d) Impairment	303(d) Priority
COSPBE01a	Mainstem of Bear Creek from the boundary of the Mt. Evans Wilderness area to the inlet of Evergreen Lake.	Witter Gulch to inlet of Evergreen Lake		Temperature, Aquatic Life (provisional)	H
COSPBE01c	Bear Creek Reservoir	all	-	Chl-a, phosphorus	H
COSPBE01e	Mainstem of Bear Creek from the outlet of Evergreen Lake to the Harriman Ditch.	all	Aquatic Life		-
COSPBE01e	Mainstem of Bear Creek from the outlet of Evergreen Lake to the Harriman Ditch.	From the outlet of Evergreen Lake to Kerr/Swede Gulch		Temperature	<u>H</u>
COSPBE02	Bear Creek below Bear Creek Reservoir to South Platte River	Below Kipling Parkway (CO 390)	Aquatic Life	E. coli (May-Oct)	H
COSPBE05	Swede, Kerr, Sawmill, Troublesome and Cold Springs Gulches and Cub Creek	Swede/Kerr Gulch		E. coli	L

Barr/Milton Model Input and Bear Creek Load Predictions

The Bear Creek Watershed is in the defined “data” shed for the BMW pH/DO TMDL. 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 a source that contributes about 1.8 % of the external load of Total Phosphorus. 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 2013, the average Total Phosphorus at BCWA site 45 was 1,785 pound/year. The Association annually provides the Barr/Milton Watershed Board a technical memorandum detailing water quality data at site 45 BCWA Technical Memorandum 2013.08, January 2014).

Macroinvertebrate Analysis and Aquatic Life Compliance

Since 2004, the Association has conducted macroinvertebrate sampling and data collection at 14 sites, including Colorado Parks and Wildlife fish survey sites along Bear Creek: Morrison (west end), Idledale, Lair o' the Bear Park, O' Fallon Park, Bear Creek Cabins, Main Street Evergreen (across from the Little Bear), above Evergreen Lake upstream within Dedisse Park, Bear Tracks, above Singing River Ranch at the Mt. Evans Boundary area, and Golden Willow Bridge. The sampling design in Bear Creek has targeted a combination of slow and fast riffles with various amounts of cobble substrate at the sites. The program provides information on site variation, including both spatially and temporally variation at each site. Table 20 summarizes existing macroinvertebrate data. There was no macroinvertebrate sampling done in 2013 due to the September flood event.

Table 20 MMI Attainment and Impairment Summary for Bear Creek Watershed

BCWA Site	WQCD Site	Location	Zone	Stream Segment	Total Taxa	MMI	O/E	Shannon Index	HBI
14a	122	Morrison Park	Transition	1e	27	72.9	0.79	3.8	4.9
13a	122C	Idledale	Transition	1e	24	51.3	0.71	2.5	4.6
12	122a	Lair O' Bear	Transition	1e	22	49.9	0.80	3.9	4.4
9	122b	O'Fallon	Transition	1e	33	68.0	0.93	3.7	3.7
8	5762	Bear Creek Cabins	Transition	1e	25	44.3	0.79	3.6	2.9
5	5763	Little Bear, Downtown	Transition	1e	21	40.0	0.53	3.8	4.2
3a	5764	Keys on the Green	Mountain	1a	31	46.9	0.92	3.5	4.2
58	5768C	Boundary MEW	Mountain	1a	34	72.5	0.89	3.4	4.6
2a	5768D	Golden Willow	Mountain	1a	31	71.9	0.86	4.0	4.6

V. Wastewater Treatment Facilities Loading and Compliance

Wasteload Compliance

The total wasteload allocation of phosphorus from all wastewater treatment facilities in the Bear Creek Watershed is 5,255 pounds per year. Table 21 lists the permitted wastewater treatment facilities. Each individual discharger in the Bear Creek Watershed is limited to an annual wasteload of total phosphorus, except as provided through trading provisions. Wastewater discharges cannot exceed a total phosphorus effluent concentration of 1.0 mg/l as a 30-day average. No facility exceeded the assigned wasteload allocations (Table 21).

Table 21 Treatment Facility Wasteload Allocations

Bear Creek Watershed Wastewater Treatment Plants	Phosphorus Pounds/ year	2013 Phosphorus Pounds/year	Percent of Allocation
Evergreen Metropolitan District	1,500	332.28	22%
West Jefferson County Metro District	1,500	225.88	15%
Genesee Water and Sanitation District	1,015	319.64	31%
Town of Morrison	600	102.51	17%
Kittredge Sanitation and Water District	240	76.24	32%
Forest Hills Metropolitan District	80	62	78%
Conifer Metropolitan District/Conifer Sanitation Association	80	0.88	1%
Aspen Park Metropolitan District	40	5.07	13%
Jefferson County Schools – Mt. Evans Outdoor Lab	20	6.70	34%
Jefferson County Schools - Conifer High School	110	1.66	2%
Bear Creek Cabins (Bruce & Jayne Hungate)	5	1.81	36%
Brook Forest Inn	5	3.34	67%
Geneva Glen ¹	5	Not reported	0%
Total Operational Facilities Lbs/year	5,200	1,138.01	22%
Bear Creek Development Corp. - Tiny Town ³	5	Hauling Columbia	
The Fort ²	18	No Monitoring	
Singing River Ranch	30	Not Operational	
Reserve Pool	2	Not used 2013	
Total Phosphorus Wasteload lbs/year	5,255		

1-Geneva Glen treatment system land applies, no reporting to Association

2-Permit; No established monitoring

3-Records from Columbia Sanitary show 35,000 gallons hauled - .02 dry metric figured on 2% solids.

Permit Compliance and Plant Expansions/Actions

Table 22 shows permitted wastewater treatment facilities in the watershed, status of wastewater planning, and reported permit compliance problems. All wastewater treatment plants in the watershed are minor facilities using the WQCD permit classification system. The Association worked on planning and review efforts for Forest Hills Metro District and Town of Morrison.

Table 22 Wastewater Treatment Plant Planning Status

Facility	Wastewater Utility Plan	Any Updates, Lift Station, or Amendments	Facility Upgrades [2013-2016]	Compliance Problems
Evergreen Metropolitan District	Yes	Lift Stations	No	No
West Jefferson County	Yes	No	No	No
Genesee	Yes	No	No	No
Kittredge	Yes	No	No	No
Morrison	Yes	New Plant	In-progress	No
Jefferson County Schools Conifer High School	Yes	No	No	No
Jefferson County Schools Mt Evan Outdoor	Yes	New facility Design	Yes	Yes, WLA
Forest Hills Metropolitan District	No	New Plant	No	Yes, WLA

Facility	Wastewater Utility Plan	Any Updates, Lift Station, or Amendments	Facility Upgrades [2013-2016]	Compliance Problems
Conifer Sanitation Association	Yes	No	Yes	No
Aspen Park Metro District	Yes	Infiltration gallery, Outfall	Yes	No
Conifer Metro District (CMD)	Yes	No	Yes	Chloride variance
The Fort	Yes	New Treatment Works, Monitoring	Yes	No
Bear Creek Development	No	No	No	Yes, WLA
Bear Creek Cabins	No	No	Yes	Yes, WLA
Singing River Ranch	Yes	Plugged Influent	No	No
Brook Forest Inn	No	Yes, new upgrades	Yes	Yes, WLA
Geneva Glen	Yes	No	Better Monitoring	No

Utility Supported Programs

Pharmaceutical Recycling Program

The Association financially supports a used medicine drop-off location in Evergreen (BCWA Fact Sheet 23). The utilities have sent notices with their monthly billings to support pharmaceutical recycling programs.

Sanitary Sewer Incentive Programs in the Evergreen Area.

The Evergreen Metropolitan District and Upper Bear Creek Water and Sanitation District offer a 50% discount to the current sewer tap fee to property owners within the District Boundaries with Individual Septic Disposal Systems willing to connect.

The West Jefferson County Metropolitan District offers a discount of \$9,000 to the current sewer tap fee to property owners within the District Boundaries willing to connect their ISDS to the distribution system.

Trading Program

The Association maintains a pollutant-trading program as defined in *Trading Guidelines* (Association 2006) and in *Bear Creek Reservoir Control Regulation #74* for total phosphorus trades specific to the Bear Creek Watershed: Point source to point source trades (regulation and permit); and Nonpoint source to point source total phosphorus trading specific to the Bear Creek Watershed (*Trading Guidelines*). The *Bear Creek Trading Guidelines* allow permitted point source dischargers (Colorado Wastewater Discharge Permits) to either receive phosphorus pounds for new or increased phosphorus wasteload allocations in exchange for phosphorus loading reductions from nonpoint source pollutant reduction or through approved point source trades. Table 23 lists all Association trades. The reserve pool remained at 2 pounds and no changes made in 2013. The trades in the watershed remain consistent with the total wasteload allocations listed in Table 23. The Association has developed 3 policies to support the trading program:

1. BCWA Policy 1 Trading Program - The BCWA supports nutrient (nitrogen and phosphorus) trading as a long-term and necessary water-quality management practice for the Bear Creek Watershed. The BCWA will maintain and periodically update Nutrient Trading Guidelines.
2. BCWA Policy 19 Nutrient Trade Eligibility - The BCWA defines eligible participants and sets minimum criteria for eligibility in a Bear Creek Association Trade Agreement.
3. BCWA Policy 26 Point to Point Trade Administration – The BCWA establishes a trade administration program to help assist small wastewater dischargers in the watershed and sets a value to phosphorus trade credits.

Table 23 Phosphorus Trading Activity in Bear Creek Watershed

Involved Agencies	Type of Trade	Active Trading in 2013
Forest Hills Metro District (FHMD) had trade agreement with West Jefferson County Metro District(WJCMD) ¹	Point Source to Point Source	No- Discontinued in 2012
City of Lakewood Coyote Gulch Project	Nonpoint source trade credits	Under data collection/ reviewed by Association; trade credit calculated in 2011/ confirmed 2013
The Fort Restaurant	Reserve Pool to Point Source	Permit in Progress; Trade reflected in reserve pool limit previously granted by the WQCC
Jefferson County Schools (Conifer High School and Mt. Evans Outdoor School)	Point Source to Point Source	In Discharge Permits; no change in pounds; reallocation between facilities
Conifer Metropolitan District	Reserve Pool to Point Source	Trade reflected in reserve pool limit previously granted by the WQCC

Watershed Stormwater Management

City of Lakewood MS4 Program

The City of Lakewood has a municipal separate storm sewer permit (*CDPS Stormwater Permit Annual Report for 2013, Municipal Stormwater Permit No.: COS-000002*; City of Lakewood, April 1, 2014). Lakewood supports many stormwater management programs in the watershed, including the *Rooney Road Recycling Center*, which also serves as watershed prevention BMP. The Lakewood facility collected multiple types of waste products for proper disposal (includes oil, paint, antifreeze, misc. chemicals, and solid wastes) from the mountain areas as well as the Front Range. This process keeps materials out of septic systems and helps reduce illegal dumping in the watershed. Lakewood regularly reports to the Association on stormwater management practices and programs. More information about Lakewood’s municipal stormwater program is contained in their CDPS Stormwater Permit Annual Report.

Jefferson County MS4 Program

Jefferson County has a municipal separate storm sewer permit and Jefferson County’s program includes Public Education and Outreach; Public Participation and Involvement; Illicit Discharge Detection and Elimination; Construction Site Runoff Control; Post Construction Site Runoff Control; and Pollution Prevention/Good Housekeeping. The county provides opportunities for residents and visitors in the watershed to learn and be involved in environmental stewardship and programs that promote water quality. The county has a comprehensive storm sewer outfall map to trace sources of potential illicit discharges and illegal dumping in the watershed.

Jefferson County also maintains an erosion and sediment control program as part of their MS4 permit. The county maintains a small-site erosion control manual that explains the basic principles of erosion control and illustrates techniques to control sediment from small development sites. Jefferson County has an inspection program for illicit discharges, construction activities, and includes post-construction Inspections (Table 24).

Table 24 Jefferson County Storm Water 2013 Activities and Actions

Activity	Inspections/ Action
Illicit Discharge Verbal Notification of Violation	4
Illicit Discharge Monetary Penalty/Fine	0
Construction Sites Covered by Program	256
Construction Inspections	1871
Enforcement Verbal Notification of Violation	120
Post-Construction Inspections	3
Storm drain marking program	Ongoing

BCWA Stormwater Monitoring Program

The Association gathers data prior to, during and after storm events occurring in the watershed. Continuous monitoring of storm events could allow up to 36 hours of data. The parameters are temperature, dissolved oxygen, pH, and conductivity. The intent is to measure changes in these parameters due to run off from adjacent properties including roadways, parking lots and open spaces. The Association is developing a separate stormwater data set.

The Association monitors selected stormwater loadings in locations in the middle section of the watershed. The Association identified a number of potential stormwater runoff locations requiring corrective land use controls. The Association works with local businesses that cause minor nonpoint source runoff from their business sites with the implementation of runoff controls. These runoff control programs are successful. The Association actively identifies erosion problem areas for potential future projects.

The *BCWA Policy 3 4-Step Review Process* used by the Association (referral processes for land use applications from Jefferson and Clear Creek Counties) is directed at land disturbances that have a potential to cause water quality degradation. Specifically, the policy directs the Association to evaluate stormwater runoff and determine if the application contains appropriate techniques to mitigate any significant runoff that could degrade receiving water quality.

Clear Creek County Stormwater Management Program

Clear Creek County has posted a number of educational materials on the county website directed at stormwater management on home-sites, commercial properties, along mountain roadways and driveways, to protect groundwater and surface water resources. The report *Managing Stormwater to Protect Water Resources in Mountainous Regions of Colorado* (Clear Creek County Community Development, July 2009) outlines appropriate best management practices, techniques to maintain pre-development hydrology, and resource impacts from development in mountainous terrain.

VI. Nonpoint Source Program

Septic System Management

In 2013, the Association continued limited discussions with Jefferson County Health Department based on previous presentations made to the Jefferson County Board of Health and the Jefferson County Commissioners. Jefferson and Clear Creek counties reviewed their septic system regulations. The Association predicts onsite wastewater systems in a number of specific areas in the Bear Creek Watershed contribute to water quality degradation. There are 16,000- 20,000-onsite systems in the watershed, depending on the estimation method. Based on existing county taxing records, there are an estimated 20,000+ lots where there is a permitted onsite system, un-permitted system or developable lot.

The Association has two policies directed toward site-specific wastewater treatment/ disposal systems in the watershed.

1. *BCWA Policy 11 Site-Specific Wastewater Treatment/ Disposal Systems* - There are five types of human-generated wastewater treatment/disposal types currently in use within the Bear Creek Watershed. Besides point sources, there are four types of small site-specific wastewater treatment/disposal systems include both publically-owned and individual or private systems. State and county regulations cover these systems (Clear Creek, Jefferson and Park counties). There are not good inventories, only rough estimates, available to the BCWA for these small site-specific wastewater treatment/disposal systems. *The BCWA asserts any publically owned and operated*

site-specific wastewater treatment/disposal systems (SSWDs) have the potential to adversely affect water quality within the Bear Creek Watershed. Pollution caused by SSWDs will be considered by the BCWA as “point sources”. As such, nutrient point source pollution sources in the watershed maybe subject to a wasteload allocation under existing regulation. Water quality degradation associated with publically owned SSWDs may be included in the BCWA annual report to the Colorado Water Quality Control Commission as an unregulated point source pollution problem.

2. BCWA Policy 11 Supplement – 1) Clear Creek County ISDS Vault and Privy Regulations and 2) Jefferson County ISDS Vault and Privy Regulations

The Association has two special monitoring efforts in progress to determine surface water quality affected from areas on septic systems: Kerr/Swede Gulch and Cub Creek. The Kerr/Swede Gulch focus on a limited number of septic systems (<35) that potential add nutrients to the lower portion of the drainage between site 52(Confluence) and site 53 (Riefenberg) (Figure 26). The monitoring program suggests there is a nutrient load that is potentially related to septic system discharge.

The Association is also monitoring upstream and downstream on Cub Creek where there are > 1,000 septic systems. The total phosphorus load distinctly increases from upstream to downstream by 90% on average. However, the nitrogen decreases in comparison, with instream uptake. The coverage of hard substrate in lower Cub Creek in late summer is generally over 50%.

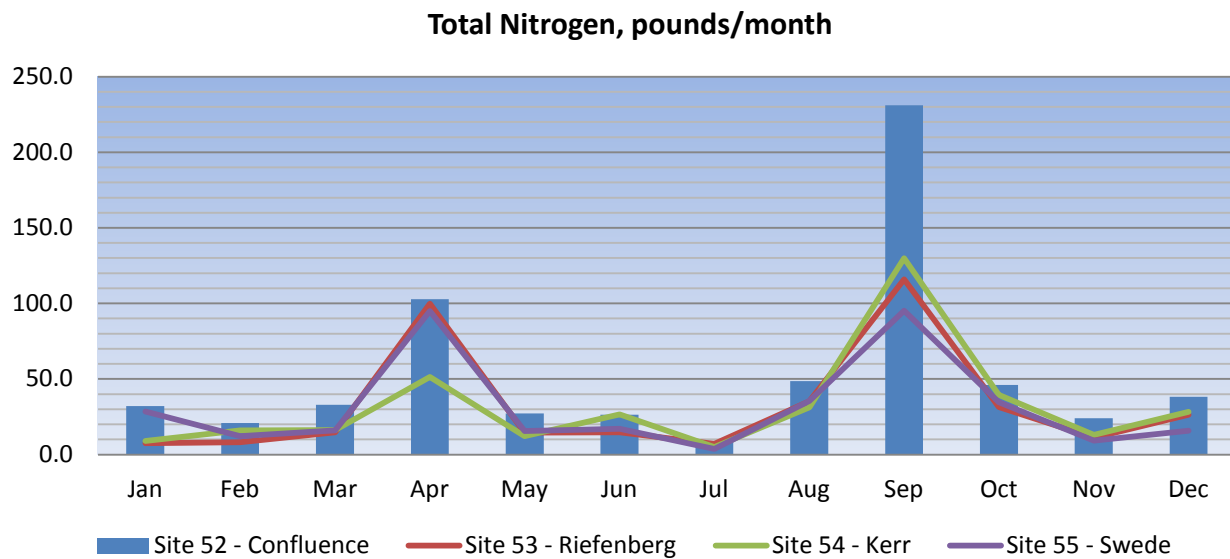


Figure 26 Onsite System Study - Comparison of Total Nitrogen Between Sites 52 and 53

Selected Watershed Nonpoint Source Programs

The management of nonpoint sources in the Bear Creek Watershed is a component of the Association planning and management programs. Phosphorus reduction from nonpoint sources is still required in the watershed. A lack of implementation authority limits the nonpoint source program. The Association does maintain a comprehensive watershed-monitoring program to determine sources of nutrient loading into waterways.

Policy Direction

The Association has established policies to help manage nonpoint sources within the watershed:

1. BCWA Policy 15 Nonpoint Source Strategies and BMPs - The Association maintains a comprehensive watershed-monitoring program to determine sources, including nonpoint

sources, of nutrient loading into waterways. The policy shows management strategies and implementation tools used by the Association.

2. *BCWA Policy 17 Beneficial Recycling of Natural Resources in Bear Creek Watershed* - The Association considers recycling as a best management practice that can help manage natural resources and protect water and environmental quality in the watershed. Recycling programs protect water quality by reducing or eliminating pollutants before they become a problem. Recycling programs can manage household hazardous waste products, organic material/yard wastes, slash, manure generated at stabling operations, clean fill material, recyclable materials (e.g., cans and bottles) disposed at parks and open spaces, and prescription drug take-back programs.
3. *BCWA Policy 18 Illegal Material Dumping as a Pollutant in Bear Creek Watershed* - The Association considers the disposal of, including but not limited to, construction waste, yard waste, organic material (e.g., pine needles) or other plant materials into waterways within the watershed as nonpoint source pollution. This form of waste disposal can harm water quality and is not an acceptable practice in the watershed.
4. *BCWA Policy 27 Source Water Protection* - The BCWA supports the designated areas of concern identified in the Phase 2 Bear Creek Wildfire/Watershed Assessment Report and acknowledges that there is a potentially high risk from wildfires that could significantly impact water supply infrastructure and source waters within portions of the watershed

Water Quality Monitoring Tiers

Activities, unregulated point sources and nonpoint sources in the watershed have the potential to generate water quality pollutants. However, not all activities, unregulated point sources or minor “non-point” sources of pollutants cause measureable degradation of waters within the watershed. As such, the BCWA asserts it will be more effective over the next 10-years (through 2023) to target a more limited subset of unregulated point and non-point sources within the watershed that have the greatest potential to cause either site-specific or watershed-wide water quality degradation (*BCWA Policy 10 Water Quality Monitoring Priority Tier Designations*).

Online Management System (ACM DSS)

Throughout 2013, Association member organizations and staff were involved in collaborative development of an online watershed management system through a Colorado State University dissertation research case study project. The purpose of the system was to increase the capacity of BCWA to adapt to changing circumstances and to cooperate more effectively with public landowners and community members to achieve greater nutrient reductions over time. Modules include issues reporting, interactive maps, group search, a topical knowledge base, projects and options, and watershed plan input.

The Association established an Adaptive Co-Management Decision Support System (ACM DSS) as a BCWA best management practice (*BCWA Policy 21 Online management System*), which can help address nonpoint sources within the watershed. This online management process is an interactive decision support tool to help manage natural resources and protect water and environmental quality in the watershed. The ACM DSS or online management process functions to:

- Evolve and document the BCWA membership and manager understanding of the watershed characteristics and responses, risks and uncertainties,

- Provide a method to learn from past actions and better plan for future actions with an express goal to improve overall watershed resilience, and
- Maintain an online management mechanism to forge partnerships for shared governance and coordinated response to unexpected events.

The Association can review ACM DSS analytical results as entered into and maintained in the *Plan*, *Monitoring Data*, and *Maps* sections of the online program, and use the *Issues Reporting Tool* to report problems in the watershed. The Association membership and manager can create mitigating *Projects*, and then identify stepwise *Options* to pursue these goals, incrementally. Projects and options are by the membership as personal watershed improvement goals. The membership can also agree to create projects with options that require more coordinated actions and pooled resources.

Preliminary Nonpoint Source Analysis in EPA BASINS GWLF-E

The CSU research project also included detailed analysis of non-point source pollution and system complexity and uncertainty. Wastewater dischargers have already reduced phosphorus discharges by over ninety percent with little effect on seasonal TP or Chl-a levels or Bear Creek Reservoir trophic status, which remains stably eutrophic. Therefore, it is important to determine other potential sources of nutrients for control to improve water quality in Bear Creek Reservoir.

Geographic Information Systems were used to developed thematic layers for subbasins, soils, landuse, elevation, horse densities and pastures, paved and unpaved roads, streams, point discharges, weather, and urban areas. This information was used in EPA BASINS GWLF-E mass balance analysis to provide a screening level estimate of potential nutrient sources. Modeling results are preliminary and they will require additional refinement using more advanced EPA BASINS extensions.

Results indicate that the over 9,000 septic systems in the watershed may contribute a similar total phosphorus load as wastewater point discharges or slightly more. The many roads adjacent to streams, and unpaved private drives, in addition to streambank erosion and urban development, contribute fifteen times more, mostly particulate, phosphorus. The large contribution of sediment-based phosphorus agrees with the original 1990 Clean Lakes Study estimates, USGS Sparrow model results for the greater Missouri Basin, and BCWA's own estimates of suspended load from storms, snowmelt runoff, and flooding events. Statistical analysis also indicates that total phosphorus does not typically decrease with increasing flow, which would be expected as wastewater discharges were diluted, if they were the main cause. This may indicate, as found in a recent Poudre River study (Son 2012)¹, that further reduction in WWTF discharge load allowances may not improve Bear Creek Reservoir water quality. Therefore, policies and projects that more directly address the effects of nonpoint sources and other reservoir management alternatives will be targeted in future years.

September 2013 Flood Sediment Study at Bear Creek Reservoir

Following the September 2013 Flood, Bear Creek Reservoir was drawn down quickly from a flood pool high of about 5,608 feet MSL back to permanent pool depth of 5,558 feet. Eight sediment samples from the dam face, the north dock, Pelican Point, and near the mouths of Bear and Turkey Creeks were analyzed to determine how fine sediments that had been transported to the reservoir might affect trophic status. Results indicated that plant available total phosphorus determined using the AB-DTPA method ranged from 14-22 ppm, which represents a medium to high runoff potential according to Colorado Phosphorus Index Soil Test P Risk Factors.

¹ Son, J. 2013. Nutrient Load Inputs to the Cache La Poudre River Watersheds (dissertation). Colorado State University, Fort Collins, CO. (ISBN-13: 978-1303154706)

Total phosphorus content of samples ranged from 469 to 531 ppm (mg/kg) except for the only submerged sample taken on Turkey Creek of 213 ppm, which had also experienced less flooding. Extractable iron was more than 345 ppm and manganese exceeded 250 ppm for several of the sediment samples. Calcium content of 14-19 ppm and cation exchange capacity above 20 meq/100g were also somewhat elevated, which may allow the sediments to hold more nutrients. This could be beneficial, if total phosphorus remains adsorbed or precipitated out with Ca, Mg, and Fe. However, if sediments are disturbed through wind action, bioturbation, pH changes, or become anoxic, total phosphorus may be released. The feedback mechanisms that will determine a net increase or decrease in internal loading can only be determined definitively from summer sampling in 2014 and beyond.

Based on the thickness of sediments deposited by the flood, it is estimated that between 3,000 and 5,000 pounds of total phosphorus may be contained in the 0.5 to 1 acre-feet of sediment deposited in this single flood event. This estimate, based on the thickness of shoreline sediment deposits, is probably quite conservative. The higher density of muddier, colder incoming floodwaters would likely have caused even more sediment to plunge into the deeper reservoir pool, reducing its likelihood of discharge. Therefore, at least one sediment core is planned for 2014 to better estimate total sediment deposited. At the mouth of Bear Creek, sand was deposited over some of the finer sediment, which could also mitigate total phosphorus release.

September 2013 Flood Recovery

Bear Creek jumped its channel in many locations and caused extensive flood damage throughout the urban corridor (*BCWA Fact Sheet 16 September 2013 Flood*). Bridges and culverts were destroyed or damaged, road sections were washed out, utility lines exposed or damaged, and other park and public infrastructure damaged. The stream morphology is altered and habitats are changed at most Association monitoring sites. The Association is applying an adaptive management process to adjust monitoring, strategies and options, and redefine restoration projects throughout the watershed (*BCWA Fact Sheet 14 Flood Recovery Tips; BCWA Fact Sheet 17 Health, Hydrology and Sediments; and BCWA Fact Sheet 18 Flood Score Card*).

Evergreen Metro District received FEMA funding and plans to dredge sediment from Evergreen Lake in 2014-2015. The City of Lakewood also received FEMA funding for park and reservoir repairs. Jefferson County Open Space, Denver Mountain Parks, CDOT, and landowners adjacent to affected streams throughout the watershed were also involved in flood repair work that will continue in 2014-2015.

Nonpoint Source Education -

The Association has an active education and outreach program to help raise awareness with watershed citizens on the need for non-point source management and controls. Association members are involved in numerous educational and training efforts for schools, clubs, and local agencies and often assist with seminars and conferences. The Association actively promotes use of *smart management practices* to lessen water quality and environmental degradation caused by nonpoint sources (*BCWA Policy 15 Nonpoint Source Strategies and BMPs*).

Watershed Education and Training Efforts

The Association provides information in the form of brochures, fact sheets, maps, training classes and presentations to the community on water quality management and environmental issues and supports educational programs/ activities (e.g., Evergreen Chamber Duck Races, Earthday, Audubon, Evergreen Trout Unlimited, City of Lakewood, and the Clear Creek Water Festival). The Association participated in two panel discussions for Earthday events. The Association developed and provided a flood

recovery brochure at several special flood recovery town hall meetings. The Association held a Watershed 101 class for watershed citizens.

The Association Manager and the Lakewood Bear Creek Park Manager produced an informational video to characterize the effects of the flood on Bear Creek Reservoir and the watershed, which was available on U-tube and Lakewood channel 8. The Association was involved in cooperative meetings with the Barr-Milton Watershed Association, the Lower Bear Creek Watershed Group, Denver Department of Environmental Health, and the Colorado Lake and Reservoir Management Association. The Association was a member of the special Clear Creek/ Bear Creek Fire Hazard Study.

[BCWA Newsletter](#)

The Association has established a quarterly newsletter that is distributed to membership and a large number of watershed citizens. The newsletter contains one or more articles directed at nonpoint pollution management or education.

[Future Watershed Manager Program](#)

The Association developed a future watershed manager program and works with the 5 watershed high schools to provide educational opportunities, training classes and materials related to watershed and water quality management. The Association has a “Watershed 101” training course and develops more courses as part an outreach program. The Association worked with students at Evergreen High School to develop several monitoring and restoration projects on the school property and along Wilmont Creek. These students designed and, with funding support from the Association, built a rain garden that fixes a stormwater runoff problem at the school.

[Geo-Locate Sign Program](#)

The Association developed and installed a new educational signage project in the watershed. The 11 kiosks have educational messages that target nonpoint problems and solutions. Signs are located at public accessible sites beginning at the Jefferson County Outdoor School to the Lakewood City buildings. Each sign has a base message and a site-specific message. People will be able to Geo-locate BCWA signs, collect the keywords from each sign, and share findings with Association through the web site www.bearcreekwatershed.org.

[Bear Creek Regional Parks, Lakewood](#)

The city has a number of education and campfire programs held at Bear Creek Park (e.g., Junior Naturalist) that includes environmental and water quality elements. The Association has developed education materials, handouts and otherwise supported the park programs.

[Evergreen Trout Unlimited](#)

The Association works with Evergreen Trout Unlimited and other partners in identifying and implementing new stream restoration projects/programs. Evergreen Trout Unlimited conducts spring and fall cleanout operations in Evergreen Lake, Bear Creek downtown, O’Fallon. ETU collects over 10 cubic yards of trash and debris, annually. ETU contributes time and materials to the temperature monitoring program. Several Association members are members of ETU.

[Wilmot Elementary School in Evergreen](#)

Annually, the fourth grade classes at Wilmot Elementary School in Evergreen participate in a one-day class on centered on the ecology of Evergreen Lake. They do walking tours around the lake. Several sites around the lake are set up for each group to spend time at, including a stop at the Evergreen Metropolitan District Water Treatment Facility.

Manure Management

The Bear Creek Watershed Association recognizes animal manure and associated liquid waste stream is a contributing factor in nonpoint source pollution within the Bear Creek Park *BCWA Policy 4 Manure Management* and as evaluated in BCWA Technical Memorandum 2013.04 - *Manure Management Bear Creek Park, Lakewood*). An *Animal Facility* or similar project can lead to an accumulation of nutrients in the park over the long term, especially in areas with repeated applications, such as the stables and trails. Manure management strategies used in the Bear Creek Park should not increase the total annual load of total nitrogen or total phosphorus above ambient conditions where such waste can or potentially can reach surface waters in the watershed or within alluvial groundwater. Bear Creek Park staff began manure management practices that included construction of composting bins for large animal waste products and managing trail crossings at waterways.

Summit Lake

Bear Creek Watershed Association continued to monitor four sampling stations at Summit Lake and upper Bear Creek, Mt Evans Wilderness, Clear Creek County Colorado (*BCWA Technical Memorandum 2013.01 - Sampling Program Summit Lake*). The Association historic sampling Site 36 (Summit Lake at outfall) and Upper Bear Creek Site 37 monitor “background” conditions. Monitoring data show atypical water quality results for an alpine ecoregion. The station data demonstrates there is a pollution source(s) causing elevated nutrient loads, low pH conditions and reduced dissolved oxygen. Association observations suggest that one origin of the pollutants was the new/old toilet vaults at the Summit Lake parking lot. Denver Parks and Recreation in 2013 repaired the new vaults.

The new state interim Total Phosphorus standard for cold-water streams is 110 ug/l and the concentration measured in the plume exceeds 4,112 ug/l. The Association measured nearly 3,108 ug/l of Total Nitrogen and the new state interim Total Nitrogen Standard for cold-water streams is 1,250 ug/l. While these measured results aren’t technically a standards violation at this time, they are indicative of a significant pollution problem degrading the aquatic biota and habitat. This nutrient loading contributed to excessive (100% coverage) attached algal growth (periphyton) on rock substrate in Bear Creek. The Association has also documented fish kills that appear attributable to the pollution plume. The Association provides the City and County of Denver, Colorado Department of Parks and Wildlife, Colorado Water Quality Control Division, State Forest Service and National Forest Service technical memorandums with data results and conclusions. Denver has committed to additional characterizations of the water quality problem(s) and is working towards mitigation of any problem(s) associated with the Denver Mountain Park Facilities.

Snow Storage and Parking Lot Green-Infrastructure

Space is limited in the community of Evergreen and for other small communities in the Bear Creek Watershed where most development, especially commercial, is located adjacent to the creeks and tributaries. Consequently, most parking lots and roadways are constructed right to the edge of the normal high watermarks for the streams and creeks. As such, winter snow removal simply pushes the snow load into the waterways. This plowing procedure inevitably includes asphalt and debris from the roadsides. In the central parking lot in Evergreen, the process has led to collapse of about 8-feet of a portion of the lot into Bear Creek. The parking lot collapse point is where a major stormwater drainage system discharges into the stream. The Association has spoken with Evergreen Trout Unlimited and members of the Evergreen Area Chamber of Commerce, and the parking lot owner about ways to improve runoff from the central parking lot and other drainage points in the community. The Association is actively pursuing grant opportunities to establish and test a new snow storage and parking lot maintenance practice. The Association and community have discussed the concept of green infrastructure best management practice for the central parking lot. Snow removal deposition into waterways and stormwater management are a high priority for water quality management within the Bear Creek Watershed.

Clear/Bear Creek Wildfire/Watershed Assessment

The Association was a partner in a watershed assessment that identified and prioritized sixth –level creek/watersheds based upon their hazards of generating flooding, debris flows and increased sediment yields following wildfires that could have impacts on water supplies. The study expanded on current wildfire hazard reduction efforts by including water supply watersheds as a community value. The watershed assessment followed procedures prescribed by the Front Range Watershed Protection Data Refinement Work Group (2009). This Bear Creek assessment provides an identification of opportunities and constraints for each Zone of Concern in the watershed (<http://www.jw-associates.org/clearbearcreek.html>).

Evergreen Metropolitan District Source Water Assessment

Throughout 2013, Evergreen Metro District worked with the Colorado Rural Water Association and a steering committee to develop a Source Water Protection Plan (SWPP). Source water protection is a voluntary, non-regulatory, proactive approach to preventing the pollution of lakes, rivers, streams, and groundwater that serve as sources of drinking water. A SWPP includes: the area in need of protection, the potential sources of contaminants, and management approaches that could help to reduce the risk of contaminants entering the source waters. The wildfire watershed assessment report identifies a zone above the reservoir as a high priority zone of concern. The protection plan will include necessary best management practices necessary to lessen the water quality impact to Evergreen Lake following a major upstream wildfire. It is anticipated that significant nonpoint source pollution could be generated by storm events following a major fire. The district has identified areas in need of protection and several potential sources of contamination. This data will be assimilated into the district’s GIS system. The district will track additional sources of contamination and begin developing the management plan to help reduce the risks of these contaminants reaching Evergreen Lake.

Evergreen Metropolitan District Canal Cleaning Operation

District crew installed large-boulder riprap along the side of the sedimentation channel that enters Evergreen Lake. The access road had eroded away to the point where it was difficult for cleaning operations. The rock was donated by CDOT from piles along Highway 74. The crew placed approximately 35-50 yards of rock. The district monitors and maintains a storm sewer catch basin at Evergreen Lake. Generally, the district on an annual basis removes fine sand and silt from the inlet channel to Evergreen Lake to reduce the sedimentation rate in the lake. In previous years, this material was disposed at a location to prevent subsequent erosion into waterways. In 2013, there was no sediment removal because of a lack of a disposal site for removed material. The channel to the lake had not silted in since the removal of the sediment the previous year. Staff will continue to look for potential sites or users for the material. The District monitors the performance of this catch basin and evaluates if the installation of additional catch basins along upper Bear Creek would benefit the stream.

Coyote Gulch Nonpoint Source Restoration

The Association is involved in a nonpoint source project sponsored by the City of Lakewood that restored a severely eroded section of Coyote Gulch. Coyote Gulch revegetation began in June 2007 and became well established in 2008. The Association has a paired water-sampling program, which allows a determination on the effectiveness of the restoration effort at phosphorus reduction (Table 25). The Association has monitored flow and limited chemistry since March 2006 in Coyote Gulch. The Association Technical memorandum Coyote Gulch Summary (TM 2013.05) provides a detailed summary of the monitoring and data. Table 26 identifies the annual available total phosphorus trade pounds consistent with the Association trade program. Figure 27 shows the total phosphorus reduction.

Table 25 **Coyote Gulch Nutrient Base Loads**

	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
Loading Pounds After Stable					
Reservoir			Above Project		
		Nitrate	T. Phos	Nitrate	T Phos
Total Pounds		9,065	574	10,672	661
Average		156	10	184	11
Median		89	4	119	4

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

Table 26 Coyote Gulch Total Phosphorus Trade Pounds

Total Phosphorus Trade Pounds				
	Total Base Flow		Trade Ration Pounds	
	Monthly	Annual	Monthly	Annual
Average	5.4	65.3	7.3	87.1
Median	5.3	64.1	7.3	87.7
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 = 81.8 pounds Total Phosphors				

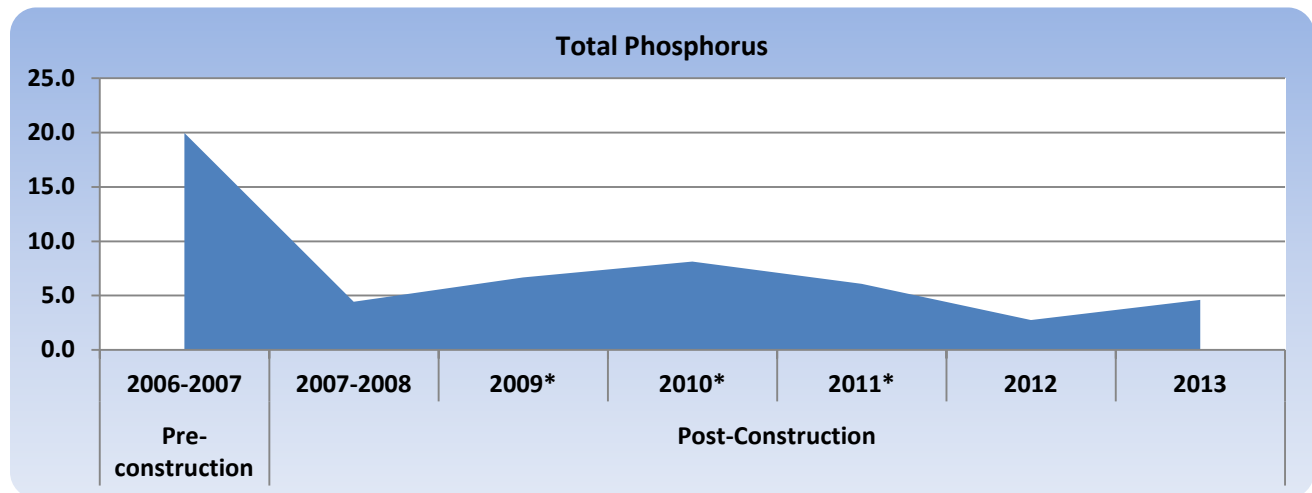


Figure 27 Total Phosphorus Reduction at Coyote Gulch Project

Association Land-Use Review

The Association has 27 “policies” to help with management of the watershed program. The Association is a referral agency to land use agencies within the Bear Creek Watershed, including cities and counties. The Association reviews referral applications for consistency with local, regional and state water and environmental regulations, associated policies and the watershed management plan. To assist the Association in the referral process, a “Referral Review Guidance” (Association 2007)

outlines general components of the Association land disturbance mitigation preferences, Association review and comment guidance. This guidance addresses nonpoint sediment loading before it becomes a watershed problem. Referred land use applications that cause a land disturbance and/or a potential to degrade water quality are subject to review and comment by Association.

The Association completed eight referrals in 2013 that addressed issues related to erosion, septic management, land disturbance, re-zoning, water quality degradation and appropriate use of best management practices. Two community plans were updated. The Association provided information for the *Indian Hills Community Plan* and Clear Creek County planning. The Association supports Jefferson County and Clear Creek County in the update and development of community plans for select portions of the watershed.

BCWA and Membership Special Programs

Denver Water Department Watershed Assessment

The Denver Water Department completed an independent review project of water quality in the Bear Creek Watershed and a cost alternative analysis to determine cost-effective clean-up options (Bear Creek / Turkey Creek Watershed Water-Quality Alternatives and Costs Bear Creek / Turkey Creek Watershed Project Technical Memorandum 2 Contract Number 13223A , Prepared for the Denver Water Board, Hydro Consultants, April 15, 2011). DWD is evaluating implementation programs as addressed in the study and reviewed findings and recommendations with the Association.

Lakewood Regional Parks Recycling Efforts

The City of Lakewood is in their 10th year of recycle and litter management at their regional parks, including Bear Creek Park. In 2013, the program recycled motor oil, metal scrap (6280 pounds scrap), mixed paper, cans, glass and plastic (70 cubic-yards), Electronic (120 pounds), all batteries (36 pounds), paints, and other chemicals which are disposed of at the Rooney Road Recycling Center. The city continues trash clean up along Bear Creek and Turkey Creek drainages and around the reservoirs. Activities completed in 2013 included maintenance of manure management bins, volunteer erosion control projects, willow planting and wetlands enhancement, park clean-up, trail work, trail stream-crossing closure and vegetation management. *Recycle Your Fishing String* program helped keep shorelines clean. Lakewood had 646 volunteer hours logged for flood clean up.

Aspen Park/ Conifer Waste Recycling Program

The Conifer Area Council has maintained a “Recycling / Sustainability Committee”, which supported community recycling. Information from this committee is distributed to the Association membership. The committee has begun a slash removal program for pine beetle damaged trees. The program also takes recycled materials to the Rooney Road Recycling Center.

The Rooney Road Recycling Center

The Rooney Road Recycling Center provides proper disposal programs for residents of Unincorporated Jefferson County and the cities and towns of, Arvada, Golden, Lakewood, Mountain View, Lakeside, Edgewater, Morrison, and Wheat Ridge, to recycle their household hazardous waste (HHW). HHW includes electronic waste, household chemicals, paints, propane cylinders and automotive products. HHW materials collected at the facility since 1994 total more than 6 million lbs of potential surface water and ground water pollutants. The HHW program serviced over 4,000 participants, with City of Lakewood accounting for over 25 % of the total participation and the Bear Creek Watershed accounting for 38% of the total participants.

Invasive Species Protection Programs

Aquatic Nuisance Species Bear Creek Reservoir

Bear Creek Lake Park is involved in Colorado efforts to stop the spread of Aquatic Nuisance Species in Colorado waters. A Watercraft Inspection and Decontamination station is located in the Whitetail parking lot. All trailer and motorized boats require inspection by state certified inspectors at the station for any aquatic invaders. Station staffed from 6am to 8pm on Fridays and the weekends, then every morning and evening during the week. During the middle of weekday, the entrance gate would call out when a boat came in and the nearest staff member would do the inspection. Annually, the lake closes from November 15 to March 15. The park did > 2,300 standard inspections with no positive samples.

Aquatic Nuisance Species Evergreen Lake

The Evergreen Park & Recreation District requires a permit for all personal watercraft to be on Evergreen Lake. This is an opportunity to do the mussel inspection at the Lake House prior to launch. The Recreation District staff inspects boats and trailers.

The recreation district and the Evergreen Metropolitan District have a program to harvest and compost the invasive algal species Elodea from the lake in the summer months. The districts introduced grass carp to manage the Elodea growth.

Noxious Weed Management

Clear Creek, Jefferson and Denver Counties have noxious weed management programs. The Association reports sightings of noxious weeds and otherwise cooperates with these programs.

Invasive Algal Species in Bear Creek and Turkey Creek

The Association has begun collecting and identifying invasive algal species found in streams throughout the watershed.

U.S. Army Corps of Engineers

The U.S. Army Corps of Engineers updated the master plan for Bear Creek Dam and reservoir (Bear Creek Dam and Lake Project South Platte River, Colorado, Design memorandum PB-10, July 2012). This master plan for the Bear Creek Dam and Lake Project updated the original 1980 Bear Creek Dam and Lake Master Plan and subsequent 1988 partial update.

The Corps of Engineers released an updated sedimentation analysis for Bear Creek Reservoir (Tri-Lakes Sedimentation Studies Area-Capacity Report Revised: July 2011; M.R.B. Sediment Memorandum 23a). There has been a decrease in gross storage capacity:

Gross storage capacity in Bear Creek Lake has decreased from the original capacity of 78,101 acre-feet in 1980 to 77,293 acre-feet in 2009, the year of the latest sediment range line survey. This amounts to a total storage reduction of 808 acre-feet, or an average depletion rate of 27.9 acre-feet per year. The original projected storage depletion rate for Bear Creek Lake was approximately 20 acre-feet per year. The Bear Creek Lake flood control pool storage capacity has decreased from of 28,762 acre-feet in 1980 to 28,514 acre-feet in 2009, an average of 8.6 acre-feet per year.

Colorado Department of Parks and Wildlife

The Association supports the Division of Parks and Wildlife fishery surveys. These surveys characterize how trout populations respond to both natural and human induced alterations, including changes to water and environmental quality. The Association maintains a Fishery Analysis and Protocols Guidance. There were no fishery surveys in 2013 due to flood conditions.

VII. Association Annual Reporting

The Association produces an annual data report (*BCWA May 2014*) and a *2013 Master Data Spreadsheet (February 2014)* that includes data analyses, and raw data (Association website www.bearcreekwatershed.org). The Association transmits these data reports to the Water Quality Control Division Staff. The watershed-monitoring program summarized in an Association data report (*Bear Creek Watershed Association Data Report, May 2014*).

All of the Association annual reporting documents are available electronically and posted on the website. The Association provides multiple reporting documents designed to meet the multiple functions of various groups. The reporting helps member entities with reporting to their respective boards, commissions and groups. There is also a citizen interest in the watershed and reporting helps keep the public informed. Many educational groups visit the watershed and it has become a widely used outdoor classroom. The Association supplies water quality and environmental materials for these various educational uses. Technical memorandum published by the Association in 2013 includes:

2013.01	Summit Plume
2013.02	Kerr Swede Summary 2013
2013.03	Coyote Gulch Summary January 2014
2013.04	Manure Management BCP
2013.05	BCR 2013 Summary Statistics & Graphs
2013.06	MBCW 2013 Summary Graphs
2013.07	2013 Summary BCR Loading
2013.08	Barr Milton TMDL Summary
2013.09	Evergreen Lake Summary