

Bear Creek Watershed Association

2014 Annual Report



Bear Creek Watershed



WE ALL LIVE IN A WATERSHED

A *watershed* is an area of land where rain and snowmelt drain into local streams, rivers, lakes, and reservoirs. Bear Creek Watershed extends from Mt. Evans in Clear Creek County to Bear Creek Reservoir in Morrison. The main streams are Bear Creek and Turkey Creek. Bear Creek Watershed drains into the South Platte River. How we use land and live in our watershed alters its water resources. Bear Creek Watershed Association (BCWA) works to protect and restore water quality in our watershed in accordance with Colorado stream standards and classifications.

Visit www.bearcreekwatershed.org to learn more and complete a watershed survey. Share your watershed experience and pictures.

BE A WATERSHED WARRIOR!

Watershed Warriors are people who care about the water in their watershed and want to make a difference. They are the people who help protect and restore the water in our watershed.

WALL OF FAME

Recreation and water quality

Recreation is an important use of water. These activities are economic drivers in this watershed, but may erode shorelines and stream banks, add nutrients, disrupt fisheries and wildlife, and spread undesirable invasive species. There is a delicate balance between land, water, vegetation, wildlife, and people. Illegal dumping is a problem in this watershed because it degrades water quality. BCWA and Lakewood encourage responsible recreational use.

Water quality changes from the top to here

Water that flows from the top of the watershed (Mt. Evans at 14,240') down to the plains continually changes in quantity and quality. BCWA monitors the watershed to understand trends of where, when, and how the water becomes polluted. BCWA looks for ways to reduce pollution. Amounts of nutrients (phosphorus) and flow increase from Mt. Evans to Bear Creek Lake Park. Riparian buffer zone preservation is an important pollution control practice supported by BCWA.

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Adopted by Motion April 8, 2015

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

Contents

I.	WQCC Summary	v
1.	Status Of Water Quality.....	v
2.	Wastewater Treatment Facilities Loading and Compliance	vi
3.	Nonpoint Source Loading.....	vii
4.	Status Of Water Quality Goals and Standards.....	vii
5.	Phosphorus Trading Program	viii
II.	Bear Creek Watershed Association Program	1
III.	Status of Water Quality in the Reservoirs and Watershed	2
	Monitoring Program Update.....	2
	Watershed Studies	3
	Stream Flow Studies.....	3
	Hydrology.....	4
	Water Quality Studies.....	5
	Kerr/Swede Gulch E. coli Study	7
	Reservoirs	9
	Bear Creek Reservoir and Inflow Nutrients	9
	Bear Creek Reservoir Indicator Trend Variables	12
	Bear Creek Reservoir Aeration Practice Manages Summer Dissolved Oxygen	16
	Upgraded Aeration System BCR.....	17
	Bear Creek Reservoir Sediment Study	18
	Evergreen Lake Study	19
IV.	Meeting Water Quality Goals and Standards for the Watershed.....	20
	Dissolved Oxygen Compliance in Bear Creek Reservoir.....	20
	Temperature Standards Bear Creek Watershed.....	21
	Bear Creek Reservoir Temperature Compliance.....	21
	Watershed Stream and Lake Compliance.....	22
	303(d) Listing	24
	Barr/Milton Model Input and Bear Creek Load Predictions	25
	Macroinvertebrate Analysis and Aquatic Life Compliance.....	25
V.	Wastewater Treatment Facilities Loading and Compliance.....	25
	Wasteload Compliance	25
	Permit Compliance and Plant Expansions/Actions	26
	Utility Supported Programs	27
	Pharmaceutical Recycling Program	27
	Sanitary Sewer Incentive Programs in the Evergreen Area.....	27
	Trading Program.....	27
	Watershed Stormwater Management.....	28
	City of Lakewood MS4 Program	28
	Jefferson County MS4 Program	28
	BCWA Stormwater Monitoring Program.....	29
	Clear Creek County Stormwater Management Program.....	29
VI.	Nonpoint Source Program	29
	Onsite Wastewater Treatment System Management	29
	Selected Watershed Nonpoint Source Programs	30
	Policy Direction.....	31
	Water Quality Monitoring Tiers.....	31
	Online Management System (ACM DSS).....	31
	Preliminary Nonpoint Source Analysis in EPA BASINS GWLF-E	32
	Nonpoint Source Education -	32
	Watershed Education and Training Efforts	32
	BCWA Newsletter	33
	Future Watershed Manager Program.....	33

Geo-Locate Sign Program	33
Bear Creek Regional Parks, Lakewood	33
Evergreen Trout Unlimited.....	33
Wilmot Elementary School in Evergreen	33
Manure Management.....	33
Summit Lake	34
Clear/Bear Creek Wildfire/Watershed Assessment.....	34
Evergreen Metropolitan District Source Water Assessment	34
Evergreen Metropolitan District Canal Cleaning Operation	34
El Pinal Wastewater Lift Station.	35
Coyote Gulch Nonpoint Source Restoration	35
Association Land-Use Review	36
BCWA and Membership Special Programs	36
Denver Water Department Watershed Assessment.....	36
Lakewood Regional Parks Recycling Efforts.....	36
Aspen Park/ Conifer Waste Recycling Program	37
The Rooney Road Recycling Center	37
Invasive Species Protection Programs.....	37
Aquatic Nuisance Species Bear Creek Reservoir	37
Aquatic Nuisance Species Evergreen Lake	37
Noxious Weed Management.....	37
Invasive Algal Species in Bear Creek and Turkey Creek.....	38
U.S. Army Corps of Engineers.....	38
Colorado Department of Parks and Wildlife	38
VII. Association Watershed Plan and Annual Reports	38
Be a Watershed Warrior!	39
BCWA Watershed Plan	39

List of Figures

Figure 1	Annual Total Phosphorus Deposition into Bear Creek Reservoir Bottom Sediments.....	v
Figure 2	Total Phosphorus Loading by Stream Segments in the Watershed	vi
Figure 3	Total Nitrogen Loading by Stream Segment in the Watershed	vi
Figure 4	Total Phosphorus Reduction at Coyote Gulch Restoration Site	viii
Figure 5	Bear Creek Watershed.....	1
Figure 6	Reservoir Monitoring Stations; Site 2 is the Routine P1 Station (2015 image)	3
Figure 7	Monitoring Station in Bear Creek Park	3
Figure 8	In-Flow Estimates by Month into Bear Creek Reservoir	4
Figure 9	Annual Flows into Bear Creek Reservoir.....	5
Figure 10	Bear Creek above Evergreen Annual Acre-feet/year Flow	5
Figure 11	Kerr/Swede Gulch Sample Sites.....	7
Figure 12	Estimated Total Phosphorus loading into Bear Creek Reservoir.....	10
Figure 13	Total Nitrogen Loading into Bear Creek Reservoir.....	10
Figure 14	Estimated Total Nitrogen Loading Trend for Bear Creek Reservoir.....	10
Figure 15	Total Phosphorus Annual Trend at Bear Creek Reservoir	11
Figure 16	Annual Total Phosphorus Bear Creek Reservoir.....	11
Figure 17	Bear Creek P-1 Sites Nitrate-Nitrogen Concentrations	11
Figure 18	Total Nitrogen Bear Creek Reservoir	12
Figure 19	Bear Creek Reservoir Phytoplankton Species Diversity	14
Figure 20	Phytoplankton Average Biovolume by Functional Group	15
Figure 21	Secchi Depth Bear Creek Reservoir	15
Figure 22	Bear Creek Reservoir Chlorophyll Trend.....	16
Figure 23	Walker Trophic Index Trend Bear Creek Reservoir.....	16
Figure 24	Fishing Very Popular on Bear Creek Reservoir, Both Winter and Summer	17

Figure 25	Bear Creek Reservoir Dissolved Oxygen Trend.....	17
Figure 26	New BCR Aeration Configuration	18
Figure 27	DO Compliance Bear Creek Reservoir.....	20
Figure 28	Temperature Compliance Bear Creek Reservoir	22
Figure 29	Onsite System Study - Comparison of Total Phosphorus Between Sites 52 and 53	30
Figure 30	Total Phosphorus Reduction at Coyote Gulch Project	36
Figure 31	Bear Creek Restoration in Bear Creek Park	37
Figure 32	Corps of Engineers Dam Improvements.....	38

List of Tables

Table 1	Point Source versus Nonpoint Source Phosphorus Loading, Bear Creek Reservoir	vii
Table 2	Association Membership, Dischargers and Participation	2
Table 3	Harriman Ditch Nutrient Load Removal	4
Table 4	2014 Technical Memorandum of the Association.....	6
Table 5	Middle Watershed Chemistry.....	6
Table 6	Upper Watershed (Summit Lake) Chemistry	7
Table 7	Kerr/Swede Gulch Data Summary	8
Table 8	Kerr/ Swede Gulch E. Coli Geometric Mean Summary.....	9
Table 9	Bear Creek Reservoir Summary Statistics (July September)	12
Table 10	Annual Bear Creek Reservoir Load Estimates	13
Table 11	Bear Creek Reservoir Select Trend Parameters.....	14
Table 12	Bear Creek Reservoir Phytoplankton Summary Data	14
Table 13	Estimated Sediment Load into Evergreen lake.....	18
Table 14	Estimated Sediment Load into Bear Creek Reservoir	19
Table 15	Phosphorus Content of BCR Sediments	19
Table 16	Water Quality Data Summary for Evergreen Lake	20
Table 17	Temperature Standards in Bear Creek Watershed.....	21
Table 18	Temperature Compliance Summary Bear Creek Reservoir	22
Table 19	Watershed Temperature Compliance Summary Warm/ Cold Seasons	23
Table 20	Water Quality Compliance at Watershed Monitoring Sites	23
Table 21	303(d) List Bear Creek Watershed	24
Table 22	MMI Attainment and Impairment Summary for Bear Creek Watershed	25
Table 23	Treatment Facility Wasteload Allocations	26
Table 24	Wastewater Treatment Plant Planning Status.....	26
Table 25	Phosphorus Trading Activity in Bear Creek Watershed.....	28
Table 26	Summary of 2014 MS4 Programs for Inspections and Enforcement Actions.....	29
Table 27	Coyote Gulch Nutrient Base Loads	35
Table 28	Coyote Gulch Total Phosphorus Trade Pounds.....	35

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 32,940 acre-feet with about 26,345 acre-feet (80%) from Bear Creek and 6,595 acre-feet (20%) from Turkey Creek. The internal loading problem with Bear Creek Reservoir has not diminished over the last 7-years (Figure 1). The total phosphorus deposition into reservoir bottom sediments is over 12,500 pounds since 2008. The reservoir continues to experience late summer phytoplankton blooms (2014 peak density of *Anabaena flos-aquae*, Peak Biovolume ($\mu\text{m}^3/\text{mL}$) = 787,726), which are linked to the internal nutrient loading problem. The BCWA has identified some strategies to address the internal loading problem (*BCWA Policy 20 Preferred Management Strategies EGL and BCR*).

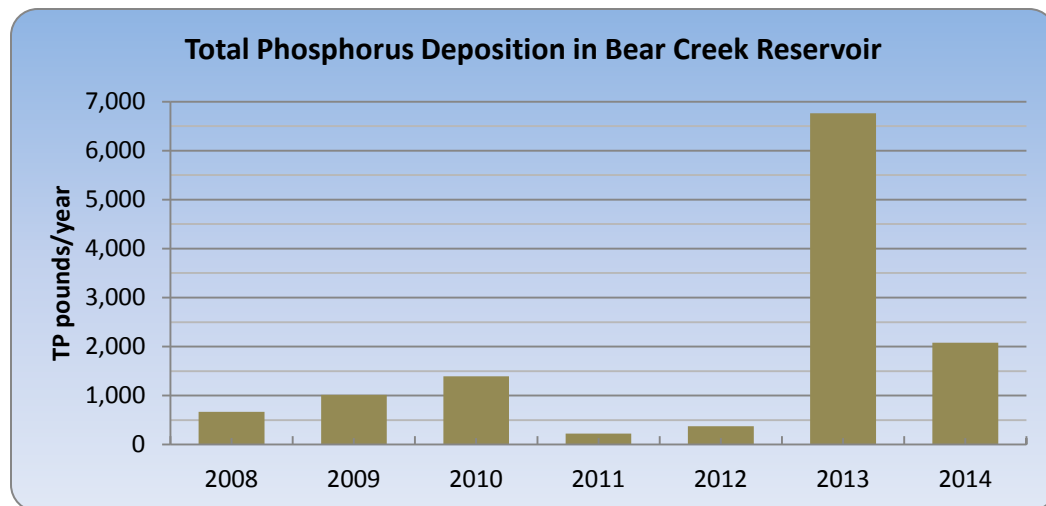


Figure 1 Annual Total Phosphorus Deposition into Bear Creek Reservoir Bottom Sediments

The total phosphorus load from the watershed comes from a combination of wastewater treatment plant point source loads, other point sources (e.g., onsite wastewater treatment systems), and nonpoint sources, including stormwater runoff. The estimated total phosphorus load in 2014 from all sources reaching the reservoir was 4,010 pounds (88% from Bear Creek) at a flow of about 26,345 acre-feet. There was about 52,000 pounds of total nitrogen loading into the reservoir with 85% derived from the Bear Creek drainage.

The Association monitors watershed nutrients by major stream segments beginning near Mt. Evans (segment 7) and extending downstream to Bear Creek Reservoir. From a water quality perspective, the watershed showed good recovery from the September 2013 major flood event. The flood event caused a nutrient flush with most waterways having very low nutrient concentrations for about six-months following the event. In the 2014 monitoring season, the total phosphorus (Figure 2) and total nitrogen (Figure 3) concentrations and loads began to return to pre-flood conditions. The majority of nutrient load comes from the urbanized corridor of segment 1a (above Evergreen Lake to the Clear Creek County Line), and segment 1e, which is the mainstem of Bear Creek

from Evergreen Lake to the Harriman Ditch Diversion. There was about 1,600 pounds of total phosphorus passed through Evergreen Lake, with an additional 1,100 pounds added from the Cub Creek drainage. Additional, total phosphorus loading into Bear Creek below Evergreen to Morrison was about 1,000 pounds. The BCWA has established specific monitoring sites to better characterize specific tributary drainages with elevated total phosphorus loading and develop improved management strategies for these areas (*BCWA Policy 15 Nonpoint Source Strategies and BMPs*). The BCWA also improved integrated planning efforts with other agencies to help resolve several identified pollute loading problems (*BCWA Policy 29 BCWA Integration with Other Planning Efforts*).

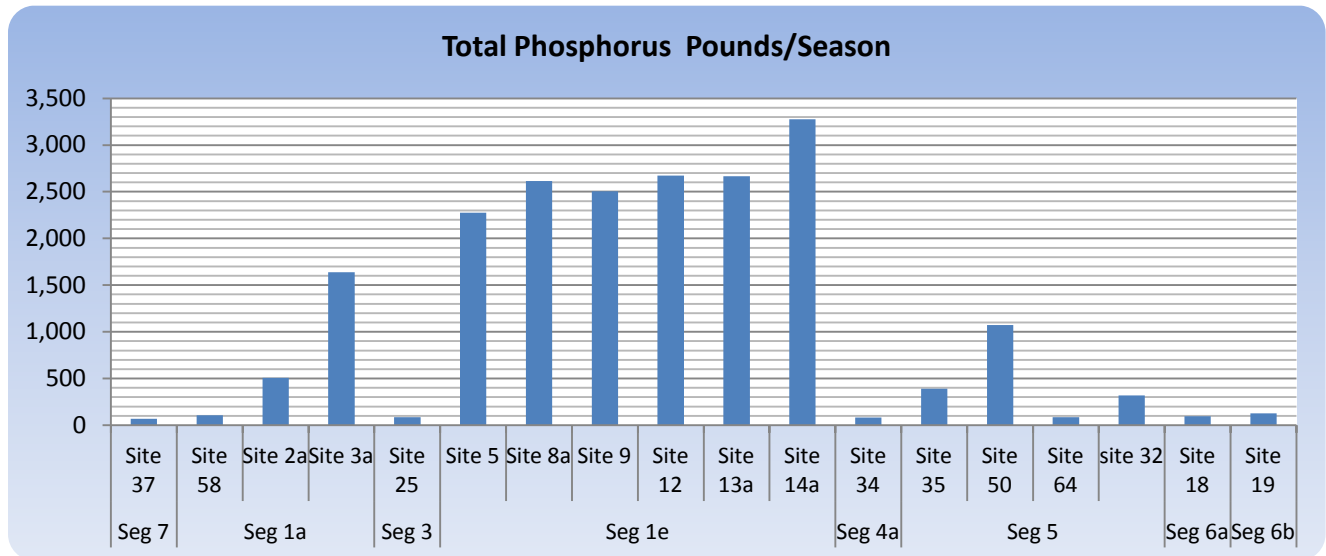


Figure 2 Total Phosphorus Loading by Stream Segments in the Watershed

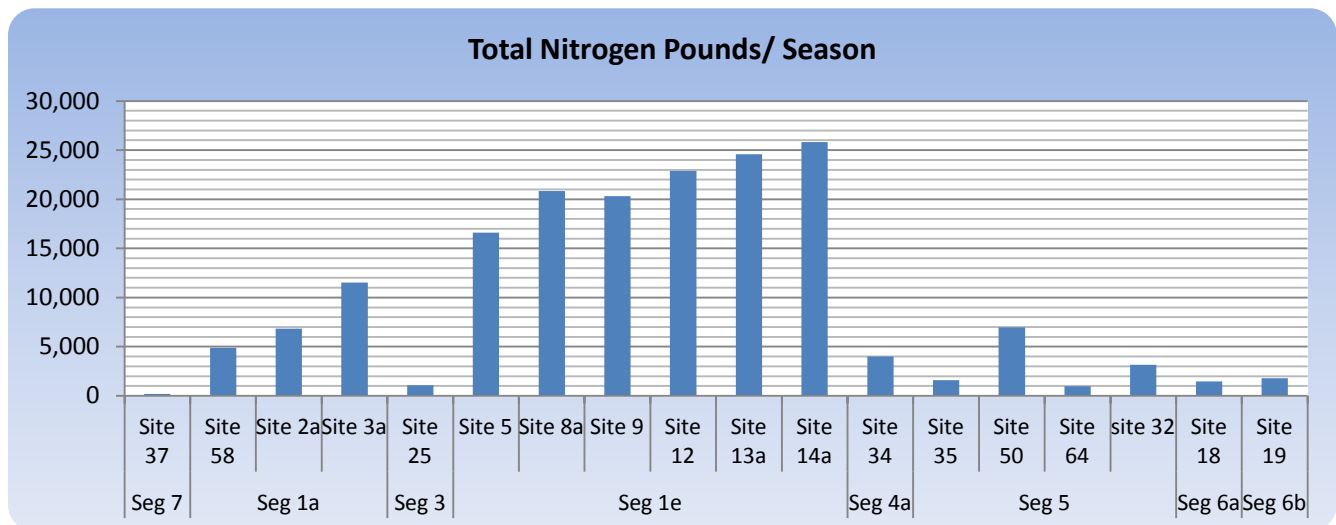


Figure 3 Total Nitrogen Loading by Stream Segment in the Watershed

2. Wastewater Treatment Facilities Loading and Compliance

In 2014, wastewater dischargers reduced total phosphorus waste load contributions to just 1,074 pounds annually. BCWA analysis of the total phosphorus data record indicates that only about 20-35% of this total phosphorus load from permitted dischargers actually reaches the Bear Creek Reservoir. There were no significant permit compliance problems. Some of the smallest dischargers are finding it difficult to 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 2014, requiring nutrient monitoring by surface discharging wastewater dischargers. Larger WWTFs chose to participate in BCWA watershed level Regulation 85 sampling and reporting in conjunction with stream sampling for data comparability.

3. Nonpoint Source Loading

Throughout 2014, 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 four 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 on an annual basis (Table 1). The point source load of total phosphorus in 2014 (Table 1) was 1,076 pounds (37%), while the nonpoint source load reaching Bear Creek Reservoir was about 2,935 pounds (63%). On average over 15 years of data record, only about 28% of the potentially generated nonpoint source total phosphorus reached Bear Creek Reservoir. Some of the nonpoint source load reduction can be attributed to improved Jefferson and Clear Creek county management practices for road maintenance, construction practices, stormwater controls and land use controls. This 2014 nonpoint source phosphorus loading is still showing an influence from the September 2013 flooding event.

Table 1 Point Source versus Nonpoint Source Phosphorus Loading, Bear Creek Reservoir
2014 Total Phosphorus Loading (Pounds)

	Total TP Load	PS	NPS	%NPS
Turkey Creek Drainage	489	7	482	99%
Bear Creek Drainage	3,521	1,069	2,452	56%
Discharged into Reservoir	4,010	1,076	2,934	63%
Site 45 Outflow BCR	1,980			
BCR Total Phosphorus Deposition	2,031			

The Association online system is a permanent management policy (BCWA Policy 21, December 2013). Watershed plan and administration policies were developed by the Association, 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 (See the BCWA *PGO1 Master Index List* and *PGO2 Document Categories*). Association policies are an essential component of the Association’s interactive online *watershed plan* and they help to continually improve watershed-planning efforts and provide tools to understand watershed dynamics.

4. Status Of Water Quality Goals and Standards

The Association has 33-years of active service to the watershed in Clear Creek, Jefferson and Park Counties. The Association has 30-years of data and studies to support watershed science. During this time, the Association has removed or immobilized about 350 tons of phosphorus in the watershed. The 82 volunteer-years of effort by Association membership has helped waters in the watershed meet standards and classified uses.

Average seasonal total phosphorus of 44.7 µg/L in Bear Creek Reservoir exceeds the 32 µg/L goal-standard. Average seasonal chlorophyll-a of 8.3 µg/L was below 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 19° Celsius. There were no exceedances of the *Weekly Average Temperature (WAT)* or 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 no temperature compliance problems in both the warm and cold seasons. The only water chemistry exceedances of standards measured in the 2014 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 2014 (See Table 25 in the *BCWA 2014 Annual Report* for a status of trading activity summary). The Association has established four trading policies to improve future trading programs (*BCWA Policy 1 Trading Program, BCWA Policy 19 Nutrient Trading Program Eligibility, BCWA Policy 26 Point to Point Trade Administration, and BCWA Policy 35 Membership Entity Termination and Permit Closure*). The Association Coyote Gulch restoration project has established the annual available total phosphorus trade pounds consistent with the Association trade program at 88 pounds (*BCWA TM 2014.04 Coyote Gulch Summary*). The project has effectively reduced total phosphorus loading by about 75% on an annual basis (Figure 4).

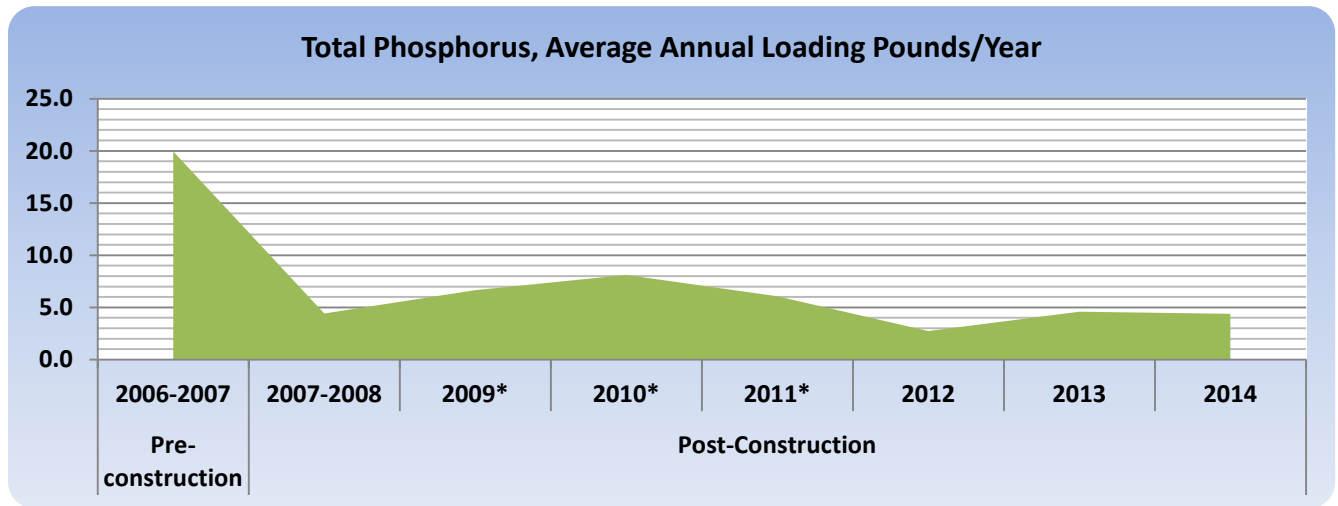


Figure 4 Total Phosphorus Reduction at Coyote Gulch Restoration Site

II. Bear Creek Watershed Association Program

The Bear Creek Watershed (Figure 5) 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 (*BCWA Policy 13 Watershed Boundary*). The watershed extends from the Mount Evans Wilderness on the western end to the Town of Morrison on the eastern end (*BCWA Map 01 Watershed Boundary*). 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 (*BCWA Fact Sheet 10 Control Regulation 74*). The Bear Creek Watershed Association (Association) oversees implementation of the Control Regulation (*BCWA Fact Sheet 1 BCWA Overview; BCWA Policy 12 Vision Mission & Targets*).

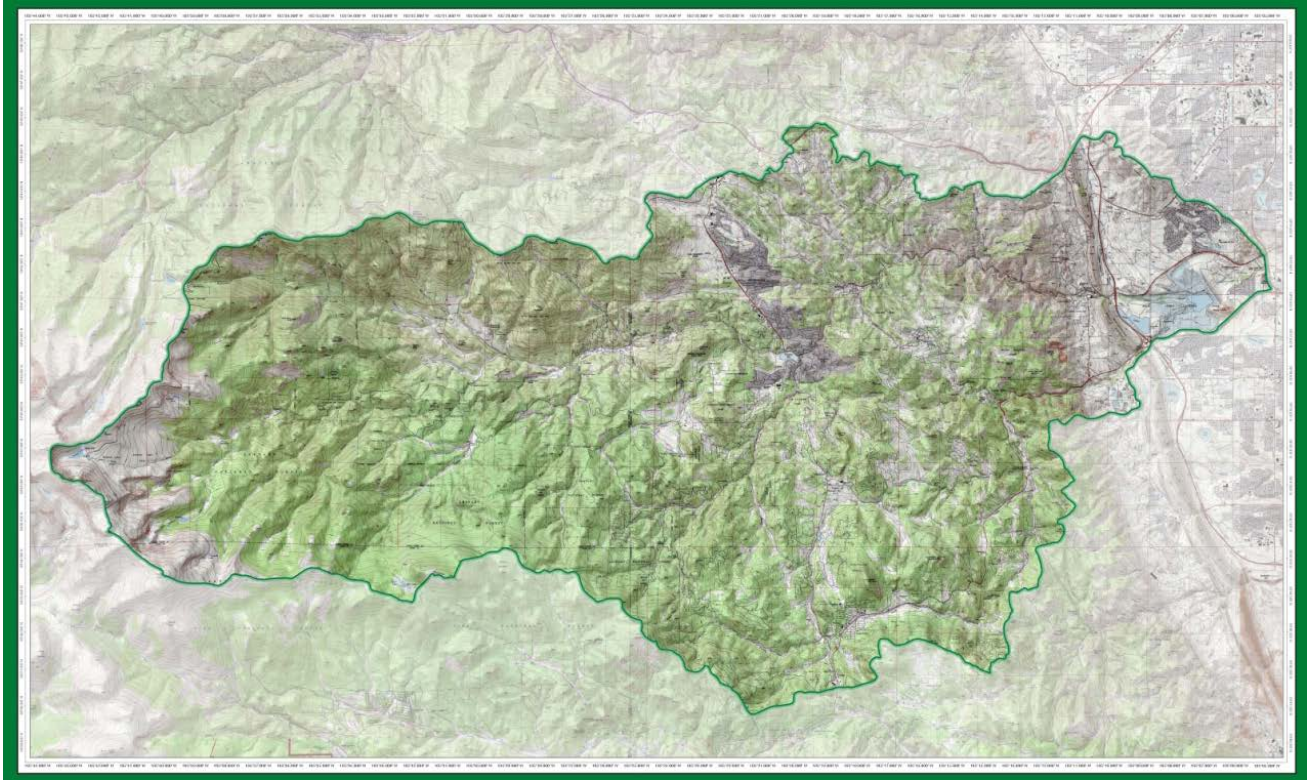


Figure 5 Bear Creek Watershed

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 (*BCWA Policy 28 BCWA Watershed Plan*).

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 (*BCWA Policy 29 BCWA Integration with Other Planning Efforts*).

Table 2 Association Membership, Dischargers and Participation

Members & Participants	Wastewater Discharger	2014 Participation
Counties		
Jefferson County		Active
Clear Creek County		Active
City and Towns		
City of Lakewood		Active
Town of Morrison	Yes	Active
Water & Sanitation Districts		
Aspen Park Metropolitan District	Yes	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	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 Not Paid, Not Active
The Fort Restaurant	Yes	Active
Tiny Town Foundation, Inc.	Yes	Dues Paid, Not Active
West Jefferson County Metropolitan District	Yes	Active
Other Member		
Denver Water Department		Active
Participant Agencies		
Denver Health/ Parks & Recreation		Attended
Evergreen Trout Unlimited		Active
U.S. Army Corps of Engineers		Attended
WQCD		Attended

III. Status of Water Quality in the Reservoirs and Watershed

Monitoring Program Update

The BCWA monitoring plan details the 2014 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 2014 monitoring program (version 2014.01) 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 6; 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 ½ 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. Figure 7 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 6 Reservoir Monitoring Stations; Site 2 is the Routine P1 Station (2015 image)

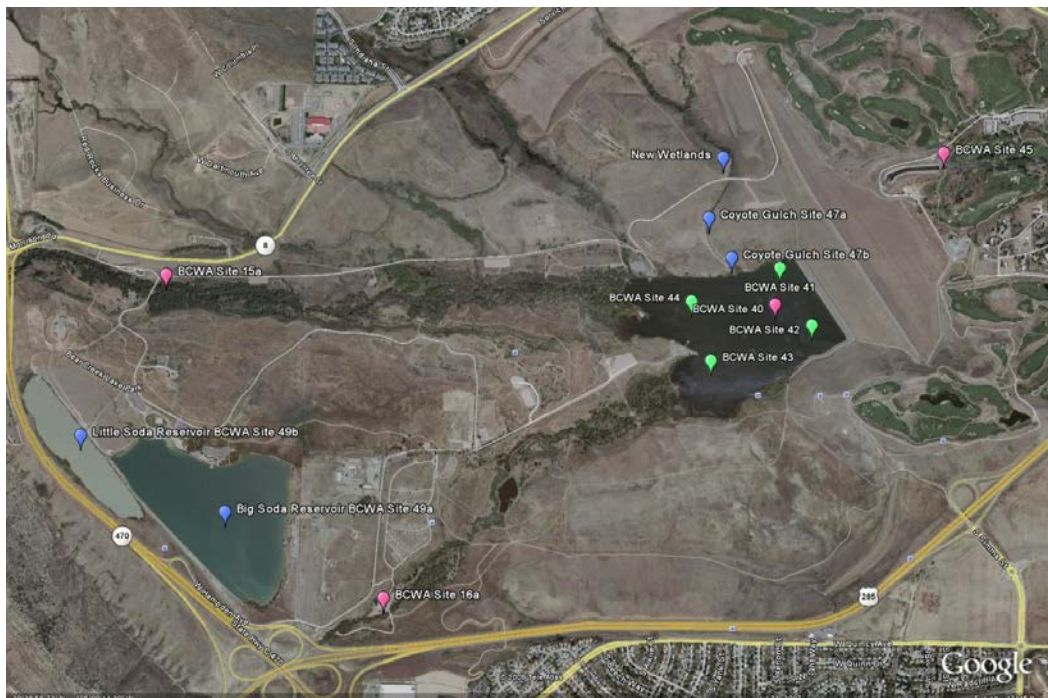


Figure 7 Monitoring Station in Bear Creek Park Watershed Studies

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 were destroyed by the September 2013 flood and they have not been replaced. The Association also conducts tributary stream flow studies.

Hydrology

The BCWA evaluates the basin hydrology. In 2014, the total estimated annual discharge into Bear Creek Reservoir was about 32,940 acre-feet (Figure 8) with about 34,690 acre-feet flow through and no measureable evaporation and infiltration.

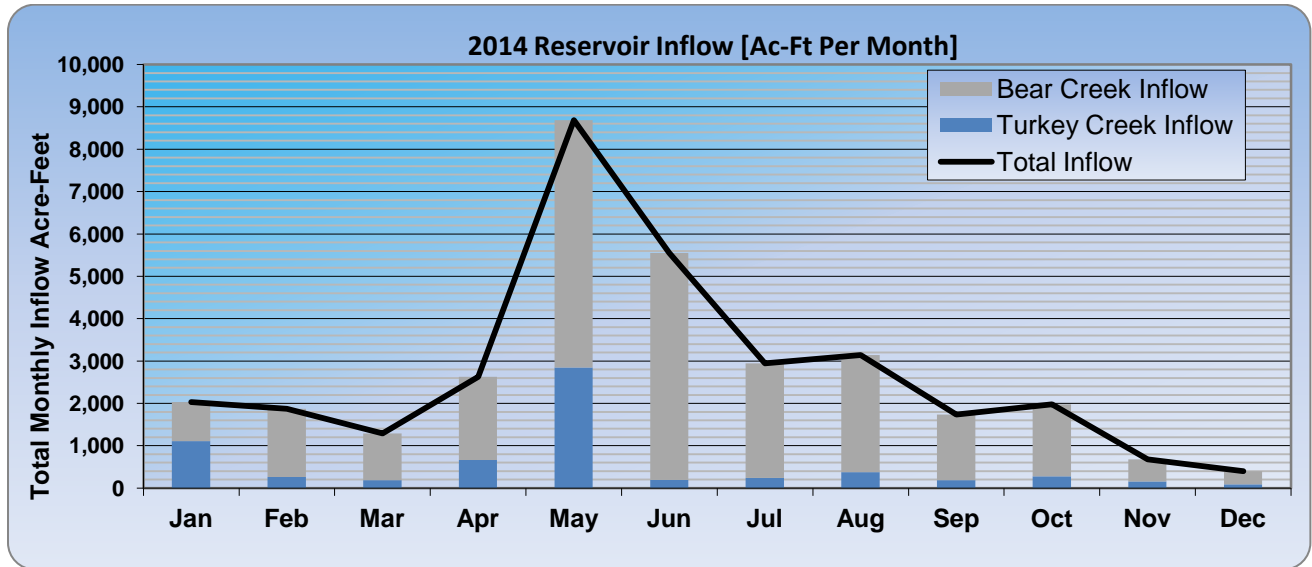


Figure 8 In-Flow Estimates by Month into Bear Creek Reservoir

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 2014, the Harriman diverted water for 273 days with about 4,291 acre-feet of removal as reported by Denver Water Department. Lower Bear Creek was dewatered (<5 cfs flow) for about 50 days or 15% of the time. The BCWA analyzed the nutrient load removal from the Harriman Ditch (Table 3). The diversion reduces the total phosphorus load to Bear Creek Reservoir by about 20%.

Table 3 Harriman Ditch Nutrient Load Removal

DWD Harriman Ditch					
Segment	BCWA Site	Season May-October			
		Nitrate Pounds	TN Pounds	TP Pounds	Ac-Ft
Seg 1e	Site 14a	12,468	25,806	3,275	24,885
Seg 4a	Site 34	2,803	4,572	85	1,468
Total Above Harriman		15,271	30,378	3,360	26,353
Seg 1b	Site 15a	11,536	25,095	2,652	16,519
Removal Harriman		3,735	5,283	708	9,834
% Removal		24%	17%	19%	37%

Comparing in-flow estimates at the Morrison gaging station (2014, 26,350 ac-feet) and at the BCWA site in Bear Creek Park (2014, 16,520 ac-feet) provides an estimate of the amount of water diverted from the watershed by the Arnett-Harriman Canal. For example, in 2014 the Bear Creek water use diversion reduced flow to the reservoir by about 9,835 ac-ft (-37 %).

The reservoir inflow represents flows below the water diversions and is not representative of the total watershed water flows. Figure 8 compares the 2014 reservoir monthly inflow estimates from Bear Creek (80%) and Turkey Creek (20%). Peak spring runoff occurred in May 2014. Figure 9 shows the Bear Creek in-flow estimates (1987-2014) above Bear Creek Reservoir, in Bear Creek Park. Figure 10 shows the flow estimates at the Evergreen station. Additionally, the longer time trends shown in Figures 9 and 10 depict a basic linear trend of declining flow in Bear Creek.

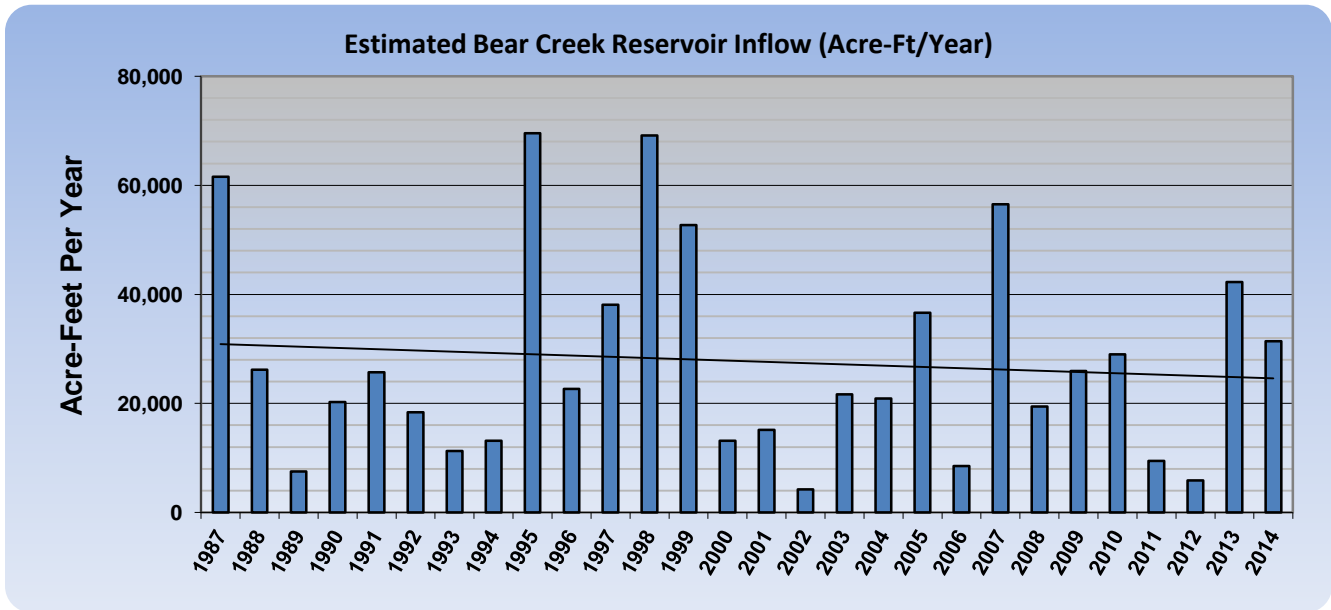


Figure 9 Annual Flows into Bear Creek Reservoir

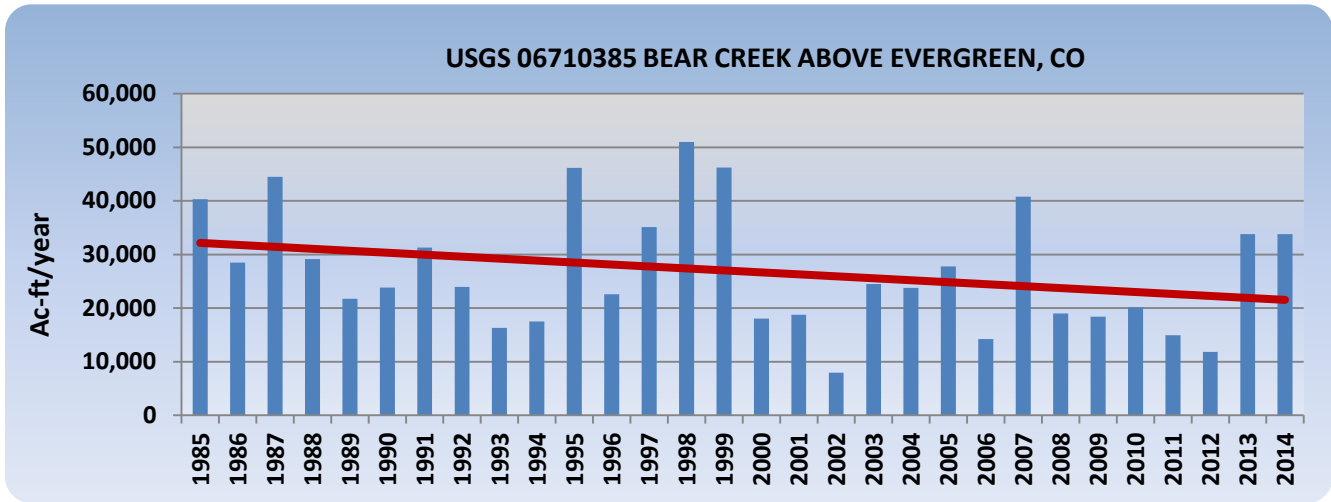


Figure 10 Bear Creek above Evergreen Annual Acre-feet/year Flow

Water Quality Studies

The BCWA summarizes its watershed-monitoring program in a data report (Bear Creek Watershed Association Data Report, March 11, 2015). 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 2014.01, BCWA January 2014, 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 2014.01, BCWA January 2014, and subsequent annual updates*.
3. Special water quality characterization and analyses studies completed on a site-specific basis.

The 2014 P1 data results are contained in the *2014 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 39 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. All loggers were removed and data downloaded after September 30, 2014.

The Association produces an annual series of technical memorandum designed to summarize the site-specific studies for any given year (Table 4).

Table 4 2014 Technical Memorandum of the Association

TM2014.01	BCR Aeration System Survey
TM2014.02	Summit Plume
TM2014.03	Kerr Swede Summary 2014
TM2014.04	Coyote Gulch Summary
TM2014.05	BCR 2014 Summary Statistics & Graphs
TM2014.06	MBCW 2014 Summary Graphs
TM2014.07	2014 Summary BCR Loading
TM2014.08	Barr Milton TMDL Summary
TM2014.09	Evergreen Lake Summary
TM2014.10	BCR Phytoplankton Summary
TM2014.11	Seasonal Nutrient Load BCW
TM2014.12	BCR Sediment Study
TM2014.13	Macroinvertebrates

Table 5 lists the 2014 middle watershed seasonal average chemistry results (full results shown in 2014 Master Spreadsheet). BCWA Technical Memorandum 2014.06 summarizes the middle watershed data. Table 6 lists the Summit Lake area watershed chemistry results (full results shown in 2014 Master Spreadsheet). BCWA Technical Memorandum 2014.02 summarizes the Summit lake data.

Table 5 Middle Watershed Chemistry

	Site ID	Site Location by Stream Segment	Season Mean			
			TN Ug/l	NO3-NO2 Ug/l	Ammonia Ug/l	T Phos Ug/l
Seg 7	Site 37	Mainstem Bear Creek Mt. Evans	308	111	14	11
	Site 58	Bear Creek above Singing River Ranch	212	114	10	5
Seg 1a	Site 2a	Golden Willow Road UBC	180	68	18	13
	Site 3a	Above Evergreen Lake at CDOW Site	188	66	15	27
Seg 3	Site 25	Vance Creek (Mt. Evans Wilderness drainage)	140	43	14	11
	Site 5	Above EMD WWTP, CDOW downtown site	281	92	33	39
	Site 8a	Bear Creek Cabins at CDOW Site	362	118	65	45
Seg 1e	Site 9	O'Fallon Park, west end at CDOW Site	354	140	40	44
	Site 12	Lair o' the Bear Park, at CDOW site	363	172	32	42
	Site 13a	Below Idledale, Shady Lane at CDOW site	408	197	31	44
	Site 14a	Morrison Park west, CDOW Site	381	184	33	48
Seg 4a	Site 34	Mt Vernon Drainage, Morrison	1,004	701	18	20
	Site 35	Cub Creek, Upstream @ Brookforest Inn	392	259	34	97
Seg 5	Site 50	Cub Creek, Upstream of Cub Creek Park	526	322	38	81
	Site 64	Troublesome at Culvert above West Jeff	950	312	21	84
	site 32	Troublesome Mouth	1,109	608	29	112
Seg 6a	Site 18	South Turkey Creek Aspen Park	552	28	21	36
Seg 6b	Site 19	North Turkey Creek Flying J Ranch Bridge	543	242	21	39

Table 6 Upper Watershed (Summit Lake) Chemistry

Site	Parameter	6/20/2014	7/18/2014	8/15/2014	9/18/2014	Average
BCWA Segment Sample Sites						
36 - Outlet Summit Lake	Total Nitrogen, ug/l	317	307	287	286	299
36 - Outlet Summit Lake	Nitrate/Nitrite as N, dissolved, ug/l	133	84	92	61	93
36 - Outlet Summit Lake	Nitrogen, ammonia, ug/l	18	17	15	5	14
36 - Outlet Summit Lake	Phosphorus, total, ug/l	6	27	8	2	11
65 - Between Pond #1 & #2	Total Nitrogen, ug/l	273	311	892	269	436
65 - Between Pond #1 & #2	Nitrate/Nitrite as N, dissolved, ug/l	131	87	2	85	76
65 - Between Pond #1 & #2	Nitrogen, ammonia, ug/l	20	16	26	5	17
65 - Between Pond #1 & #2	Phosphorus, total, ug/l	4	8	735	2	187
37 - Upper Bear Creek	Total Nitrogen, ug/l	363	297	326	246	308
37 - Upper Bear Creek	Nitrogen, ammonia, ug/l	130	112	106	97	111
37 - Upper Bear Creek	Nitrate/Nitrite as N, dissolved, ug/l	17	17	17	5	14
37 - Upper Bear Creek	Phosphorus, total, ug/l	4	10	27	2	11
Summit Plume Discharge						
63- Est Bottom Plume	Total Nitrogen, ug/l	442	170	892	5	377
63- Est Bottom Plume	Nitrogen, ammonia, ug/l	4	7	2	2	4
63- Est Bottom Plume	Nitrate/Nitrite as N, dissolved, ug/l	19	40	26	12	24
63- Est Bottom Plume	Phosphorus, total, ug/l	209	223	735	73	310

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 11). 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 5th 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 11) 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 7 shows the 2014 data summary for Kerr/Swede Gulch sample sites. Table 8 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 5-year data set shows no E. coli problem. The Association is also monitoring nitrogen and phosphorus, flow and standard field parameters. Technical Memorandum 2014.03 (BCWA, January 2015) summarizes all 2014 data for this special study.

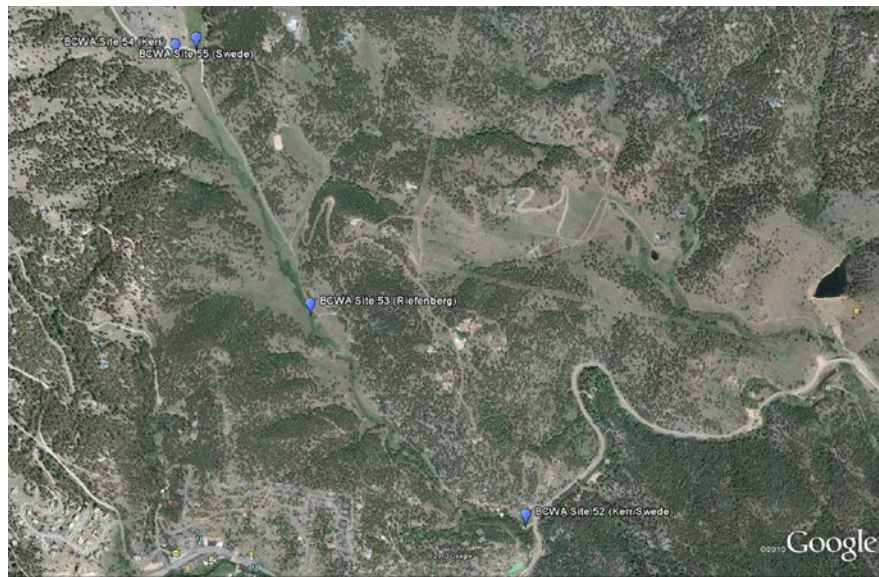


Figure 11 Kerr/Swede Gulch Sample Sites

Table 7 Kerr/Swede Gulch Data Summary

BCWA Site	Time	Temp (C)	pH	SC (ms/cm)	DO (mg/l)	E. Coli (CTS/100ml)
1/6/2014						
Site 52 - Confluence	12:40	0.6	8.15	1.00	12.2	1
Site 53 - Riefenberg	12:23	0.6	8.04	0.98	11.64	1
Site 54 - Kerr	12:10	0.6	7.82	0.944	11.26	1
Site 55 - Swede	12:05	0.3	7.68	1.08	11.74	5
2/10/2014						
Site 52 - Confluence	1:48	0.6	8.16	1.07	12.3	1
Site 53 - Riefenberg	2:02	0.5	8.1	1.08	12.02	1
Site 54 - Kerr	2:13	0.1	8.01	0.917	11.2	12
Site 55 - Swede	2:10	0.1	8.04	1.35	11.86	80
3/26/2014						
Site 52 - Confluence	1:20	4.5	8.11	0.94	11.23	1
Site 53 - Riefenberg	1:38	6.3	8.2	0.92	8.18	1
Site 54 - Kerr	1:55	7.7	8.06	0.9	9.57	4
Site 55 - Swede	1:50	6.7	8.02	1.001	9.62	2
4/21/2014						
Site 52 - Confluence	12:35	9.8	8.33	0.99	11.25	1
Site 53 - Riefenberg	12:45	10.6	8.25	1.02	10.5	1
Site 54 - Kerr	1:00	14.2	8.12	0.91	9.03	15
Site 55 - Swede	12:55	14.1	8.09	1.19	8.37	1
5/19/2014						
Site 52 - Confluence	12:20	13.1	8.26	1.00	9.4	1
Site 53 - Riefenberg	12:32	15	8.19	0.099	9.25	1
Site 54 - Kerr	12:43	17.1	8.06	0.92	7.86	3
Site 55 - Swede	12:40	16.9	7.26	1.12	7.12	3
6/16/2014						
Site 52 - Confluence	12:30	16.4	8.22	1.03	9.1	15
Site 53 - Riefenberg	12:40	17	8.08	1.02	8.67	7
Site 54 - Kerr	12:55	17.8	7.93	0.95	7.61	14
Site 55 - Swede	12:47	17.9	8.07	1.16	7.62	15
7/7/2014						
Site 52 - Confluence	12:10	17.8	8.06	1.01	7.89	25
Site 53 - Riefenberg	12:27	17.9	8.03	0.99	7.59	6
Site 54 - Kerr	12:43	18.6	7.99	0.97	7.17	21
Site 55 - Swede	12:37	17.9	8.07	1.16	7.14	30
8/18/2014						
Site 52 - Confluence	12:35	15.5	7.84	1.03	8.25	9
Site 53 - Riefenberg	12:51	14.6	8.13	1.03	7.29	3
Site 54 - Kerr	1:05	15.2	7.86	0.976	6.38	48
Site 55 - Swede	1:00	15.2	8.23	1.046	7.1	2
9/15/2014						
Site 52 - Confluence	12:17	12	8.14	1.021	10.12	1
Site 53 - Riefenberg	12:34	12.5	8.06	1.02	10.03	3
Site 54 - Kerr	12:50	13	7.87	0.985	8.72	1
Site 55 - Swede	12:43	14	7.98	1.117	8.72	10
10/20/2014						
Site 52 - Confluence	1:22	9	8.02	1.004	10.44	15
Site 53 - Riefenberg	1:34	10.6	8	1	9.8	3
Site 54 - Kerr	1:46	10.9	7.86	0.963	8.5	50
Site 55 - Swede	1:40	11.5	7.92	1.071	8.74	6
11/18/2014						
Site 52 - Confluence	1:25	0.6	8.04	1.016	12.39	1

BCWA Site	Time	Temp (C)	pH	SC (ms/cm)	DO (mg/l)	E. Coli (CTS/100ml)
Site 53 - Riefenberg	1:35	2.7	8.06	1.005	14.28	7
Site 54 - Kerr	1:52	0.3	8.05	0.0988	10.3	34
Site 55 - Swede	1:49	0.2	7.99	4.8	11.8	24
12/8/2014						
Site 52 - Confluence	1:10	1.1	8.13	1.014	12.66	12
Site 53 - Riefenberg	1:21	0.9	8.12	0.988	12.28	1
Site 54 - Kerr	1:35	0.3	8.1	0.93	12.19	1
Site 55 - Swede	1:30	1.6	8.01	1.073	11.89	1

Table 8 Kerr/ Swede Gulch E. Coli Geometric Mean Summary
E. coli Summary, Geometric Mean

BCWA Site	2010		2011						May- Oct n=24/6	
	May- Dec n=36	J-D (Annual) n=48	Jan- Feb n=8	Mar- Apr n=8	May- Jun n=8	Jul- Aug n=8	Sep- Oct n=8	Nov- Dec n=8		
	Sites 52-53			14	2	6	5	6		2
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
2014										
Sites 52-53			4	3	2	5	11	5	4	6
Site 52 - Confluence			3							6
Site 53 - Riefenberg			2							3
Site 54 - Kerr			8							11
Site 55 - Swede			6							7

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 9,000 septic systems in the watershed. The estimated total phosphorus load in 2014 from all sources reaching the reservoir was 4,010 pounds at a flow of about 35,000 acre-feet. Bear Creek drainage contributed 88% of the load (Figure 12). In comparison, the entire total phosphorus load in 2012 was 700 pounds. Although the point source discharges of total phosphorus were about 1,076 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.

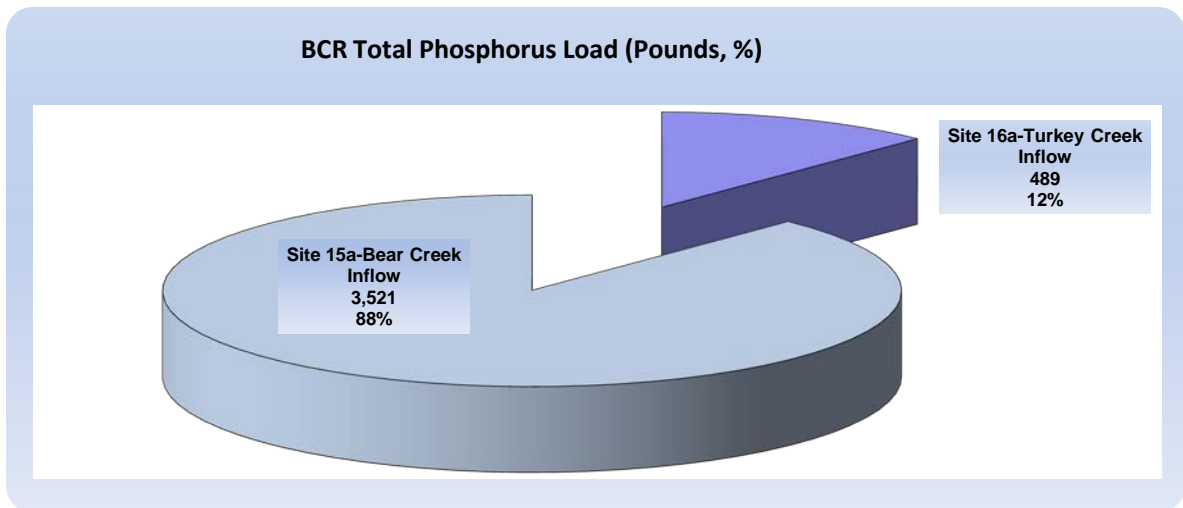


Figure 12 Estimated Total Phosphorus loading into Bear Creek Reservoir

The total nitrogen loading (Figure 13, about 52,000 pounds) was much lower than 2013 conditions (Figure 14) with 85% of the load coming from Bear Creek. Figure 16 shows the 2014 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 17 shows the total phosphorus reservoir trend. Figure 18 shows the nitrate concentrations at routine watershed monitoring stations. Figure 19 shows the total nitrogen trends.

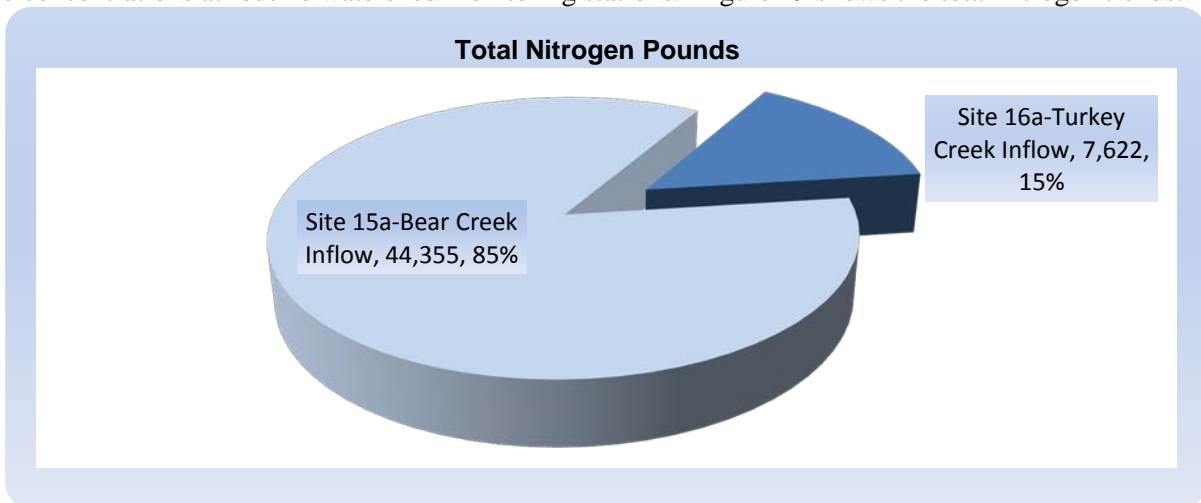


Figure 13 Total Nitrogen Loading into Bear Creek Reservoir

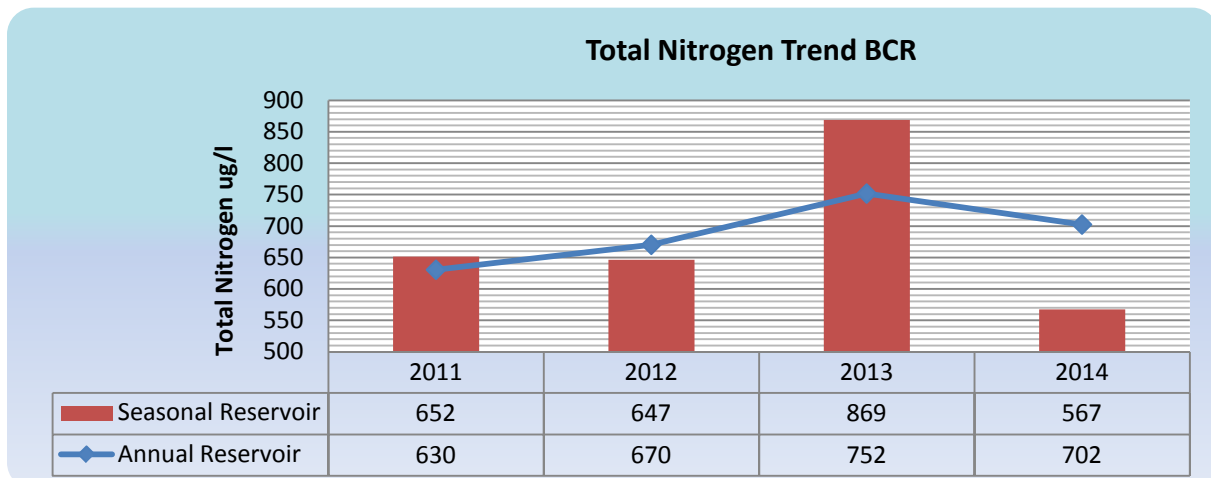


Figure 14 Estimated Total Nitrogen Loading Trend for Bear Creek Reservoir

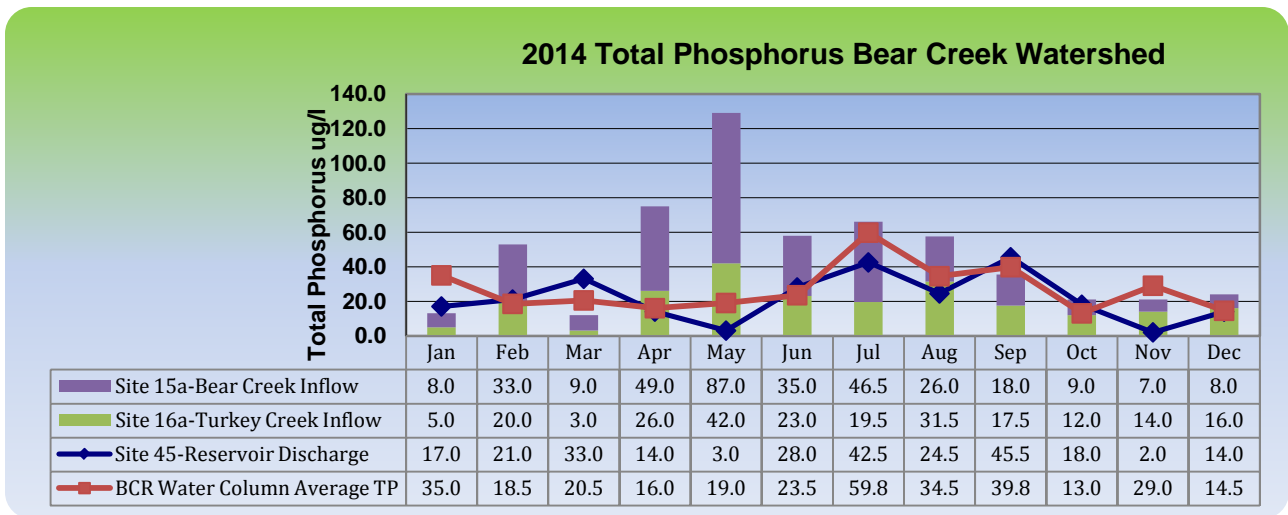


Figure 15 Total Phosphorus Annual Trend at Bear Creek Reservoir

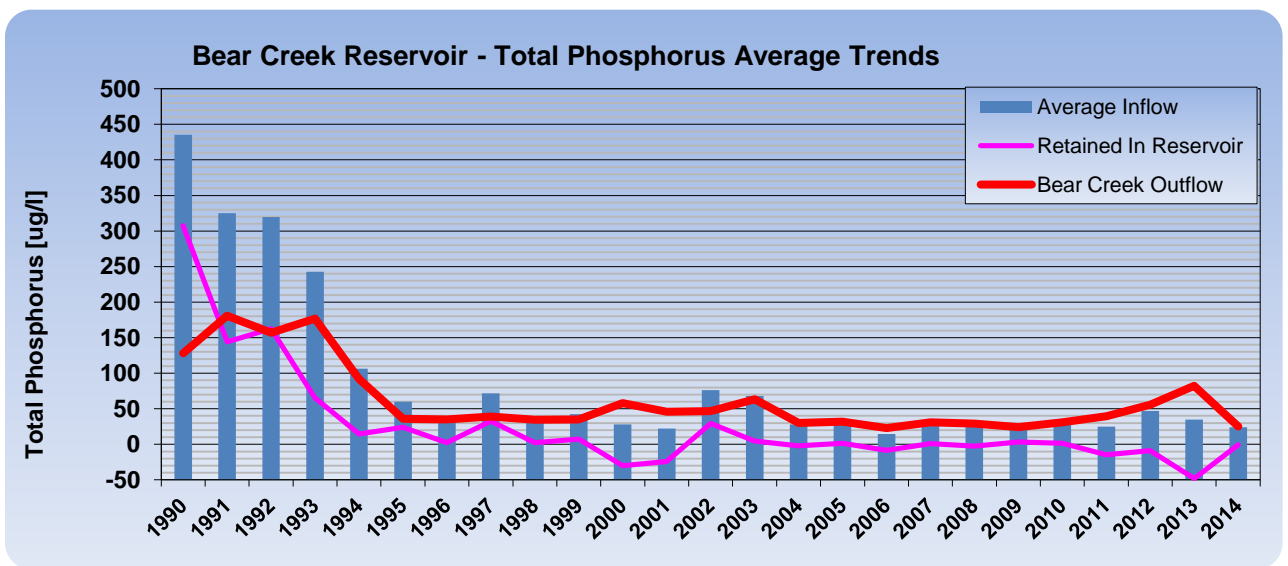


Figure 16 Annual Total Phosphorus Bear Creek Reservoir

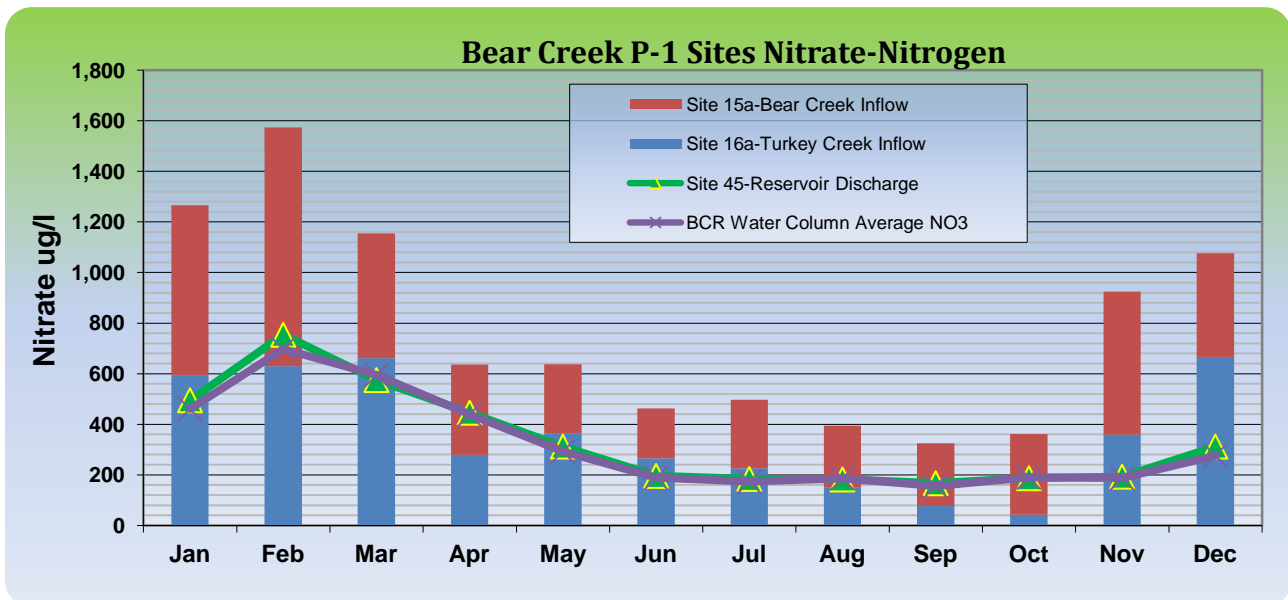


Figure 17 Bear Creek P-1 Sites Nitrate-Nitrogen Concentrations

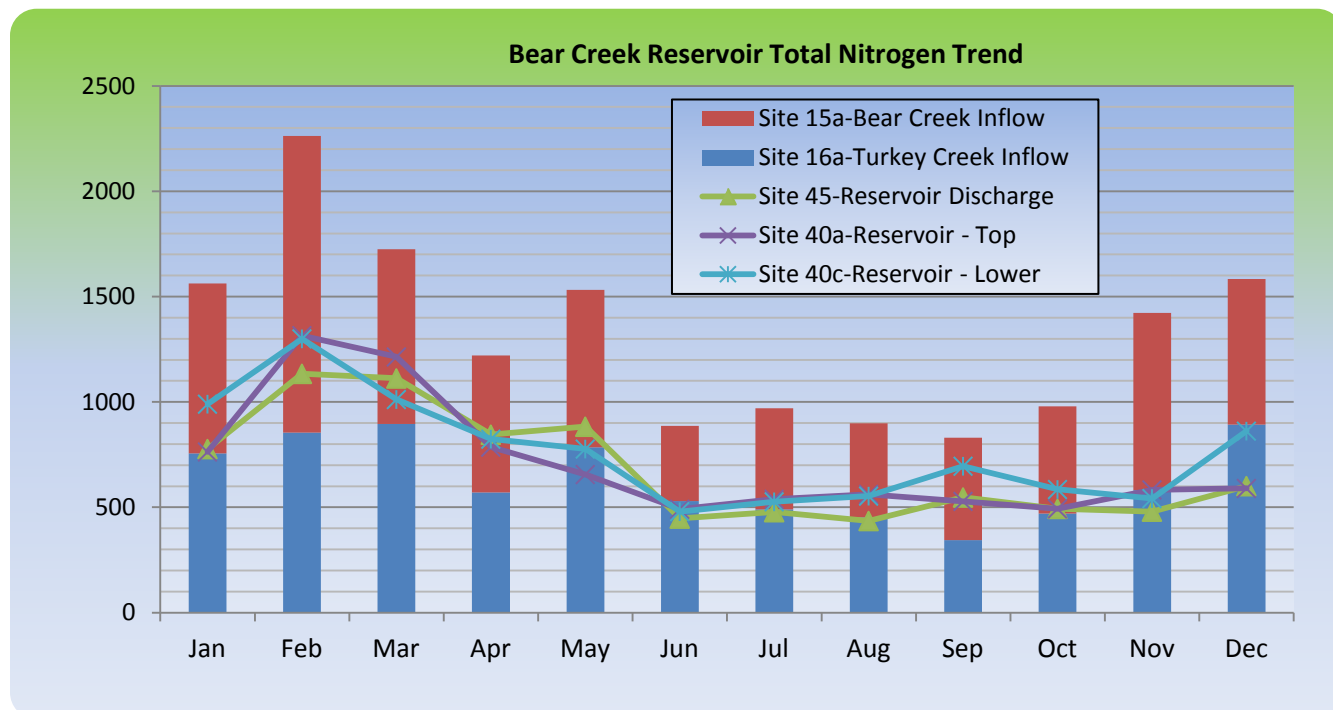


Figure 18 Total Nitrogen Bear Creek Reservoir

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 8 lists the summary statistics for the monitoring variables. Table 9 summarizes the reservoir loading data. Table 10 compares 2014 data with the long-term patterns from 1991 through 2013. In 2013, the chlorophyll and total phosphorus concentrations were below the long-term trends. Table 11 summarizes the phytoplankton data. Figure 21 shows the phytoplankton species diversity during summer sampling period. The dominance of diatoms was unusual. Figure 22 depicts the Biovolume of the functional groups, which was primarily bluegreens. Figure 23 shows the general clarity trend in the water column using Secchi measurements. May through August had the poorest clarity caused by runoff.

Table 9 Bear Creek Reservoir Summary Statistics (July September)

Reservoir Growing Season July to September

Reservoir Monitoring Parameters	Reservoir
Chlorophyll (Site 40)	
Average Growing Season Chlorophyll-a [ug/l (-1m)]	8.3
Average Annual Chlorophyll-a [ug/l (-1m)]	5.3
Peak Chlorophyll-a [ug/l]	18.3
Phosphorus	
Average Annual Total Phosphorus [ug/l]: Water Column	31
Average Annual Total Phosphorus [ug/l] -1m	25
Average Annual Total Phosphorus [ug/l] -10m	36
Growing Season Total Phosphorus [ug/l]: Water Column	45
Growing Season Total Phosphorus [ug/l]: -1m	33
Growing Season Total Phosphorus [ug/l]: -10m	56
Peak Annual Total Phosphorus [ug/l] Water Column	96
Average Annual Ortho Phosphorus ug/l] Water Column	11
Growing Season Average Ortho Phosphorus [ug/l] Water Column	18
Peak Annual Ortho Phosphorus [ug/l] Water Column	91.0
Nitrogen	
Average Annual Nitrate-Nitrogen [ug/l] Water Column	291
Growing Season Average Nitrate-Nitrogen [ug/l] Water Column	172

Reservoir Growing Season July to September

Reservoir Monitoring Parameters	Reservoir
Peak Annual Nitrate-Nitrogen [ug/l] Water Column	861
Average Annual Total Nitrogen [ug/l]: Water Column	702
Average Total Nitrogen [ug/l]: -1m	677
Average Total Nitrogen [ug/l]: -10m	728
Growing Season Total Nitrogen [ug/l]: Water Column	567
Growing Season Total Nitrogen [ug/l]: -1m	543
Growing Season Total Nitrogen [ug/l]: -10m	592
Clarity (All Profiles)	
Average Annual Secchi Depth (meters)	1.98
Growing Season Average Secchi Depth (meters)	1.33
Total Suspended Sediments	
Annual Average Total Suspended Sediments [mg/l]	7.8
Growing Season Average Total Suspended Sediments [mg/l]	10.5
Peak Total Suspended Sediments [mg/l]	23
Dissolved Oxygen (site 40 Profile)	
Annual Average at -1/2m - 2m [mg/l]	9.4
Annual Minimum at -1/2m - 2m [mg/l]	6.2
Seasonal Average at -1/2 - 2m [mg/l]	7.7
Seasonal Minimum at -1/2 - 2m [mg/l]	6.2
pH	
Annual Average at -1/2m - 2m [mg/l]	7.98
Annual Maximum at -1/2m - 2m [mg/l]	8.28
Seasonal Average at -1/2 - 2m [mg/l]	7.70
Seasonal Maximum at -1/2 - 2m [mg/l]	6.20
Specific Conductance	
Annual Average at -1/2m - 2m [uS/cm]	0.373
Annual Minimum at -1/2m - 2m [us/cm]	0.638
Seasonal Average at -1/2 - 2m [us/cm]	0.293
Seasonal Minimum at -1/2 - 2m [us/cm]	0.351
Phytoplankton Species (July- September)	
Anabaena flos-aquae	bluegreen
Aphanizomenon flos-aquae	
Microcystis aeruginosa	
Cryptomonas erosa	cryptophyte
Rhodomonas minuta	
Fragilaria crotonensis	diatom
Melosira ambigua	
Navicula cryptocephala	
Stephanodiscus niagarae	
Ceratium hirundinella	dinoflagellate
Ankistrodesmus falcatus	Green
Peak Phytoplankton	
Anabaena flos-aquae, Peak Biovolume (um ³ /mL) = 787,726	
Stephanodiscus niagarae, Peak Biovolume (um ³ /mL) = 593,524	

Table 10 Annual Bear Creek Reservoir Load Estimates

Loading - Annual Pounds	
Total Nitrogen -Total Load In to BCR	52,907
Total Nitrogen -Total Load From BCR	63,229
Total Nitrogen -Total Deposition into BCR	-10,322
Total Phosphorus -Total Load In to BCR	3,923
Total Phosphorus -Total Load From BCR	1,841
Total Phosphorus -Total Deposition into BCR	2,082
TSS -Total Load In to BCR	1,537,557
TSS -Total Load From BCR	967,137
TSS -Total Deposition into BCR	570,420

Table 11 Bear Creek Reservoir Select Trend Parameters

Parameter		2014	91-2014 Mean	91-2014 Median
Chlorophyll-a (ug/L)	Top	5	14	15
Total Nitrogen ug/l	Top	677	637	637
	Bottom	728	619	619
	Water Column	703	628	628
Nitrate-Nitrogen (ug/L)	Top	307	313	289
	Bottom	274	284	244
	Water Column	291	299	266
Total Phosphorus (ug/L)	Top	25	58	40
	Bottom	36	81	60
	Water Column	31	67	50
Total Suspended Solids (mg/L)	Top	5	7	6
	Bottom	10	11	10
	Water Column	8	8	8
Secchi Depth (m)	Top	2	2.2	2.2

Table 12 Bear Creek Reservoir Phytoplankton Summary Data

	July	August	September
Total Density (#/mL)	358	413	16,706
Total Biovolume (um ³ /mL)	578,501	447,807	759,215
Trophic State Index:	45	43	45
Functional Group	Species	Ave Density #/ml	Average Biovolume, um ³ /mL
bluegreen	3	4661	155,795
chrysophyte	4	7	617
cryptophyte	2	65	25,555
diatom	44	10	14,171
dinoflagellate	1	3	33,564
green	7	17	2,364
euglenoid	1	8	14,967

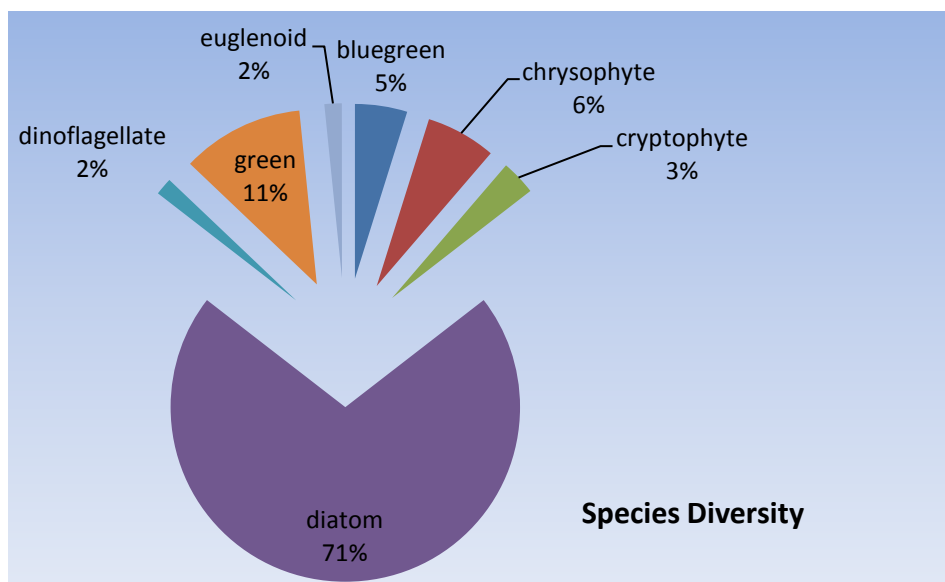


Figure 19 Bear Creek Reservoir Phytoplankton Species Diversity

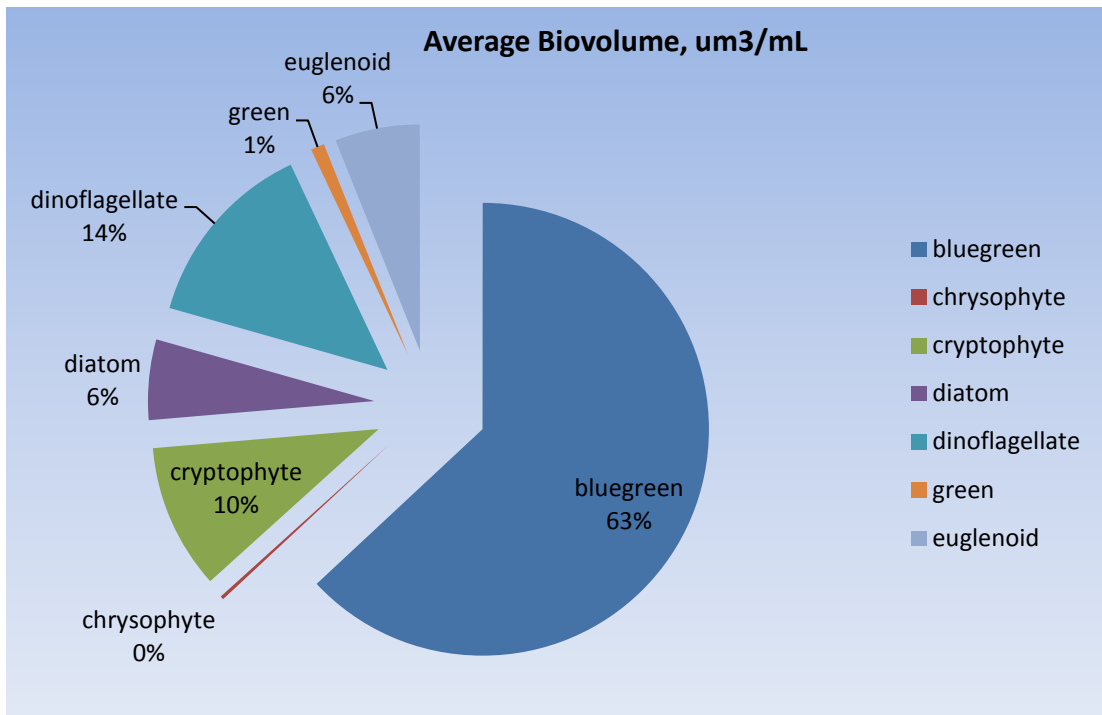


Figure 20 Phytoplankton Average Biovolume by Functional Group

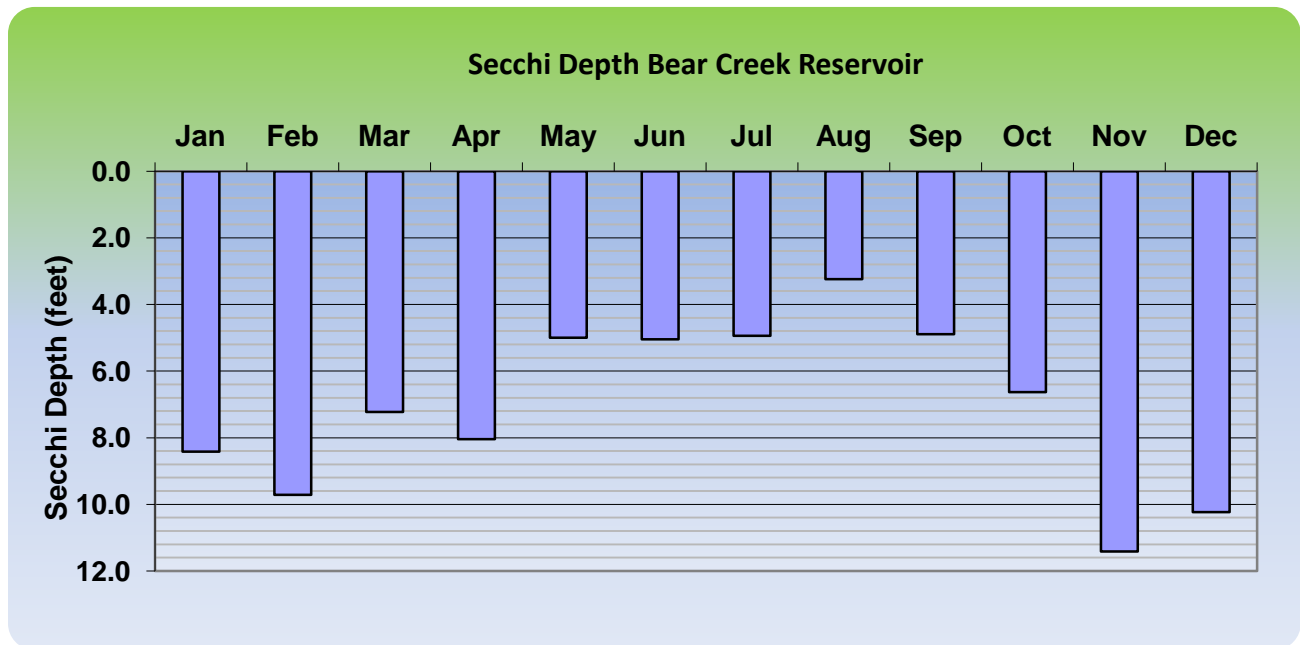


Figure 21 Secchi Depth Bear Creek Reservoir

The reservoir had several algal blooms in 2014 as evidenced by the peak July chlorophyll concentration of 18.3 $\mu\text{g/l}$ (Figure 24). The peak phytoplankton Biovolume was 787,726 $\mu\text{m}^3/\text{mL}$ 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 25). 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.

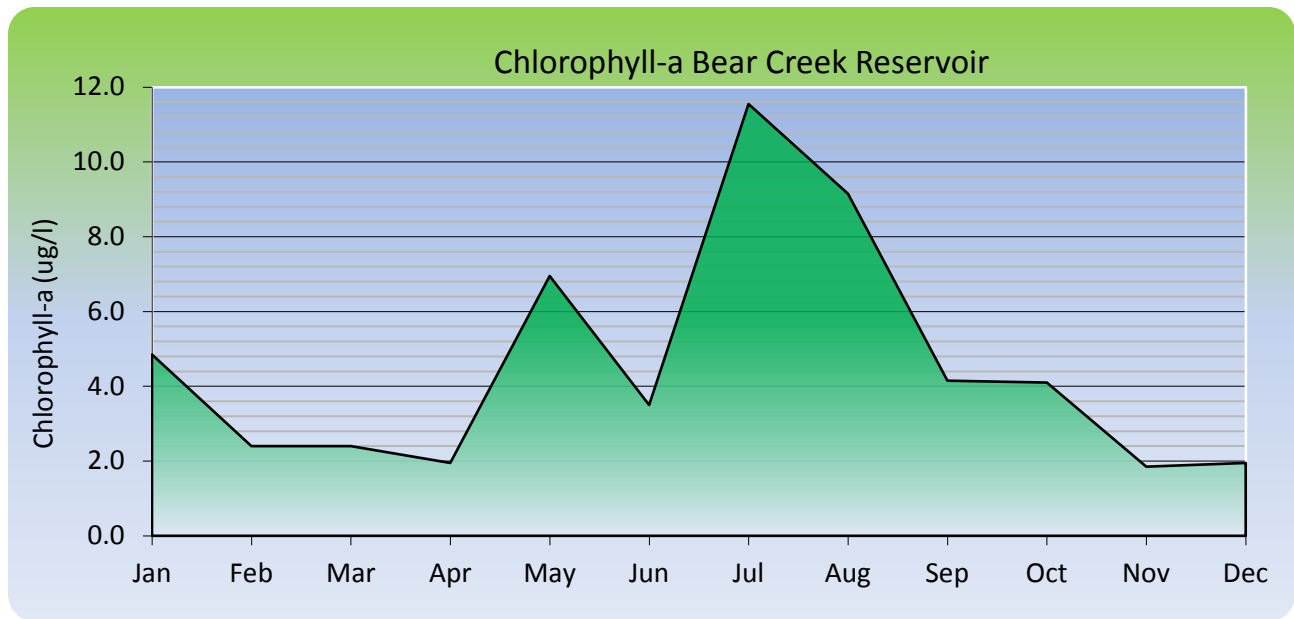


Figure 22 Bear Creek Reservoir Chlorophyll Trend

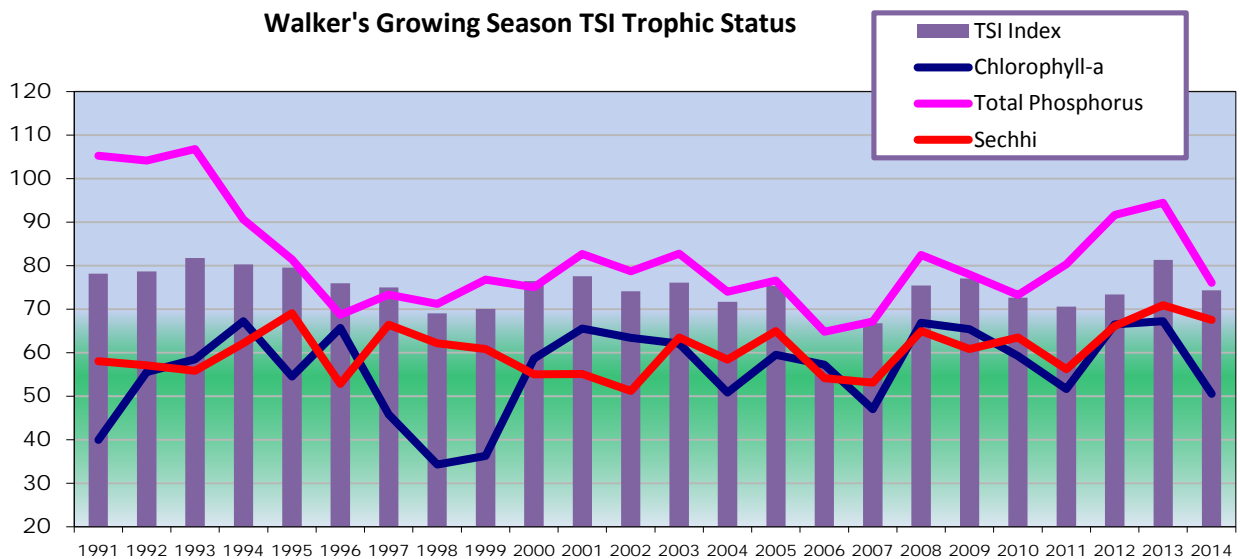


Figure 23 Walker Trophic Index Trend Bear Creek Reservoir

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 26) 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 2014, the Association and Lakewood operated the aeration system to assure oxygen transfer during phased on-off cycling (Figure 27), 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 was assessed by Lakewood and the BCWA in 2014.



Figure 24 Fishing Very Popular on Bear Creek Reservoir, Both Winter and Summer

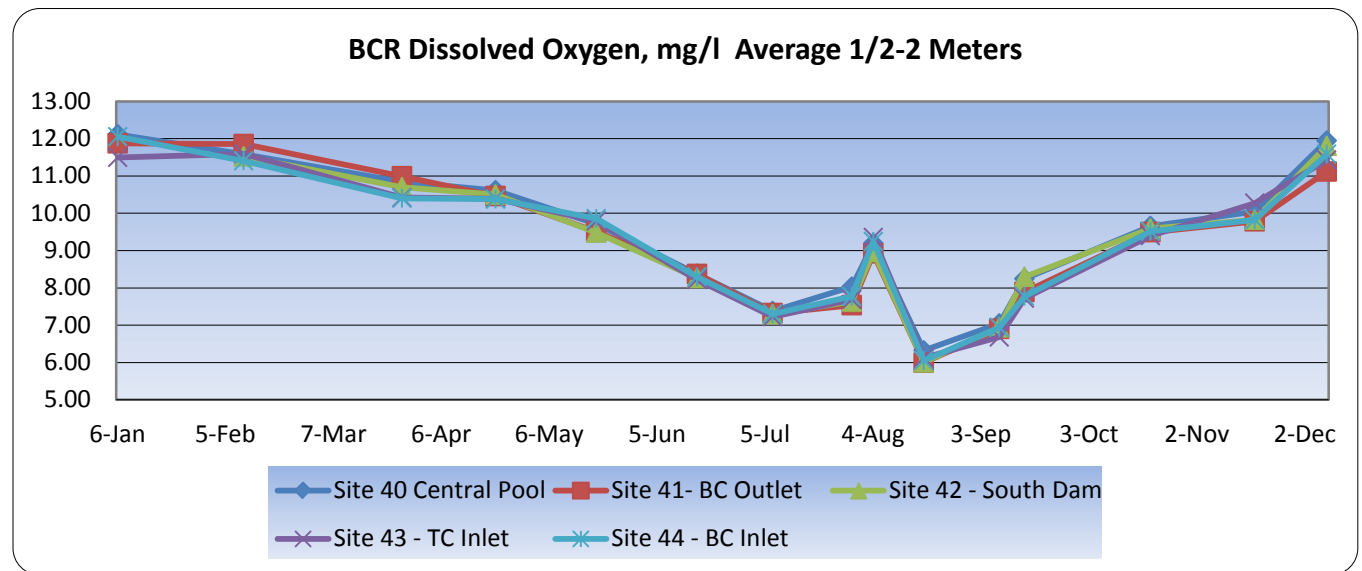


Figure 25 Bear Creek Reservoir Dissolved Oxygen Trend

Upgraded Aeration System BCR

The September 2013 flood event used Bear Creek Reservoir as a major flood control structure, which caused displacement and reduced efficiency of the in-reservoir aeration system as installed by the City of Lakewood and monitored by the BCWA (*BCWA Fact Sheet 6 Aeration BCR*). A video survey was completed on the BCR aeration system on April 30, 2014 (*BCWA TM2014.01 BCR Video Survey Aerators*). The survey demonstrated air supply line damage (kinks and holes), aeration pan displacement, overturned aeration pans, reduced function, and some losses, which reduced the overall system efficiency by 40-70% (*BCWA Fact Sheet 47 New BCR Aeration System*).

Since FEMA requires *like-kind* replacement, Lakewood determined it would be more cost effective to upgrade and replace the aeration system using Lakewood funding. The BCWA assisted with new aeration configuration, system requirements and replacement options. BCWA and Lakewood staff removed most of the old aeration

system and recycled these materials. The company *Underwater Repairs Specialist* installed 6 Quad Duraplate Diffusers (DDP9X4 Keeton Industries) and weighted line in November 2014 with assistance of Lakewood staff that corresponds to the pattern shown below. The diffusers are fine bubble (air supplied by a 15 hp compressor) and they will increase the dissolved oxygen transfer into the reservoir water column. Lakewood and BCWA will conduct an evaluation on the effectiveness and efficiency of the new aeration system in the spring/ summer growing season of 2015.



Figure 26 New BCR Aeration Configuration

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 2013 flood event introduced extremely large amounts of sediments.

The BCWA had 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 12) and Bear Creek Reservoir (Table 13). 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. In September 2014, the BCWA collected sediment samples from six locations in BCR. Sediments were analyzed for total phosphorus content (Table 14) and organic content (*BCWA TM 2014.13 BCR Sediment Survey*).

Table 13 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 14 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

Table 15 Phosphorus Content of BCR Sediments

Transect		2010	2011	2012	2012 SePRO	2014
		mgP/kg Mud	mgP/kg Mud	mgP/kg Mud	TP Sed, Mg/kg	mgP/kg Mud
		Filter	Filter	Filter	EPA 365.3, Modified	Filter
Bear Creek Transect	SedBC01	2.64	2.42	1.30		
	SedBC02	6.43	4.37	4.99		
	SedBC03	4.12	6.11	3.06	844.92	4.48
	SedBC04	5.32	2.75	4.61		
	SedBC05	3.50	5.21	4.38	1129.92	3.06
	SedBC06	4.09	1.08	4.56		
Pelican Point Transect	SedPel07	5.39	4.14	2.47		
	SedPel08	7.47	3.39	4.89	1100.76	8.07
	SedPel09	6.25	11.50	3.34		
	SedPel10	3.13	2.20	3.19	1052.08	5.69
	SedPel11	7.71	6.86	4.66		
Turkey Creek Transect	SedTC12	2.69	0.52	0.38		
	SedTC13	1.74	3.22	0.93	632.82	
	SedTC14	7.32	8.11	3.88		3.79
	SedTC15	6.99	8.15	3.18		
	SedTC16	5.76	1.91	3.90	831.88	4.85
	SedTC17	8.16	3.18	1.34		

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 16). 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 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 2014 monitoring program (Table 16). The Association monitoring program data to supports the designation of Evergreen Lake as a direct use water supply.

Table 16 Water Quality Data Summary for Evergreen Lake

Evergreen Lake, Segment 1d								
Site	Parameter (ug/l)	5/14/2014	6/16/2014	7/7/2014	8/20/2014	9/15/2014	10/6/2014	Average
EGL 4a	Total Nitrogen	272	290	288	321	275	191	273
	Nitrate/Nitrite as N, dissolved	49	68	23	42	33	39	42
	Nitrogen, ammonia	29	23	5	28	25	37	25
	Phosphorus, total	19	17	15	14	9	25	17
	Total Dissolved Phosphorus	9	5	2	6	2	8	5
	Residue, (TSS)	4.0	13.6	7.4	7	14.4	5.6	9
	Chlorophyll a	1.5	1.2	7.7	6	3.2	1.8	4
	Chlorophyll a	1.5	1.5	7.4	7	3.5	2.5	4
	Chlorophyll a Average	1.5	1.4	7.6	6.3	3.4	2.2	4
EGL 4e	Total Nitrogen	241	333	254	292	187	232	257
	Nitrate/Nitrite as N, dissolved	45	65	28	43	39	38	43
	Nitrogen, ammonia	41	31	15	43	34	38	34
	Phosphorus, total	22	21	12	30	21	26	22
	Total Dissolved Phosphorus	7	6	2	2	2	2	4
	Residue, Non-Filterable (TSS)	4.0	11.2	10.6	12	9.2	5.6	9
	Parameter Summary	5/14/2014	6/16/2014	7/7/2014	8/20/2014	9/15/2014	10/6/2014	
Water Column	Dissolved Oxygen 1/2-2m	10.89	9.73	8.31	7.05	9.63	10.00	
	Temperature (C) 1/2-2m	6.98	12.82	17.13	15.43	11.75	9.65	
	pH water column	7.70	7.86	8.00	7.53	7.98	7.75	
	Specific Conductance (us/m)	0.100	0.068	0.074	0.067	0.071	0.072	
	Bear Creek In-Flow (cfs)	30	84	50	46	34	32	

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 2003-2014 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 2014 were greater than 6 mg/l (Figure 27). Data collected in the 2014 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.

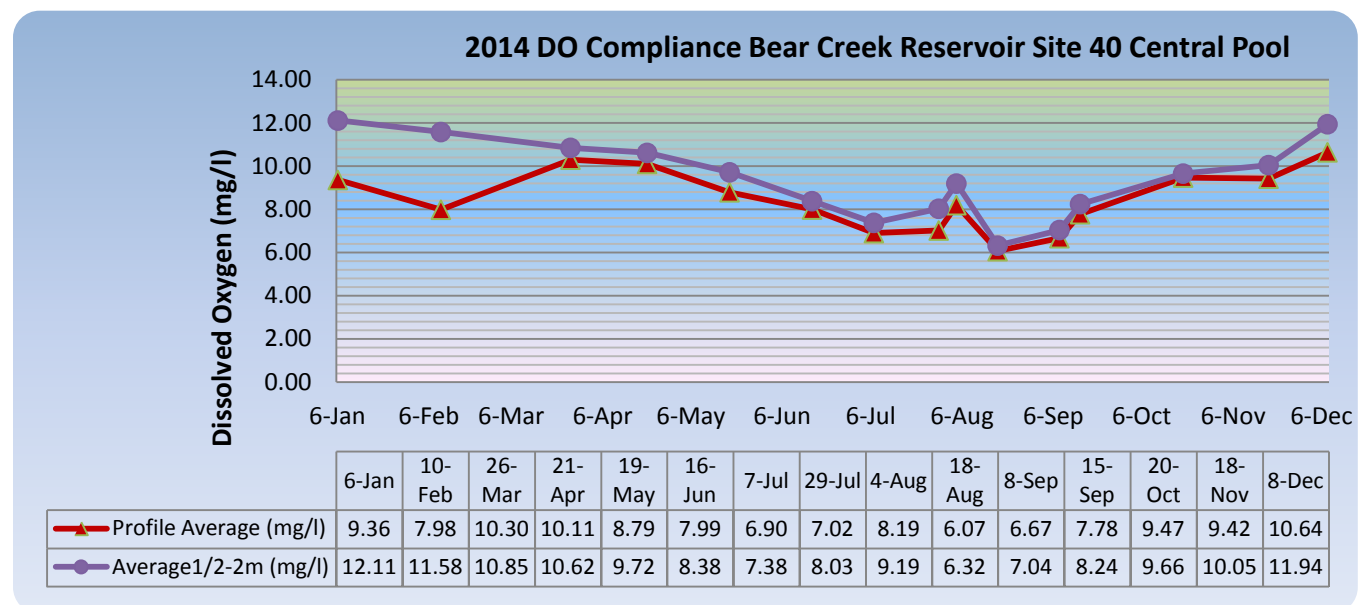


Figure 27 DO Compliance Bear Creek Reservoir

Temperature Standards Bear Creek Watershed

Table 17 shows the adopted temperature standards by segment for the watershed.

Table 17 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 28 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); two of the probes were lost during the summer season. Table 18 summarizes the temperature record for the -1m and -2m probes. The reservoir had no temperature exceedances in 2014.

Table 18 Temperature Compliance Summary Bear Creek Reservoir

Segment 1c Datalogger Temperature Summary 2014								
All Temperatures in °C	30-Min Temp. COLD/WARM SEASON		Nov 1-Mar 31 Stream Std. WAT (9°C)	Nov 1-Mar 31 2-Hr Avg. Temp.	Nov 1-Mar 31 Stream Std. DM (13°C)	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	6.36	2.53		6.42	6.94	6.01	2.84	3.88
Max	8.22	21.72		8.10	8.10	20.75	21.49	21.49
Avg	7.12	15.00		7.12	7.51	15.03	15.00	15.40
Measurements	480	22222		120	10	66	5554	462
# 9°C WAT exceeded								
% Compliance WAT								
# 13°C DM exceeded				0				
% Compliance DM				100%				
# 23.3°C WAT exceeded						0		
% Compliance WAT						100%		
# 23.8°C DM exceeded								0
% Compliance DM								100%

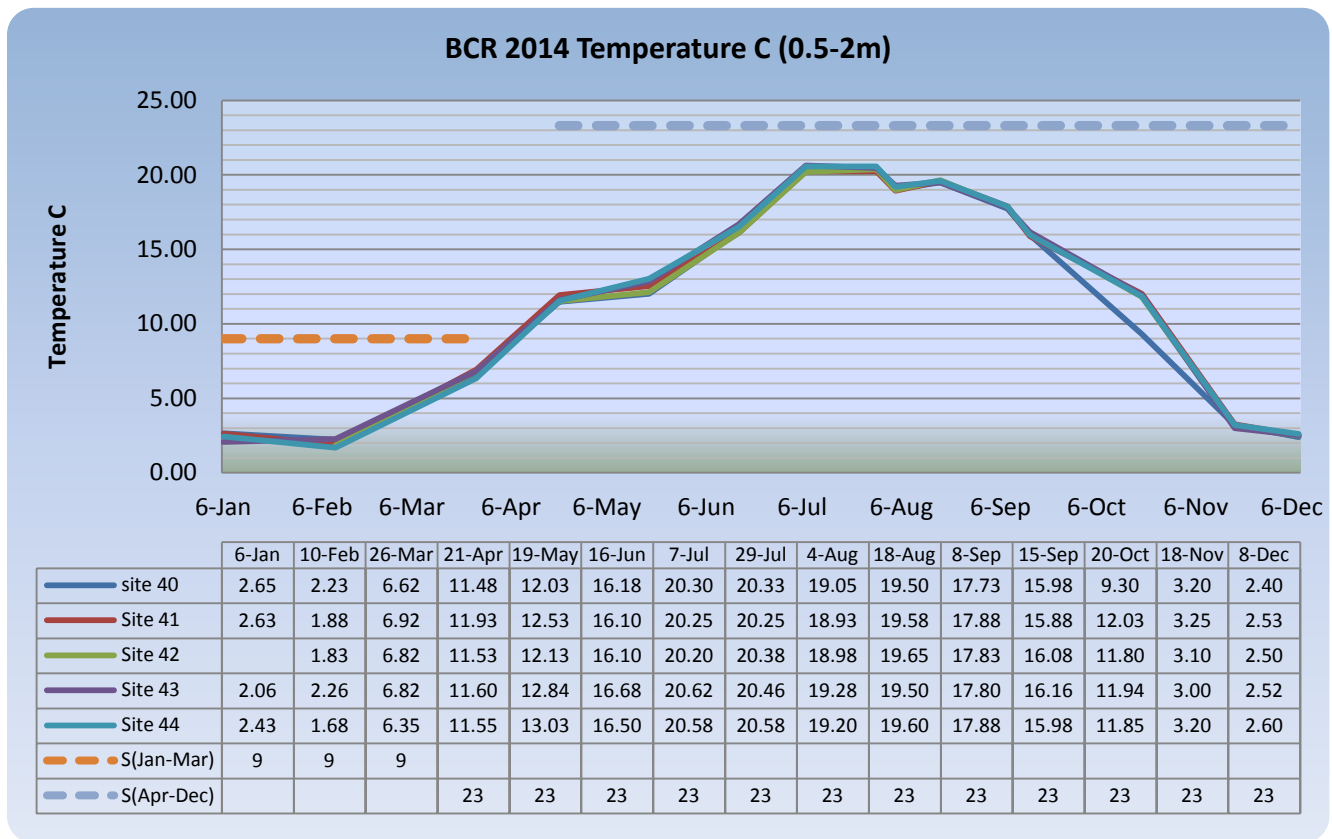


Figure 28 Temperature Compliance Bear Creek Reservoir

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 2014 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.

268,032 individual temperature data points were obtained from the twenty-eight data logger sites within the watershed (excluding the WWTP data). The warm-season and cold-season temperature compliance summary is shown in Table 19. A limited number of temperature compliance problems occurred in both the warm and cold seasons.

Table 19 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	0	0	0
% Compliance	100%	100%	100%	100%
Segment 1a	9°C WAT	13°C DM	17°C WAT	21.2°C DM
# Exceedances	0	1	0	0
% Compliance	100%	99%	100%	100%
Segment 1d	9.0°C WAT	13.0°C DM	18.2°C WAT	23.8°C DM
# Exceedances			0	0
% Compliance			100%	100%
Segment 1e	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 1b	9°C WAT	13°C DM	19.3°C WAT	23.8°C DM
# Exceedances	6	14	0	0
% Compliance	67%	90%	100%	100%
Segment 5	9°C WAT	13°C DM	18.2°C WAT	23.8°C DM
# Exceedances	4	17	0	0
% Compliance	88%	79%	100%	100%
Segment 6a	9°C WAT	13°C DM	18.2°C WAT	23.8°C DM
# Exceedances	0	0	0	0
% Compliance	100%	100%	100%	100%
Segment 6b	9°C WAT	13°C DM	17°C WAT	21.2°C DM
# Exceedances	0	1	0	0
% Compliance	100%	99%	100%	100%
Segment 2	13.7°C WAT	14.3°C DM	27.5°C WAT	28.6°C DM
# Exceedances	0	0	0	0
% Compliance	100%	100%	100%	100%
Segment 1c	9°C WAT	13°C DM	24.0°C WAT	26.0°C DM
# Exceedances		0	0	0
% Compliance		100%	100%	100%

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 20). 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 2014 watershed-monitoring program occurred at Summit Lake.

Table 20 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/NO2-N (10,000ug/L)*	Proposed Stream Std Total Phosphorous (110 ug/L)
Segment 8					
# Exceedances	1	0	0	0	0
# Measurements	4	4	4	4	4
% Compliance	75%	100%	100%	100%	100%
Segment 7					
# Exceedances	4	4	0	0	3
# Measurements	12	12	12	12	12
% Compliance	67%	67%	100%	100%	75%
Segment 3					
# Exceedances	0	0	0	0	0

	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/NO2-N (10,000ug/L)*	Proposed Stream Std Total Phosphorous (110 ug/L)
# Measurements	6	6	6	6	6
% Compliance	100%	100%	100%	100%	100%
Segment 1a					
# Exceedances	0	0	0	0	0
# Measurements	17	17	17	17	17
% Compliance	100%	100%	100%	100%	100%
Segment 1d					
# Exceedances	0	0	0	0	0
# Measurements	60	60	12	12	12
% Compliance	100%	100%	100%	100%	100%
Segment 1e					
# Exceedances	0	0	0	0	0
# Measurements	36	36	36	36	36
% Compliance	100%	100%	100%	100%	100%
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	6
# Measurements	72	72	72	72	72
% Compliance	100%	100%	100%	100%	92%
Segment 6a					
# Exceedances	0	0	0	0	0
# Measurements	21	21	21	21	21
% Compliance	100%	100%	100%	100%	100%
Segment 6b					
# Exceedances	0	0	0	0	0
# Measurements	6	6	6	6	6
% Compliance	100%	100%	100%	100%	100%
Segment 4a					
# Exceedances	0	0	0	0	0
# Measurements	6	6	6	6	6
% Compliance	100%	100%	100%	100%	100%
Segment 2					
# Exceedances	0	0	0	0	0
# Measurements	15	15	15	15	15
% Compliance	100%	100%	100%	100%	100%

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

303(d) Listing

Table 21 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 21 303(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

WBID	Segment Description	Portion	Colorado's Monitoring & Evaluation	Clean Water Act Section 303(d) Impairment	303(d) Priority
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 2014, the average Total Phosphorus at BCWA site 45 was 2,179 pound/year (*BCWA TM 2014.08 Barr Milton TMDL Summary*). The Association annually provides the Barr/Milton Watershed Board a technical memorandum detailing water quality data at site 45 BCWA TM 2014.08, 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 22 summarizes existing macroinvertebrate data. There was macroinvertebrate sampling done in 2014 (*BCWA TM2014.14 Macroinvertebrate Summary*).

Table 22 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 23 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 23).

Table 23 Treatment Facility Wasteload Allocations

Bear Creek Watershed Wastewater Treatment Plants by Drainage Basin	WQCC Adopted Phosphorus WLA Pounds/ year	2014 Discharged Phosphorus Pounds/year	% Allocation Used by WWTF
Bear Creek Drainage			
Jefferson County Schools – Mt. Evans Outdoor Lab	20	6.36	32%
Brook Forest Inn	5	1.4	28%
Evergreen Metropolitan District	1,500	286.52	19%
West Jefferson County Metro District	1,500	384.56	26%
Kittredge Sanitation and Water District	240	71.31	30%
Genesee Water and Sanitation District	1,015	251.98	25%
Forest Hills Metropolitan District	80	23.55	29%
Town of Morrison	600	40.9	7%
<i>Bear Creek Total</i>	4,960	1,066.6	22%
Turkey Creek Drainage			
Conifer Metropolitan District	40	Land Applied	0%
Conifer Sanitation Association	40	1.7	4%
Aspen Park Metropolitan District	40	4.4	11%
Jefferson County Schools - Conifer High School	110	1.05	1%
Geneva Glen ¹	5	Land Applied	0%
Bear Creek Development Corp. - Tiny Town ²	5	Hauling Columbia	0%
The Fort ³	18	No Monitoring	0%
<i>Turkey Creek Total</i>	258	7.2	3%
Total Operational Facilities Lbs/year	5,218	1,073.73	21%
Reserve Pool	37	0	0%
Total Phosphorus Wasteload lbs/year	5,255		

1-Geneva Glen treatment system land applies, no Reported Pounds

2-Records from Columbia Sanitary show they hauled 72,400 gallons in the 2014 operation season

3-Permit; No established monitoring

Permit Compliance and Plant Expansions/Actions

Table 24 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, review efforts for all facilities, and produced a series of new information sheet specific for dischargers.

Table 24 Wastewater Treatment Plant Planning Status

Facility	Wastewater Utility Plan	Electronic Planning Documents	Recent Upgrades	Facility Upgrades [2014-2017]	Compliance Concerns	Informational Sheet
Evergreen Metropolitan District	Yes	WQCD Fact Sheet, WQA, Permit	Lift Stations	Yes	Mixing zone, TIN	IFS01
West Jefferson County	Yes	WQCD Fact Sheet, WQA, Permit	No	Yes	Temp Monitoring, Mixing zone, TIN	IFS03
Genesee	Yes	Permit	No	No	No	IFS04
Morrison	Yes	WQCD Fact Sheet, WQA, Permit, Amendment	New Plant	No	No	IFS05
Kittredge	Yes	WQCD Fact Sheet, WQA, Permit	No	Yes	Mixing zone, TIN	IFS02
Forest Hills Metropolitan District	Yes	Site Application Engineering Report, Permit (2009)	New Plant	No	WLA/TP limit	IFS06
Conifer Metropolitan	Yes	WQCD Fact Sheet, WQA,	No	No	No	IFS08

Facility	Wastewater Utility Plan	Electronic Planning Documents	Recent Upgrades	Facility Upgrades [2014-2017]	Compliance Concerns	Informational Sheet
District		Permit				
Conifer Sanitation Association	Yes	Lift Station Rpt	Site Maintenance	Yes	No	IFS08
Aspen Park Metro District	Yes	WQCD Fact Sheet, WQA, Permit	Infiltration gallery, Outfall	Yes	Gallery Operation	IFS07
Jefferson County Schools Conifer High School	Yes	Site Application, Lift Station	Lift Stations, UV	Yes	Ammonia, TRC, UV	IFS10
Jefferson County Schools Mt Evan Outdoor	Yes		New Facility Design (In Progress)	Yes (New Plant)	WLA/TP limit	IFS11
Bear Creek Development Corp. - Tiny Town	No	Land Application Rpt	Hauling Columbia	Yes	Reporting, WLA	No
Bear Creek Cabins	No	Permit	No	Close Permit, Convert OWTS	No	No
Brook Forest Inn	No	WQCD Rational, WQA, Permit, Review	New upgrades	Yes	WLA/TP limit	IFS09
Geneva Glen	No		No	Better Monitoring	Reporting, WLA/TP limit	No
The Fort	Yes	Site Application	New Treatment Works, Monitoring	Yes, Connect to Willowbrook	No	IFS12
Singing River Ranch	No	WQCD Fact Sheet, WQA, Permit	Plugged Influent	Close Permit, Convert OWTS	No	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 25 lists all Association trades. The reserve pool was increased to 37 pounds in 2014, due to the closure of two WWTFs. The trades in the watershed remain consistent with the total wasteload allocations listed in Table 25. The Association has developed three 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 25 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 2014, Municipal Stormwater Permit No.: COS-000002*; City of Lakewood, April 1, 2015). The Stormwater Management Program for the City of Lakewood, Part I.B.1 of the City’s permit, consists of five different programs: Commercial/Residential Management Program, Illicit Discharges Management Program, Industrial Facilities Program, Construction Sites Program, and Municipal Facility Runoff Control Program. During the permit period in 2014, there were 1,282 inspections of construction sites and 535 enforcement actions.

Lakewood supports many stormwater management programs in the watershed, including the *Rooney Road Recycling Center*, which also serves as watershed prevention BMP. Household hazardous waste (includes electronic waste, household chemicals, paints, propane cylinders and automotive products) materials collected at the facility since 1994 total more than 5,300,608 lbs of potential surface water and ground water pollutants. Unfortunately, yard waste, construction lumber and tree limbs are no longer collected at the facility to be, ground, chipped and 100% recycled into mulch and compost. 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 (Table 26). 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 continues to participate with Rooney Road Recycling Facility and in 2014 the facility collected over 380,000 pounds of household hazardous waste. Jefferson County participated in a number of public events to reach diverse audiences for their MS4 and floodplain management programs.

Table 26 Summary of 2014 MS4 Programs for Inspections and Enforcement Actions

Land Use Agency	Permit Inspections			Permit Enforcement Actions		
	Illicit Discharges	Construction	Post Construction	Illicit Discharges	Construction	Post Construction
Jefferson County	9	1592	40	9	61	0

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.

Jefferson County regularly reports to the Association on stormwater management practices and programs. More information about Jefferson County’s municipal stormwater program is contained in their CDPS Stormwater Permit Annual Report.

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

Onsite Wastewater Treatment System Management

In 2014, 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 onsite wastewater treatment system (OWTS) regulations. The Association predicts OWTS in a number of specific areas in the Bear Creek Watershed contribute to water quality degradation. There are 9,000 +onsite systems in the watershed, depending on the estimation method. Based on existing county taxing records, there are an estimated 12,000+ 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 OWTS: Kerr/Swede Gulch and Cub Creek. The Kerr/Swede Gulch focus on a limited number of OWTS (<35) that potential add nutrients to the lower portion of the drainage between site 52(Confluence) and site 53 (Riefenberg) (Figure 29). The monitoring program suggests there is a nutrient load that is potentially related to OWTS discharge.

The Association is also monitoring upstream and downstream on Cub Creek where there are > 1,000 OWTS. 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%.

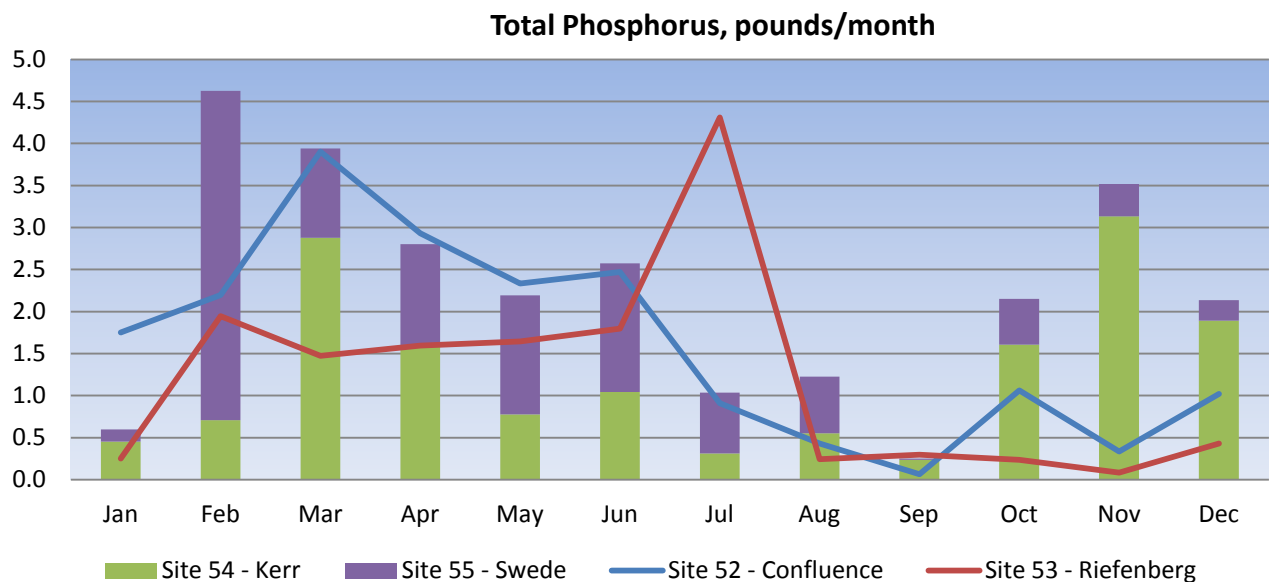


Figure 29 Onsite System Study - Comparison of Total Phosphorus Between Sites 52 and 53

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 2014, 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.

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.

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)

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. The Association newsletter reaches over 200 watershed citizens.

[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. There were 107 education programs for 3,874 participants (does not include outreach events). The Association has developed education materials, handouts and otherwise supported the park programs. There was a total visitation for BCLP of 411,522 visitors, excluding bicyclists. The city estimated use for Green Mountain and the Bear Creek Greenbelt (from trail cameras, preliminary estimates) at over 240,000 with the Greenbelt use over 200,000 for Green Mountain.

[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.

[Wilnot Elementary School in Evergreen](#)

Annually, the fourth grade classes at Wilnot 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 2014.02 - 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 and the 2014 water quality data suggests this helped resolve part of the nutrient loading.

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.

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

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 is 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

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 2014, there was approximately 5,000 cubic yards of sediment removal from the inlet channel. 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.

El Pinal Wastewater Lift Station.

In 2014, EMD made improvements to the El Pinal Wastewater Lift Station located adjacent to the headwater of Troublesome Creek. Two 15,000 gallon holding tanks were added to the station along with an improved bar screen and grit chamber. The additional capacity will allow for a longer operator response time in case of a mechanical or electrical failure. This new lift station will reduce the risk of sanitary overflows to the adjacent creek.

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 27). The Association has monitored flow and limited chemistry since March 2006 in Coyote Gulch. The Association Technical memorandum Coyote Gulch Summary (TM 2014.04) provides a detailed summary of the monitoring program and data analysis. Table 28 identifies the annual available total phosphorus trade pounds consistent with the Association trade program. Based on six years of data, there is 88 pounds of total phosphorus available for the trade program. Figure 30 shows the total phosphorus reduction. The Coyote Gulch restoration project is an effective phosphorus reduction project and management practice.

Table 27 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		
	2007-2008	128.7	4.4	160.9	5.2
Post-Construction	2009*	142.0	6.7	185.9	8.9
	2010*	203.7	8.1	222.3	8.5
	2011*	103.0	6.1	163.9	7.0
	2012	106.6	2.7	104.4	4.8
	2013	80.6	4.6	78.8	4.7
	2014	90.3	4.4	131.4	4.8
			Loading Pounds After Stable		
		Reservoir		Above Project	
		Nitrate	T. Phos	Nitrate	T Phos
Total Pounds		9,607	600	11,461	690
Average		163	10	194	12
Median		90	4	120	5

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

Table 28 Coyote Gulch Total Phosphorus Trade Pounds

Total Phosphorus Trade Pounds				
	Total Base Flow		Trade Ration Pounds	
	Monthly	Annual	Monthly	Annual
Average	5.3	63.5	7.3	88.0
Median	4.6	55.2	7.7	92.2
<i>Monthly TRP=PC Base Load-TBF Monthly Pounds/2</i>				
<i>The base trade ratio is 2:1 for Association Trade Projects</i>				
<i>Base Flows Exclude April Storm Loadings</i>				
<i>Annual Trade Pounds Available = 88 pounds Total Phosphorus</i>				

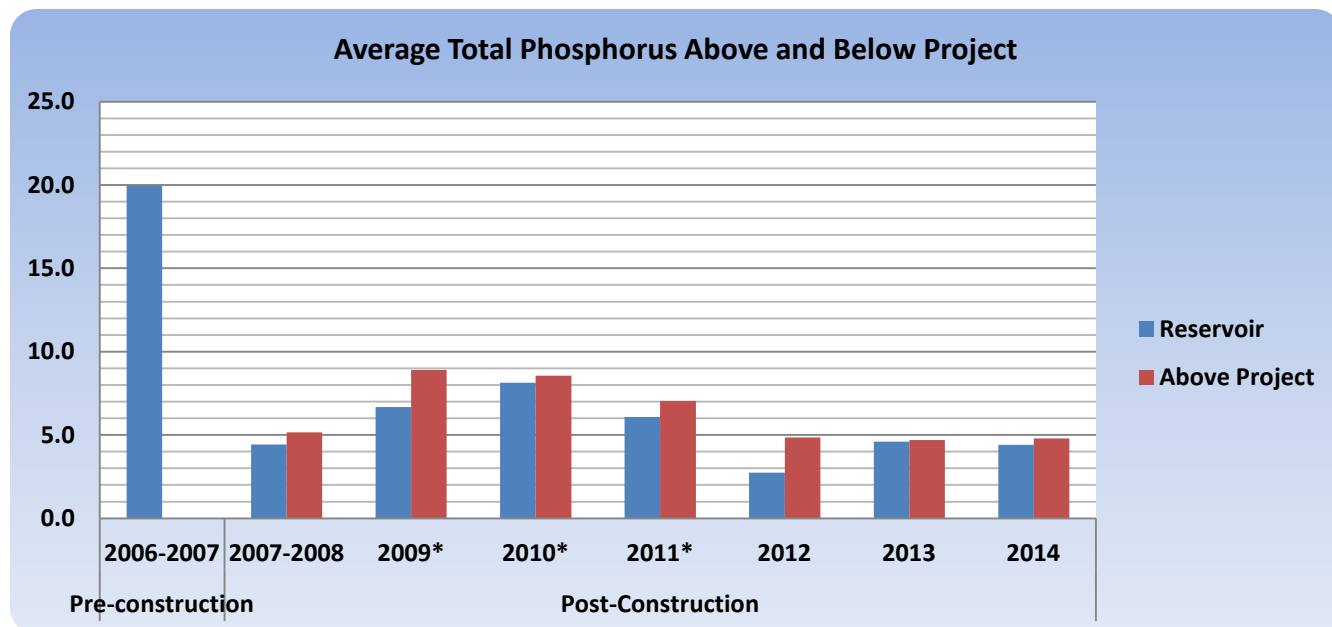


Figure 30 Total Phosphorus Reduction at Coyote Gulch Project

Association Land-Use Review

The Association has 35 “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 10 referrals in 2014 that addressed issues related to erosion, septic management, land disturbance, re-zoning, water quality degradation and appropriate use of best management practices. 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 11th year of recycle and litter management at their regional parks, including Bear Creek Park. In 2014, the program recycled motor oil, metal scrap, mixed paper, cans, glass and plastic, Electronic, all batteries, 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 2014 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. There was over 7,000 hours of volunteer efforts. Recycle Your Fishing String program helped keep shorelines clean. Additionally, the city completed several major stream restoration projects in Bear Creek Park resulting from flood damage in September 2013 (Figure 31).



Figure 31 Bear Creek Restoration in Bear Creek Park

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.

In 2014, the U.S. Army Corps of Engineers completed clean-up operations to remove debris deposited by September 2013 flood, upgrades around the outlet structure (Figure 32), road maintenance and dam stabilization projects.



Figure 32 Corps of Engineers Dam Improvements

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. The *BCWA Fact Sheet 48 Bass and Saugeye Fishery BCR*, summarizes a 2014 survey of sports fish in Bear Creek Reservoir. There was a 2014 fishery surveys; results not available from CDPW.

VII. Association Watershed Plan and Annual Reports

The Association produces an annual data report (*BCWA March 11, 2015*) and a *2014 Master Data Spreadsheet (February 2015)* 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, March 2015).

Most 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 (BCWA PGO2 Document Categories). 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.

Be a Watershed Warrior!

Geo-locate all eleven BCWA informational signs, collect the keywords from each sign, and share your findings on our website or by e-mail. If you collect all the keywords, your name will be posted on our Watershed Wall of Fame. Don't forget to look for the different animals on the signs. All of these animals are found somewhere in the watershed. Each sign has GPS coordinates that show where the upstream and downstream signs are found from your present position. You'll find the first sign at the entrance to a Jefferson County School Outdoor Learning Facility. When you find this first sign, you will read

Watershed education

Look around -you are surrounded by vast conifer forests and alpine meadows, rich with diverse plants, fish, and wildlife. A watershed is a living classroom where you learn about water quality, plant ecology, biology, wildlife management, fisheries, hydrology, forest care, environmental protection, climate change, and more. A watershed also includes its people and how we care for the land. You can make a difference by becoming watershed smart.

The BCWA challenges you to take a geo-locate trip through our unique and world-class Bear Creek Watershed.

BCWA Watershed Plan

The Association has determined and established a policy that generating a single document to serve the watershed planning elements is not practical or efficient process. A single or fixed watershed plan would be too inflexible and require frequent updating. The Association instead is using a flexible and adaptive watershed planning process maintained electronically and assessable on a designated BCWA Web site. The electronic watershed plan is an Association Watershed Plan table of contents with linked PDF files or spreadsheets, and program element descriptions. The Association Watershed Plan is designed to be flexible, adaptive and dynamic. The online watershed plan will contain elements and information required to meet all three types of water quality planning reporting.

The Association has adopted a series of policies, technical reports and factsheets that define the program (BCWA PGO1 Master Index and PGO2 Document Categories). The Association develops and distributes a number of educational and outreach materials to serve the watershed community. The Association maintains a series of standardized maps providing watershed information and characterization. The Association maintains sets of water quality and other environmental data in spreadsheets and data reports. The Association produces annual reports to meet regulatory reporting requirements. The compilation of the various Association watershed planning documents and databases meets the state and Environmental Protection Agency requirements for a complete watershed plan.