

# Bear Creek Watershed Association



## 2011 Annual Report for the Water Quality Control Commission



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

## Table of Contents

Bear Creek Watershed Control Regulation.....	1
Bear Creek Watershed Association .....	1
Members and Associates.....	1
2011 Program Participation .....	1
Control Regulation Requirements.....	2
Status of Water Quality in the Reservoir and Watershed .....	3
Monitoring Program Updated .....	3
2011 Hydrology .....	7
2011 Nutrients.....	9
2011 Reservoir Indicator Trend Variables.....	12
Bear Creek Reservoir Aeration Practice Manages Summer Dissolved Oxygen .....	16
Bear Creek Sediment Study .....	17
2011 Bear Creek Kerr/Swede Gulch E. coli Study .....	19
Wastewater Treatment Facilities Loading and Compliance .....	22
Wasteload Compliance .....	22
Permit Compliance and Plant Expansions/Actions.....	23
Trading Program .....	23
Regulated Stormwater Management.....	24
Nonpoint Source Loading and Appropriate Best Management Practices .....	25
Septic System Management.....	25
Watershed Nonpoint Source Program Elements.....	25
Association Land-Use Review.....	26
Denver Water Department Special Study .....	26
Coyote Gulch Nonpoint Source Restoration.....	26
Regional Parks Recycling Efforts.....	27
Aspen Park/ Conifer Waste Recycling Program.....	27
The Rooney Road Recycling Center.....	27
Invasive Species Protection Program.....	28
Bear Creek Reservoir .....	28
Evergreen Lake .....	28
Meeting Water Quality Goals and Standards for the Watershed.....	29
Dissolved Oxygen Compliance in Bear Creek Reservoir .....	29
Bear Creek Reservoir Temperature Compliance .....	29
Watershed Stream and Lake Compliance .....	30
Other Projects/ Programs Planned or Implemented By BCWA .....	32
Additional Association Annual Reporting.....	34

## List of Figures

Figure 1	Bear Creek Watershed .....	2
Figure 2	Reservoir Monitoring Stations; Site 2 is the Routine P1 Station.....	5
Figure 3	Monitoring Station in Bear Creek Park .....	5
Figure 4	General Sampling Locations and Wastewater Treatment Plants .....	6
Figure 5	Bear Creek Reservoir Inflow and Outflow .....	7
Figure 6	Annual Flows into Bear Creek Reservoir .....	8
Figure 7	Bear Creek above Bear Creek Reservoir Annual Acre-feet/year Flow .....	8
Figure 8	Bear Creek above Evergreen Annual Acre-feet/year Flow .....	8
Figure 9	Inflow Bear Creek Reservoir .....	9
Figure 10	Estimated Total Phosphorus loading .....	9
Figure 11	Estimated Nitrate loading .....	10
Figure 12	Estimated Total Nitrogen Loading into Bear Creek Reservoir.....	10
Figure 13	Total Phosphorus Annual Trend .....	10
Figure 14	Annual Total Phosphorus Bear Creek Reservoir .....	11
Figure 15	Bear Creek Reservoir Nitrogen Concentrations .....	11
Figure 16	Nitrogen Bear Creek Reservoir.....	11
Figure 17	Annual Bear Creek Reservoir Nitrate Trend .....	12
Figure 18	Phytoplankton Summer Total Density.....	14
Figure 19	Secchi Depth Bear Creek Reservoir .....	15
Figure 20	Chlorophyll Trend.....	15
Figure 21	Walker Trophic Index Trend Bear Creek Reservoir.....	16
Figure 22	Fishing Very Popular on Bear Creek Reservoir .....	16
Figure 23	Reservoir Dissolved Oxygen Trend.....	17
Figure 24	Bear Creek Reservoir Bottom Sample Sites .....	17
Figure 25	Total Organic Carbon in Bear Creek Reservoir Sediments .....	18
Figure 26	Grain-Size Distribution in Bottom Muds.....	19
Figure 27	Kerr/Swede Gulch Sample Sites .....	20
Figure 28	Comparison of Nutrients Between Sites 52 and 53 .....	25
Figure 29	Total Phosphorus Reduction .....	27
Figure 30	Harvesting Elodea from Evergreen Lake.....	28
Figure 31	DO Compliance Bear Creek Reservoir.....	29
Figure 32	Temperature Compliance Bear Creek Reservoir. ....	30

## **List of Tables**

Table 1	Association Membership, Dischargers and 2011 Meeting Attendance .....	1
Table 2	Diversion of Bear Creek Water by the Arnett-Harriman Ditch .....	7
Table 3	Bear Creek Reservoir Indicator Trend Variables.....	12
Table 4	Reservoir Summary for Select Trend Parameters.....	14
Table 5	Phytoplankton Summary Data .....	14
Table 6	2010 and 2011 Total Phosphorus Results .....	18
Table 7	Kerr/Swede Gulch Data Summary.....	20
Table 8	E. Coli 2011 Geometric Mean Summary.....	22
Table 9	Treatment Facility Wasteload Allocations.....	22
Table 10	Wastewater Planning Status.....	23
Table 11	Phosphorus Trading Activity in Bear Creek Watershed.....	23
Table 12	Jefferson County Storm Water 2011 Activities and Actions.....	24
Table 13	Average and total pounds per month at monitoring sites as base load (all data).....	26
Table 14	Annual Available Total Phosphorus Trade Pounds .....	27
Table 15	2011 DO Compliance in Bear Creek Reservoir.....	29
Table 16	Watershed Temperature Compliance Summary Warm/ Cold Seasons .....	30

## Bear Creek Watershed Control Regulation

The Bear Creek Watershed (Figure 1) is a specific geographic area identified in the Bear Creek Watershed State Control Regulation (Regulation #74, 5 CCR 1002-74) (Control Regulation) requiring special water quality management. The watershed includes all tributary water flows that discharge into Bear Creek Reservoir. The watershed extends from the Mount Evans Wilderness on the western end to the Town of Morrison on the eastern end. The two major tributaries are Bear Creek and Turkey Creek. The goal of the Control Regulation is to attain site-specific water quality standards and classifications through control of total phosphorus and chlorophyll. The Bear Creek Watershed Association (Association) oversees implementation of the Control Regulation.

### Bear Creek Watershed Association

The Association is the local water quality agency responsible for implementation of monitoring and tracking water quality in the Bear Creek Watershed. The Association membership includes counties, local general-purpose governments, special districts (wastewater dischargers), associate agencies, and local citizen groups (Table1). The Association membership monitors point sources and tracks nonpoint source practices, programs and loadings within the watershed. The Association management and implementation programs are at a watershed level.

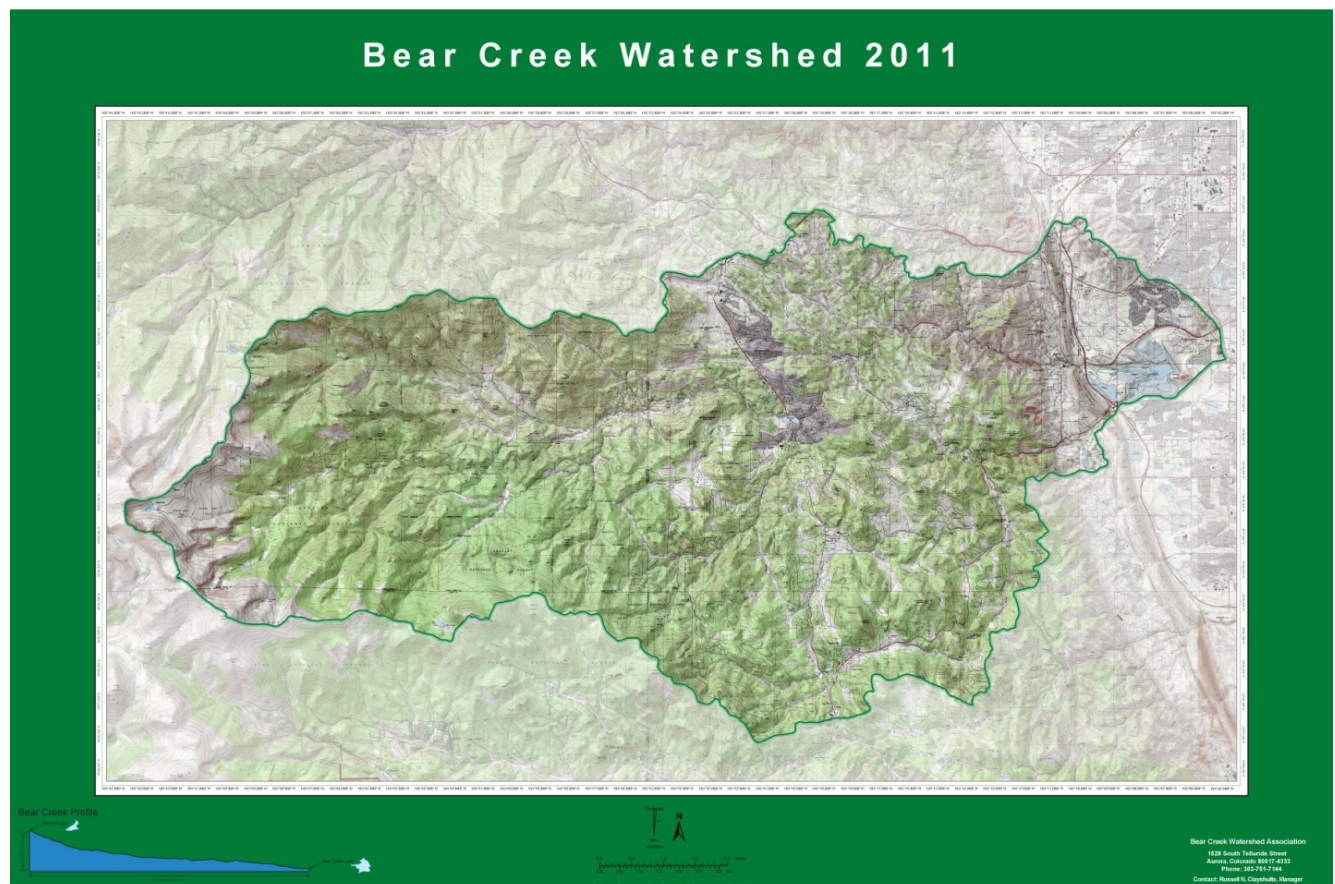
The Association provides watershed reporting as posted on the Association website [www.bearcreekwatershed.org](http://www.bearcreekwatershed.org), which serves to keep federal, state, and local governments and others informed on the state of the watershed. The Control Regulation defines specific reporting requirements, which helps the Association keep the Water Quality Control Commission and Water Quality Control Division staff updated on progress of the Association in implementing the Control Regulation.

**Table 1 Association Membership, Dischargers and 2011 Meeting Attendance**

<b>Members and Associates</b>	<b><i>Wastewater Discharger</i></b>	<b>2011 Program Participation</b>
<b><u>Counties</u></b>		
Jefferson County		<b>Active</b>
Clear Creek County		<b>Active</b>
Park County		<b>No Dues, Not Active</b>
<b><u>City and Towns</u></b>		
City of Lakewood		<b>Active</b>
Town of Morrison	<b>Yes</b>	<b>Active</b>
<b><u>Water &amp; Sanitation Districts</u></b>		
Aspen Park Metropolitan District	<b>Yes</b>	<b>Active</b>
Bear Creek Cabins	<b>Yes</b>	<b>Active (In-kind Service)</b>
Brook Forest Inn	<b>Yes</b>	<b>Active (In-kind Service)</b>
Conifer Sanitation Association	<b>Yes</b>	<b>Dues Paid, Not Active</b>
Conifer Metropolitan District	<b>Yes</b>	<b>Dues Paid, Not Active</b>
Evergreen Metropolitan District	<b>Yes</b>	<b>Active</b>
Forrest Hills Metropolitan District	<b>Yes</b>	<b>Dues Paid, Not Active</b>
Genesee Water & Sanitation District	<b>Yes</b>	<b>Active</b>
Geneva Glen	<b>Yes</b>	<b>Dues Paid, Active</b>
Jefferson County School District	<b>Yes</b>	<b>Dues Paid, Active</b>



<b>Members and Associates</b>	<b><i>Wastewater Discharger</i></b>	<b>2011 Program Participation</b>
Kittredge Water & Sanitation District	<b>Yes</b>	<b>Active</b>
Singing River Ranch	<b>Yes</b>	<b>Dues Paid, Active</b>
The Fort Restaurant	<b>Yes</b>	<b>Dues Paid, Active</b>
Tiny Town Foundation, Inc.	<b>Yes</b>	<b>Dues Paid, Not Active</b>
West Jefferson County Metropolitan District	<b>Yes</b>	<b>Active</b>
<b><u>Associate Agencies</u></b>		
Colorado Department of Transportation		<b>Not Active</b>
Denver Water Department		<b>Active</b>
Department of Public Health & Environment		<b>Not Active</b>
Jefferson County Health Department		<b>Active</b>
Kimberly Goertz-Reeves LLC		<b>Active</b>
Evergreen Trout Unlimited		<b>Active</b>
Evergreen High School		<b>Active</b>
U.S. Army Corps of Engineers		<b>Active</b>



**Figure 1 Bear Creek Watershed**

## **Control Regulation Requirements**

The Control Regulation (Regulation #74; 5 CCR 1002-74) identifies the Association's annual reporting requirements for presentation to the Water Quality Control Commission. The Association also produces reports and technical memorandums on additional activities. The remainder of this report addresses these reporting requirements: 1) Summarize status of water quality in the watershed for the previous calendar year. 2) Information on the wastewater treatment facilities loading and compliance with permit limitations. 3) The nonpoint source loading and appropriate best management practices. 4) In-stream and reservoir data analyses that indicate whether water quality goals and standards for the watershed are being met. 5) Information about water quality projects planned or implemented in the watershed. 6) Information on phosphorus trading programs.

## **Status of Water Quality in the Reservoir and Watershed**

### **Monitoring Program Updated**

The monitoring plan details the 2011 reservoir and watershed monitoring programs as approved by the BCWA Board and accepted by 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 2011 monitoring program (version 2011.01) changes, updates, major continuation studies and monitoring program elements include:

- Additional temperature probes for new stream segments. Temperature data loggers in Bear Creek Segment 1b above and below the Ward Ditch. Logger location on Cub Creek near Brookforest Inn, site 35 and lower Cub Creek, site 50. Include these sites for seasonal chemistry.
- Temperature Logger profile of Bear Creek Reservoir at Site 40 will begin in January 2011 with buoy placement and probes attached at ice-off (April-December, first week): ½ m, 1m, 1 ½m, and 2m. Field probe measurements year-round at site 40 with profile interval of ½ m, 1m, 1 ½m, 2m, 2 ½m, 3m, 3 ½ m, 4m, 5m, 6m, 7m, 8m, 9m, 10m, and 11m. Similar profile pattern used at other reservoir sites.
- Temperature Logger profile for Genesee Reservoir with single chemistry set taken off dam face with profile interval of: ½ m, 1m, 1 ½m, and 2m. Field probe measurements during July, August and September off dam face with profile interval of ½ m, 1m, 1 ½m, 2m, 2 ½m, 3m, 3 ½ m, 4m, 5m, and 10m.
- Temperature Logger profile for Evergreen Lake at ice-off (April-May) through November 1: ½ m, 1m, 1 ½m, and 2m. Field probe measurements during July, August and September at ½ m, 1m, 1 ½m, 2m, 2 ½m, 3m, 3 ½ m, 4m, 5m, and 6m.
- Maintain all other existing temperature data logger locations and seasonal monitoring periods with temperature logger placement adjust to temperature seasons.
- Recognize growing season for data collection as July, August and September. Adjust watershed chemistry analyses to focus primarily on the period of July to September.
- Monitoring sites maintained for Summit Lake in the Mount Evans Wilderness (segment 8), in upper segment 7 below Summit Lake and middle segment 7 at Bear Tracks for the July, August and September months. The Bear Tracks monitoring station is a reference station and is proposed for fishery, Macroinvertebrate, and habitat surveys in 2011.

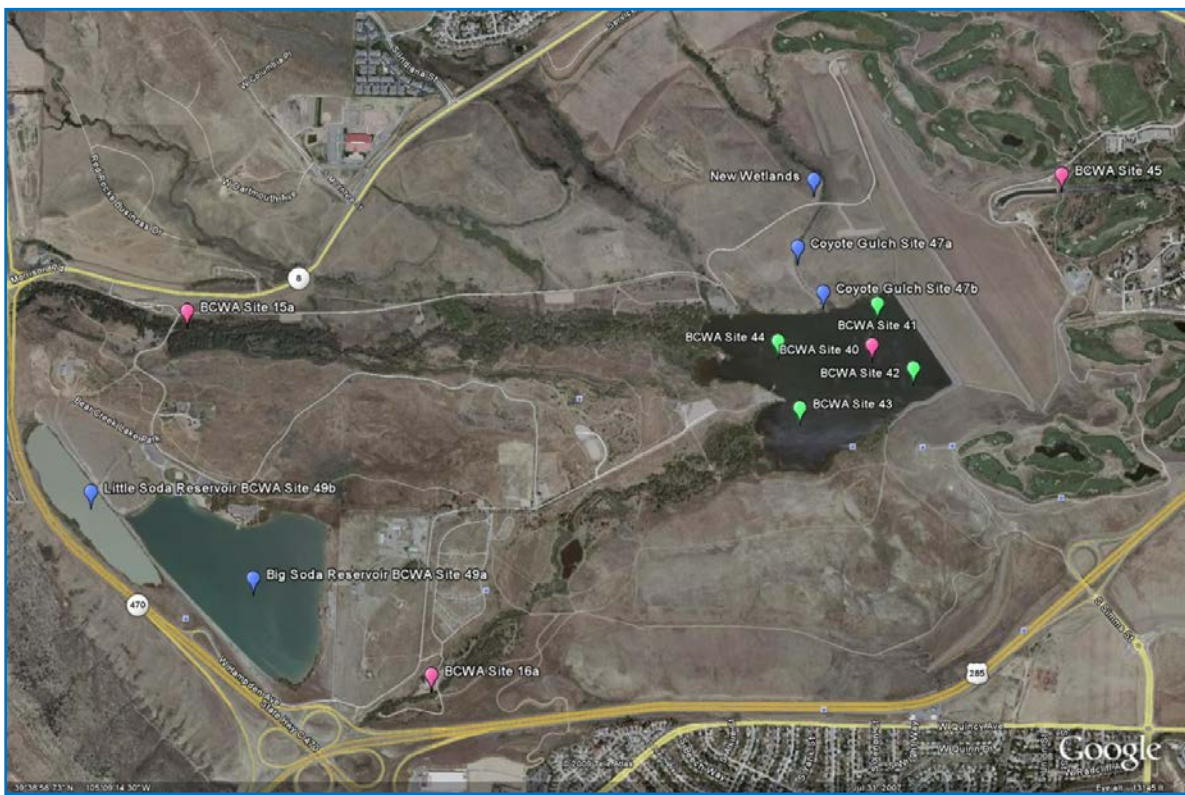
- Increase monitoring for Evergreen Lake chemistry to obtain samples at -1 meter and +1 meter in water column, and adjust position of temperature data loggers in water column. Track temperature against new standard and DO compliance in central pool of Evergreen Lake. Included Evergreen Lake in the high quality water study for drinking water reservoirs. Association collects data consistent with protection of a major drinking water supply system.
- Total nitrogen sampling for Summit lake (Site 37), segment 7 (Site 36), Bear Tracks (Site 38), below Bear Creek Reservoir at Site 45, Bear Creek Reservoir from May through November at the surface and bottom sites (sites 40a and 40c), inputs into the reservoir at sites 15a and 16a.
- Added stream staff gages at Singing River, Brookforest Inn, Little Cub at Mouth, Bear Creek Cabins and Turkey Creek. Daily and weekly reading taken at gages and compared against field measurements of flow to produce flow curves.
- Work with the City of Lakewood to closely monitor dissolved oxygen in water column and adjust the operation of the reservoir aeration system on a weekly basis to maintain DO standards, while minimizing aeration operations. This requires addition vertical probe sampling in the July to September period to monitor DO levels in the water column at site 40.
- Continue sediment and nutrient internal loading studies in Bear Creek Reservoir.
- Maintain photographic points for critical segments and conditions. Document dewatering of Bear Creek Segment 1b below both the Arnett-Harriman and Ward ditches.
- Continue special study of E. coli on Kerr/Swede Gulches. E. coli sampled year-round from 2010-2015 with field data and nutrient sampling from April-October.
- Continue special study on Coyote Gulch.
- Begin special study with Evergreen High School for Wilmont Creek, which is tributary to Evergreen Lake.
- Update listing of 2011 monitoring sites with the BCWA site identifiers, data logger location and chemistry-monitoring sites by new stream segment descriptions. Identify reference sites for segments. Maintain larger scale maps maintained by Association on Web site.

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



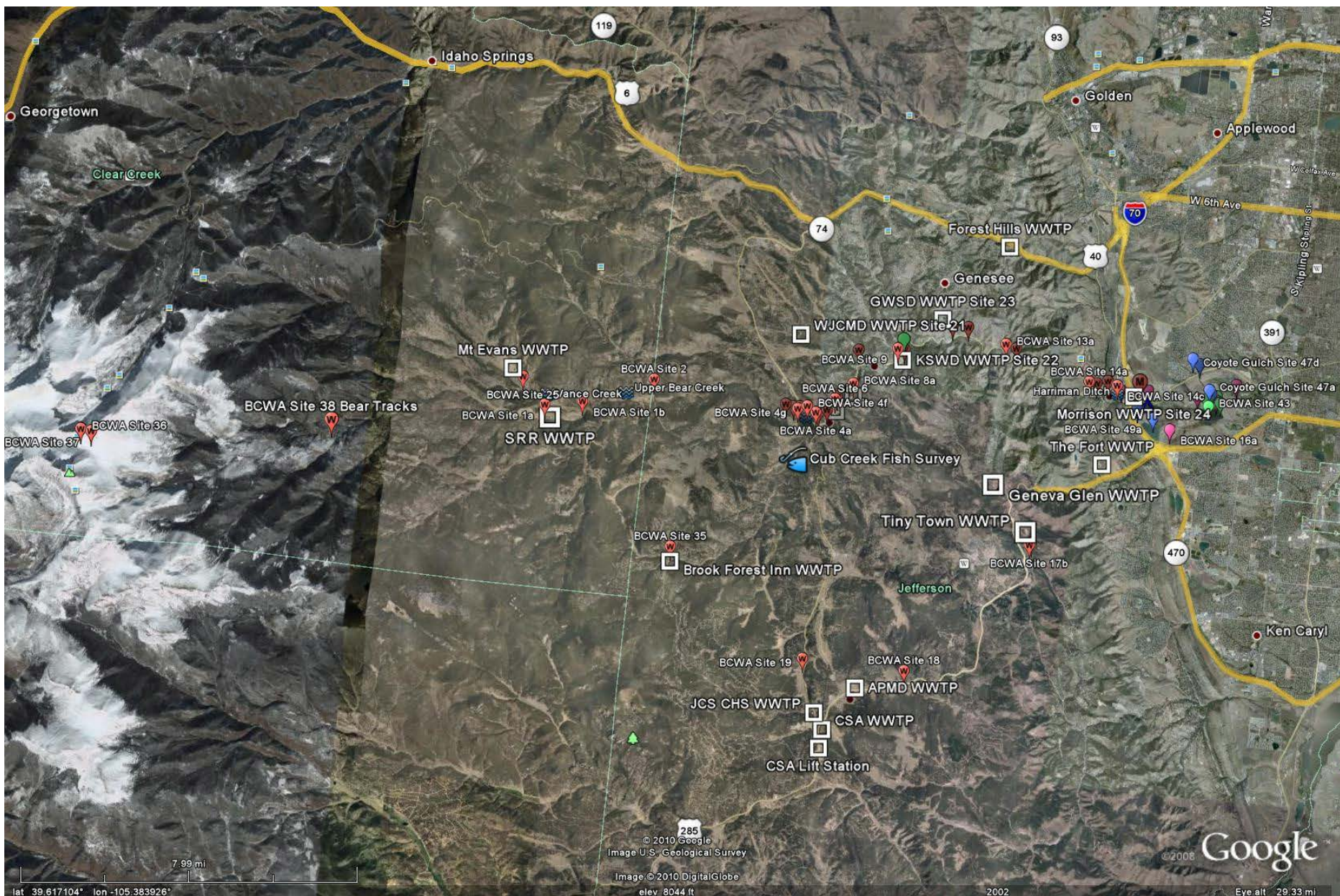


**Figure 2      Reservoir Monitoring Stations; Site 2 is the Routine P1 Station**



**Figure 3      Monitoring Station in Bear Creek Park**





**Figure 4** General Sampling Locations and Wastewater Treatment Plants



## 2011 Hydrology

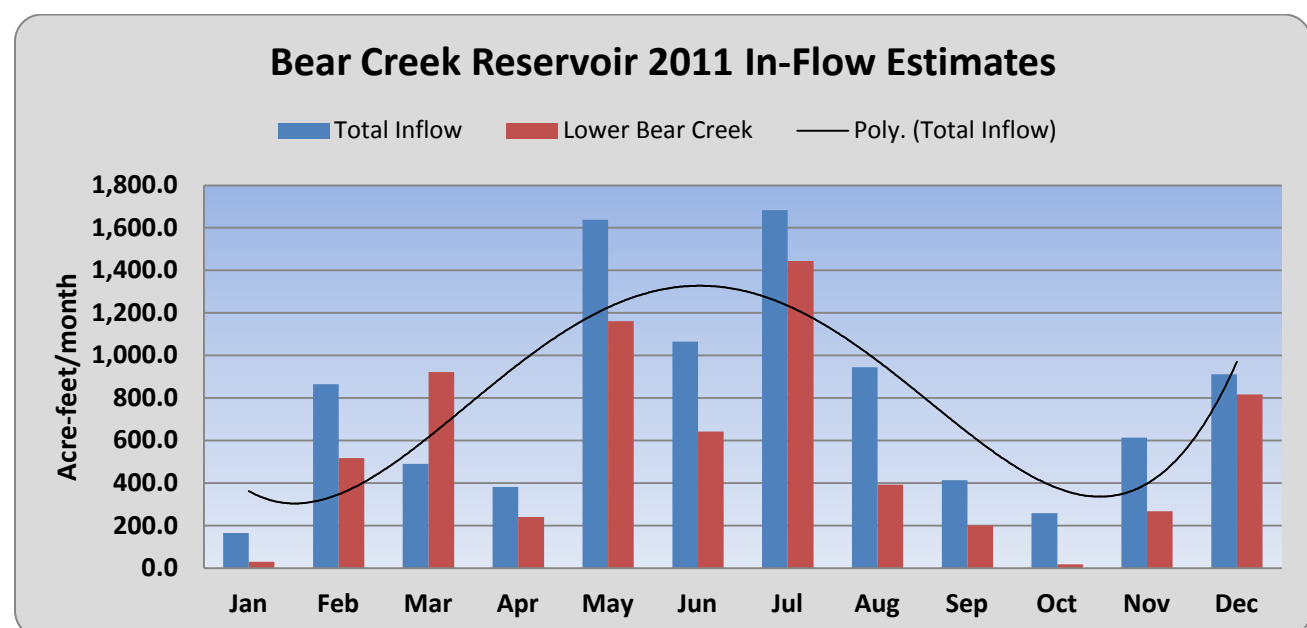
Evaluation of water quality in the reservoir includes examination of the basin hydrology, as well as chemistry. Figure 5 shows the Association estimated 1987-2011 total annual flow discharge into Bear Creek Reservoir. In 2011, the total estimated annual discharge into Bear Creek Reservoir was about 9,432 acre-feet (Figure 5) with about 6,660 acre-feet flow through and 2,773 acre-feet of evaporation. Figure 6 shows the total reservoir inflow trend from 1987-2011.

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 Association analyzed diversion data at both the Arnett-Harriman and Ward diversion points from 1999-2007. The Arnett-Harriman ditch reduces flows in lower Bear Creek below 10 cfs in the operational season about 31% of the time (Table 2). The ditch systems can completely dewatered lower Bear Creek for periods of up to 11 consecutive days. In 2011, lower Bear Creek dewatered (<5 cfs flow) for 133 days or 36% of the time.

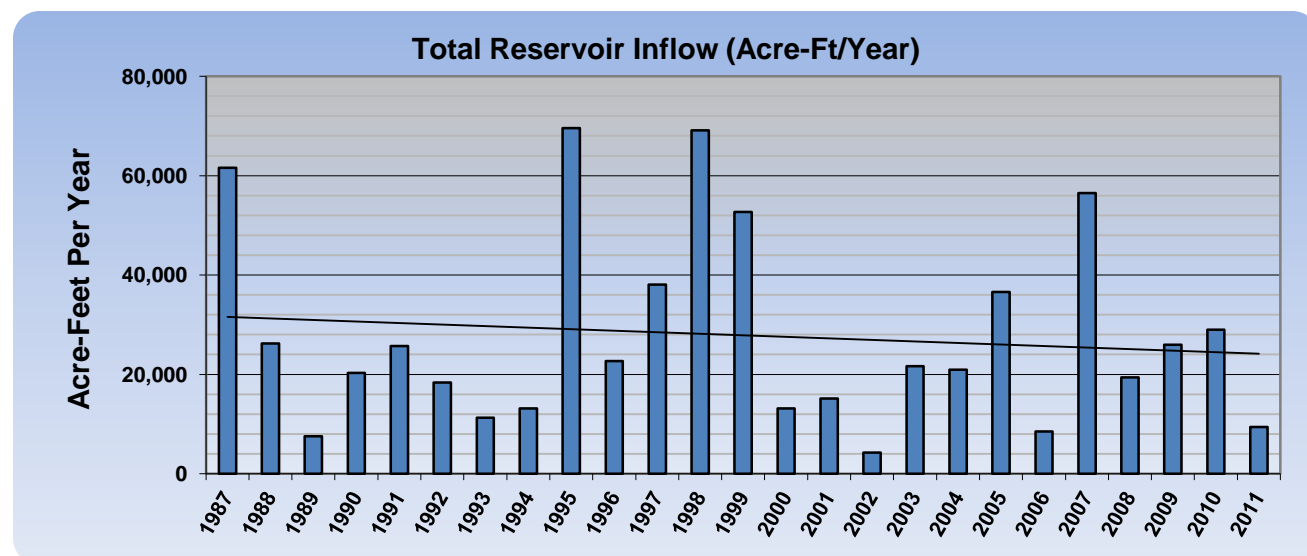
**Table 2 Diversion of Bear Creek Water by the Arnett-Harriman Ditch**

Flow Below Arnett-Harriman Diversion						
	Total Days Diversion	days below <10 cfs	days below <2.5 cfs	days below <1 cfs	days below <0 cfs	Consecutive Days <1 cfs
1999-2007	2591	813	350	172	85	Up to 11 days
		31.4%	13.5%	6.6%	3.3%	

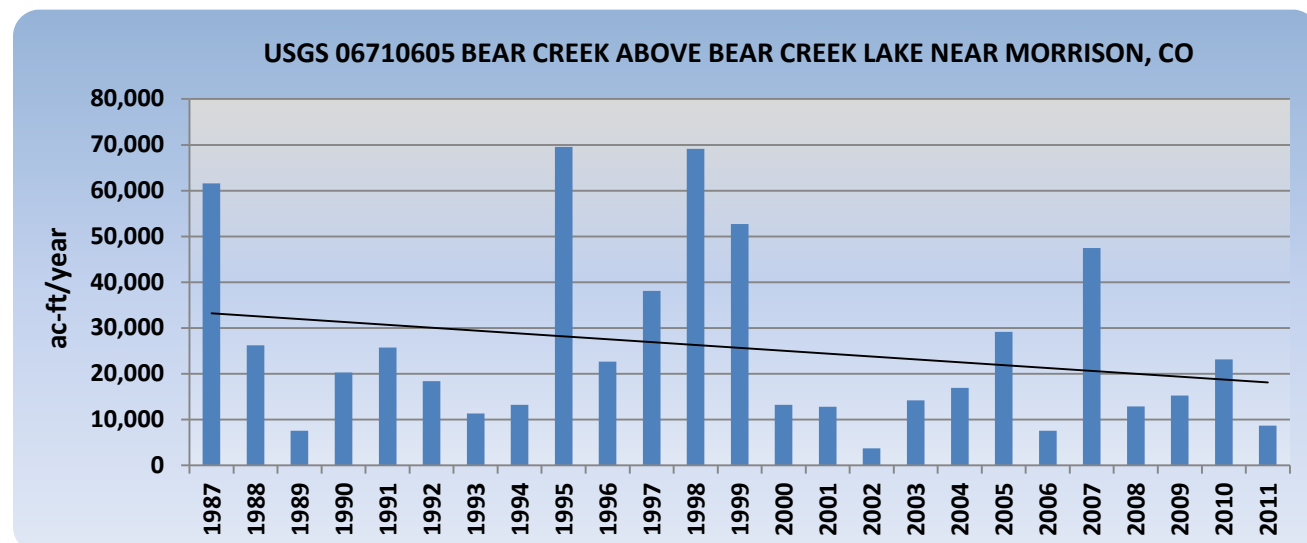
The reservoir inflow represents flows below the water diversions and is not representative of the total watershed water flows. Bear Creek flows above Bear Creek Reservoir (Figure 7) and at the Evergreen gaging station (Figure 8) provide an estimate of the amount of water diverted from the watershed before reaching the reservoir. For example, in 2011 the Bear Creek water use diversion reduced flow to the reservoir by about 6,250 ac-ft (-40 %). Additionally, the longer time trends shown in Figures 6 and 7 depict a basic linear trend of declining flow in Bear Creek. Figure 9 compares the 2011 reservoir monthly inflow estimates from Bear Creek (86%) and Turkey Creek (14%). Peak runoff occurred in May 2011. The increased Bear Creek flow in July came from two large rainfall events.



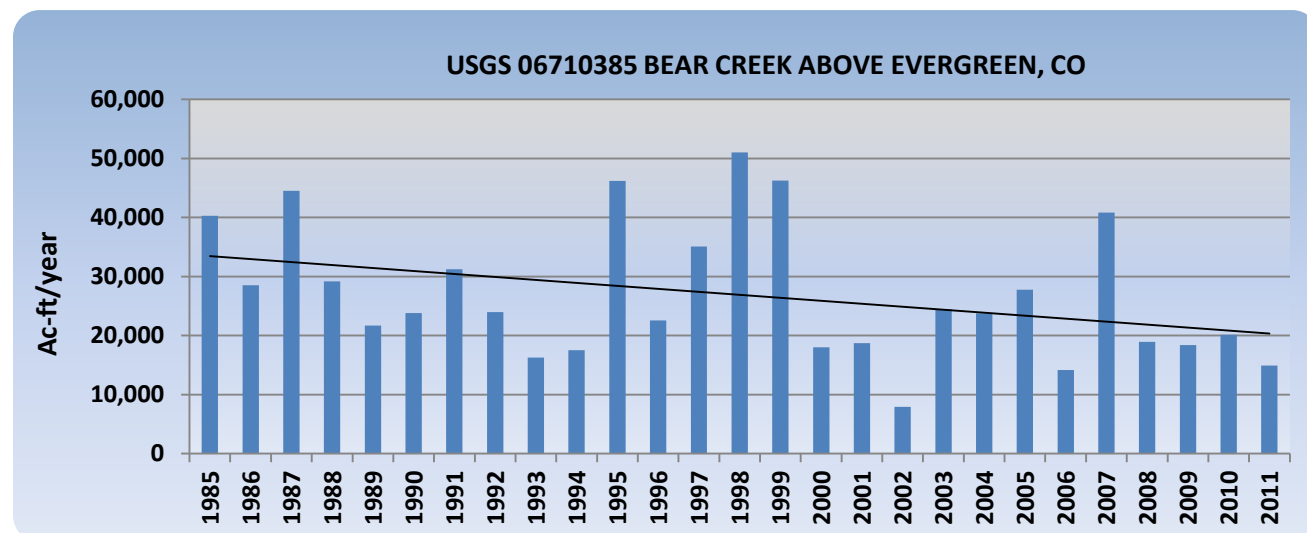
**Figure 5 Bear Creek Reservoir Inflow and Outflow**



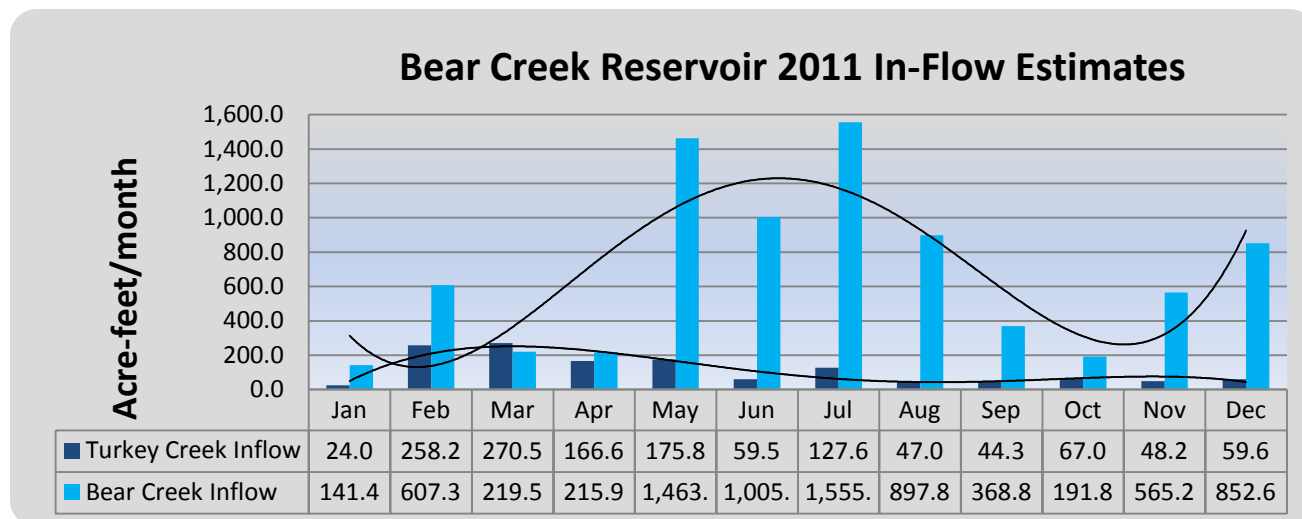
**Figure 6 Annual Flows into Bear Creek Reservoir**



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



**Figure 8 Bear Creek above Evergreen Annual Acre-feet/year Flow**



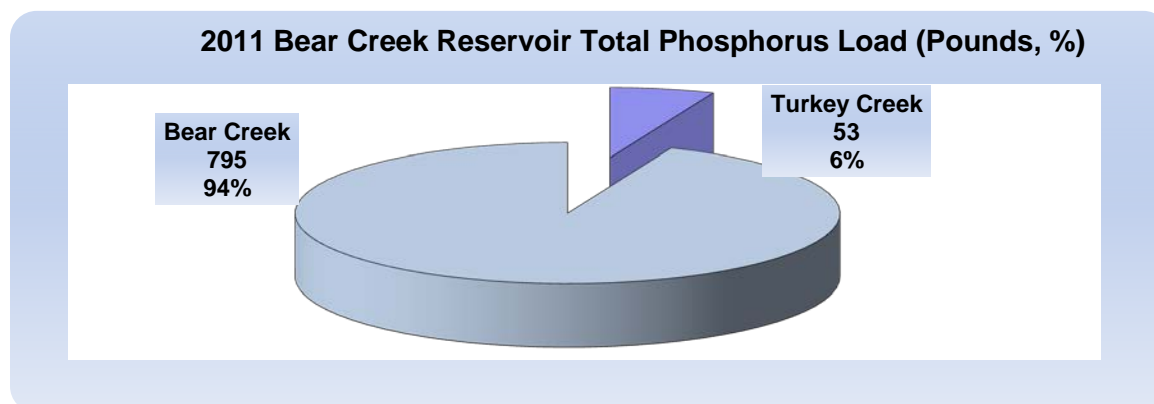
**Figure 9 Inflow Bear Creek Reservoir**

### 2011 Nutrients

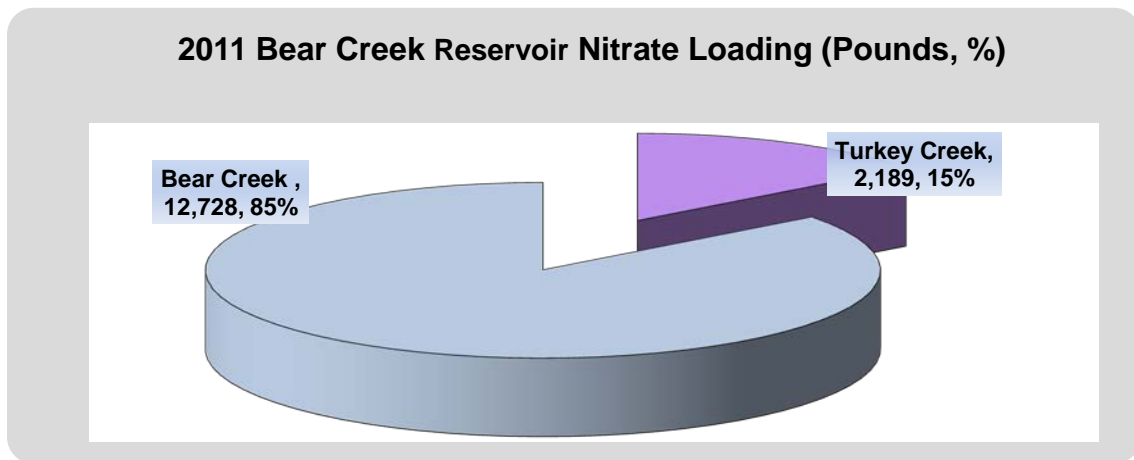
The watershed-monitoring program characterizes nutrient loading into Bear Creek Reservoir from two primary drainages: Bear Creek and Turkey Creek. The Association monitors for total phosphorus, dissolved phosphorus, nitrate-nitrite nitrogen, and total nitrogen on a monthly basis.

The total phosphorus load from the watershed comes from a combination of wastewater treatment plant point source loads and nonpoint sources, including runoff. There are over 27,000 septic systems in the watershed. The estimated total phosphorus load in 2011 from all sources reaching the reservoir was 847 pounds at a flow of about 9,432 acre-feet. Bear Creek drainage contributed 94% of the load (Figure 10). Although the point source discharges of total phosphorus were about **910** pounds, the water diversions above the reservoir are removing a portion of this phosphorus load and inflow water before it reaches the reservoir.

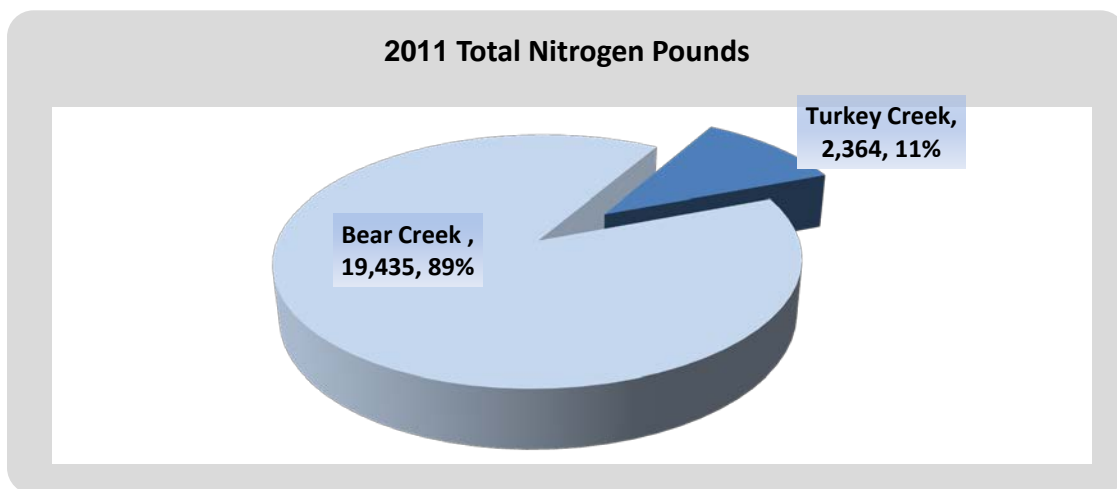
The nitrate loading (14,917 pounds) was lower than past flow conditions (Figure 11) with 85% of the load coming from Bear Creek. Figure 12 estimates the total nitrogen loading into Bear Creek Reservoir. There was about 21,800 pounds of total nitrogen loading with 89% derived from the Bear Creek drainage. Figure 13 shows the 2011 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 14 shows the total phosphorus reservoir trend. Figure 15 shows the 2011 nitrate concentrations at routine watershed monitoring stations. Figure 15 shows the 2011 total nitrogen trends. The reservoir nitrogen data shows a general reduction over the years (Figure 17).



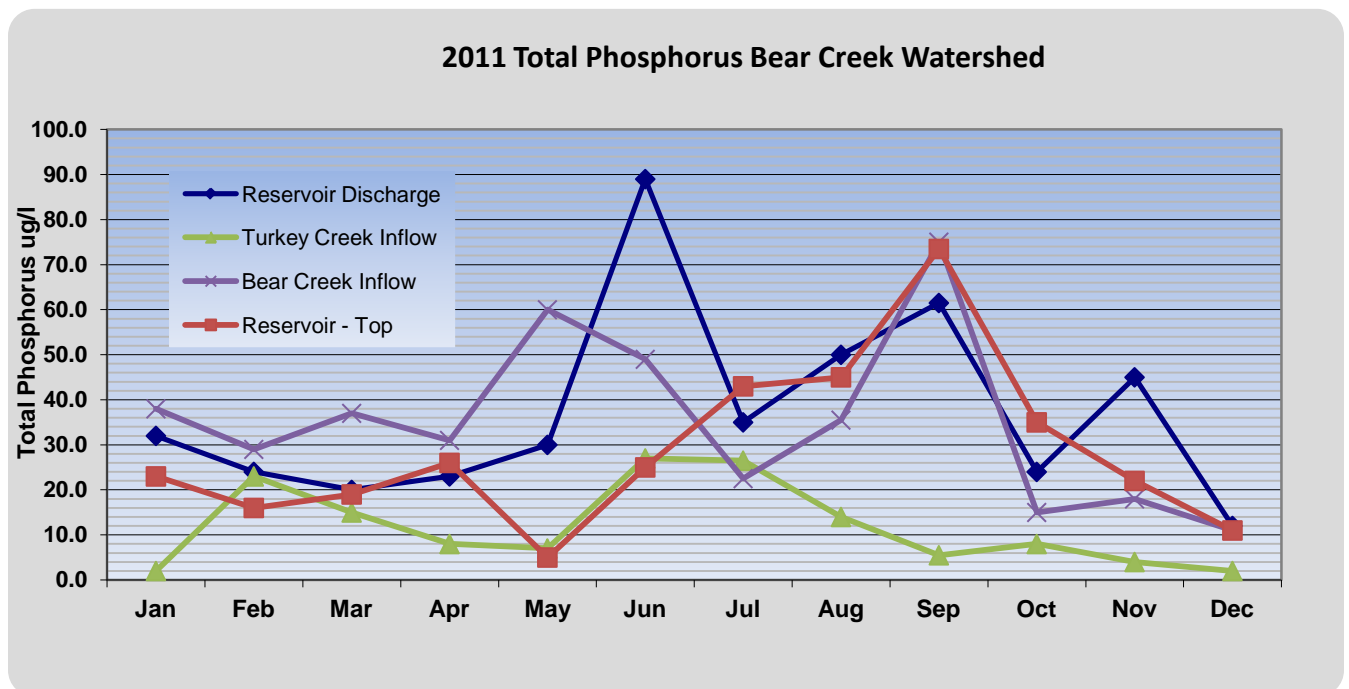
**Figure 10 Estimated Total Phosphorus loading**



**Figure 11**      **Estimated Nitrate loading**



**Figure 12**      **Estimated Total Nitrogen Loading into Bear Creek Reservoir**



**Figure 13**      **Total Phosphorus Annual Trend**



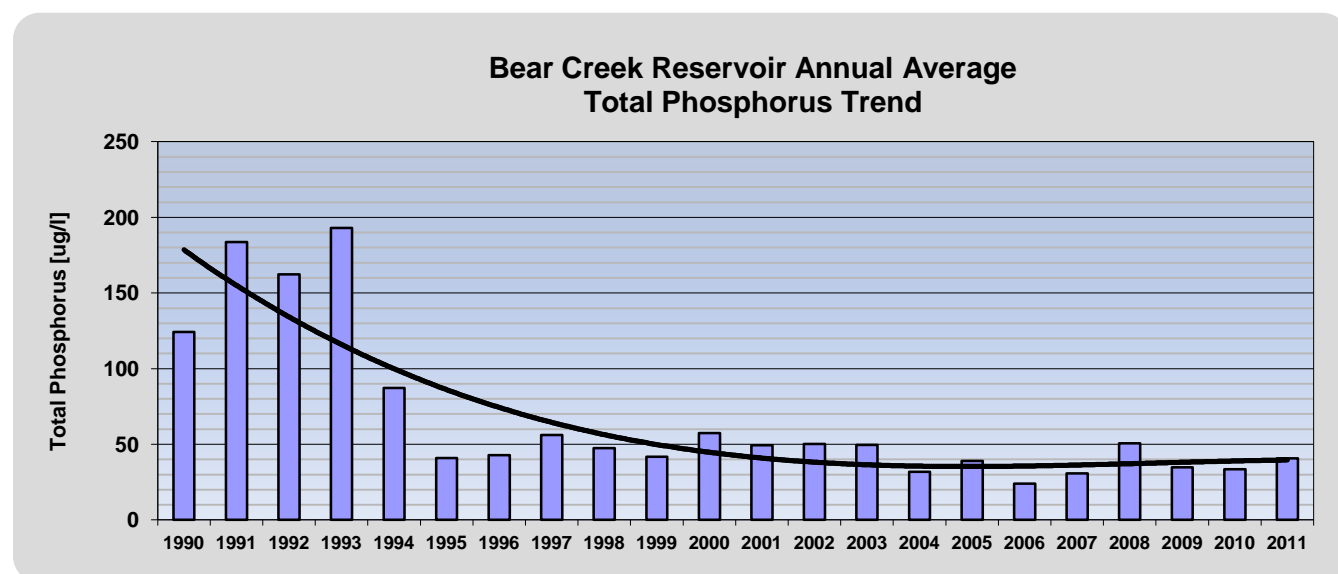


Figure 14 Annual Total Phosphorus Bear Creek Reservoir

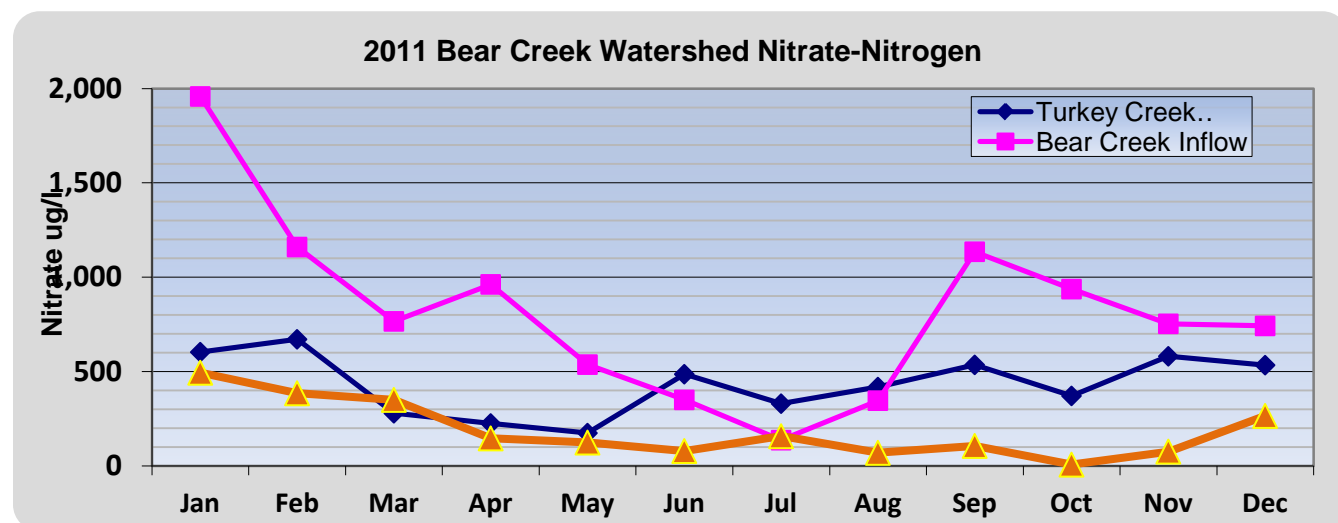


Figure 15 Bear Creek Reservoir Nitrogen Concentrations

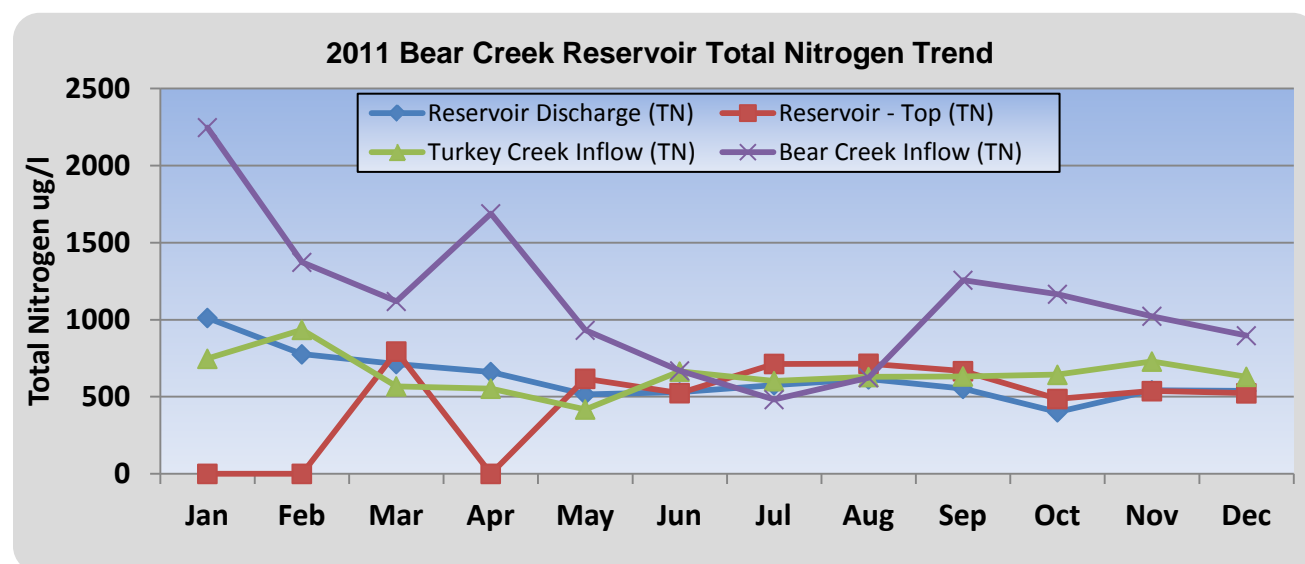
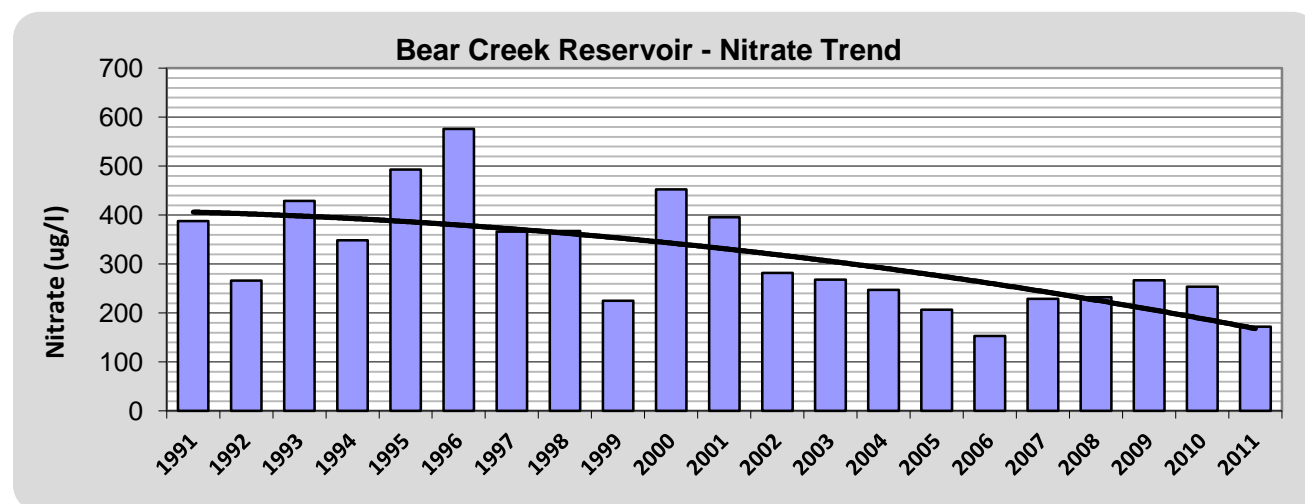


Figure 16 Nitrogen Bear Creek Reservoir



**Figure 17 Annual Bear Creek Reservoir Nitrate Trend**

### **2011 Reservoir Indicator Trend Variables**

The Association's reservoir monitoring program collects samples to analyze nutrient (nitrogen and phosphorus) concentrations, chlorophyll-a, total suspended sediments and Secchi depth as indicator trend variables (Table 3). Table 4 summarizes the 2011 reservoir data compared with the long-term patterns from 1991 through 2011. Overall, 2011 water quality improved over historic trends. Table 5 summarizes the phytoplankton data. Figure 18 shows the phytoplankton total density during summer sampling period. Figure 19 shows the general clarity trend in the water column using Secchi measurements. March and April had the poorest clarity caused by runoff.

**Table 3 Bear Creek Reservoir Indicator Trend Variables**  
*Reservoir Growing Season July to September*

Reservoir Trend Monitoring Parameters	Reservoir
<b>Chlorophyll</b>	
Average Growing Season Chlorophyll-a [ug/l (-1m)]	9.0
Average Annual Chlorophyll-a [ug/l (-1m)]	10.8
Peak Chlorophyll-a [ug/l]	17.4
<b>Phosphorus</b>	
Average Annual Total Phosphorus [ug/l]: Water Column	40.8
Average Annual Total Phosphorus [ug/l] -1m	33.7
Average Annual Total Phosphorus [ug/l] -10m	47.9
Growing Season Total Phosphorus [ug/l]: Water Column	55.2
Growing Season Total Phosphorus [ug/l]: -1m	53.8
Growing Season Total Phosphorus [ug/l]: -10m	56.5
Peak Annual Total Phosphorus [ug/l] Water Column	102
Average Annual Ortho Phosphorus ug/l Water Column	13
Growing Season Average Ortho Phosphorus [ug/l] Water Column	22.3
Peak Annual Ortho Phosphorus [ug/l] Water Column	36.8
<b>Nitrogen</b>	
Average Annual Nitrate-Nitrogen [ug/l] Water Column	172
Growing Season Average Nitrate-Nitrogen [ug/l] Water Column	111

*Reservoir Growing Season July to September*

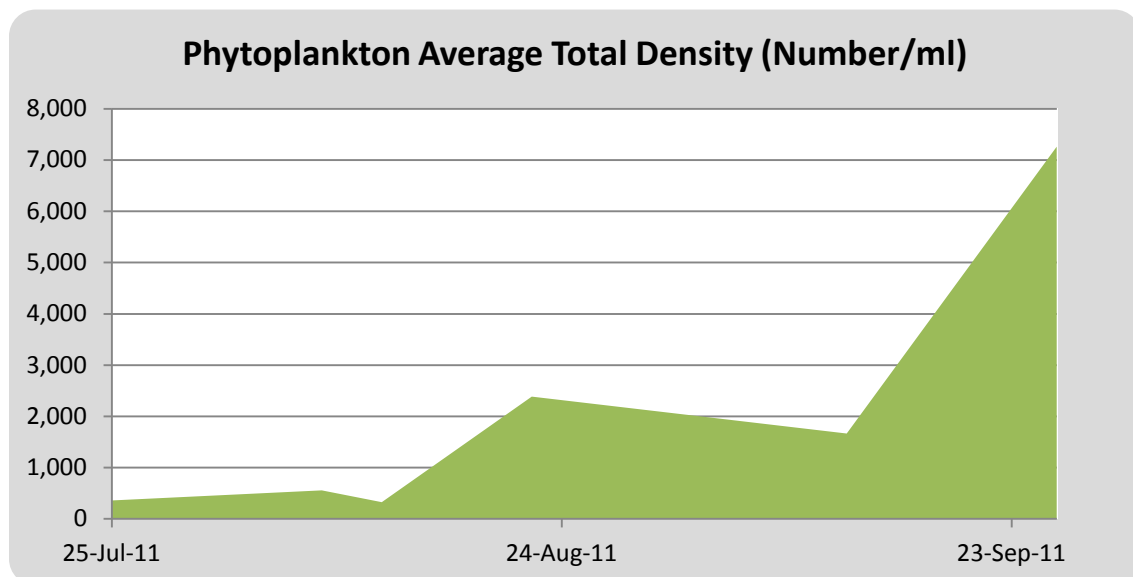
<b>Reservoir Trend Monitoring Parameters</b>	<b>Reservoir</b>
Peak Annual Nitrate-Nitrogen [ug/l] Water Column	564
Average Annual Total Nitrogen [ug/l]: Water Column	630
Average Total Nitrogen [ug/l]: -1m	799
Average Total Nitrogen [ug/l]: -10m	1005
Growing Season Total Nitrogen [ug/l]: Water Column	652
Growing Season Total Nitrogen [ug/l]: -1m	698
Growing Season Total Nitrogen [ug/l]: -10m	605
<b>Clarity</b>	
Average Annual Secchi Depth (meters)	2.2
Growing Season Average Secchi Depth (meters)	2.2
<b>Total Suspended Sediments</b>	
Annual Average Total Suspended Sediments [mg/l]	8.3
Growing Season Average Total Suspended Sediments [mg/l]	6.2
Peak Total Suspended Sediments [mg/l]	39.6
<b>Dissolved Oxygen</b>	
Annual Average at -1/2m [mg/l]	8.5
Annual Minimum at -1/2m [mg/l]	6.03
Annual Average at -2m [mg/l]	8.4
Annual Minimum at -2m [mg/l]	5.51
<b>pH</b>	
Annual Average at -1/2m [mg/l]	8.44
Annual Maximum at -1/2m [mg/l]	9.5
Annual Average at -2m [mg/l]	8.33
Annual Maximum at -2m [mg/l]	9.41
<b>Phytoplankton Species</b>	
<b>Phytoplankton Species Co-dominant Species</b>	<i>Aphanizomenon flos-aquae</i>
	<i>Diatoma vulgare</i>
	<i>Anabaena flos-aquae</i>
	<i>Cryptomonas erosa</i>
	<i>Stephanodiscus niagarae</i>
	<i>Schroderia sp.</i>
	<i>Fragilaria crotonensis</i>
	<i>Melosira varians</i>
	<i>Spirogyra sp.</i>
	<i>Nitzschia linearis</i>
	<i>Melosira ambigua</i>
<b>Peak Phytoplankton Density</b>	
<i>Aphanizomenon flos-aquae</i>	8,417,438

**Table 4      Reservoir Summary for Select Trend Parameters**

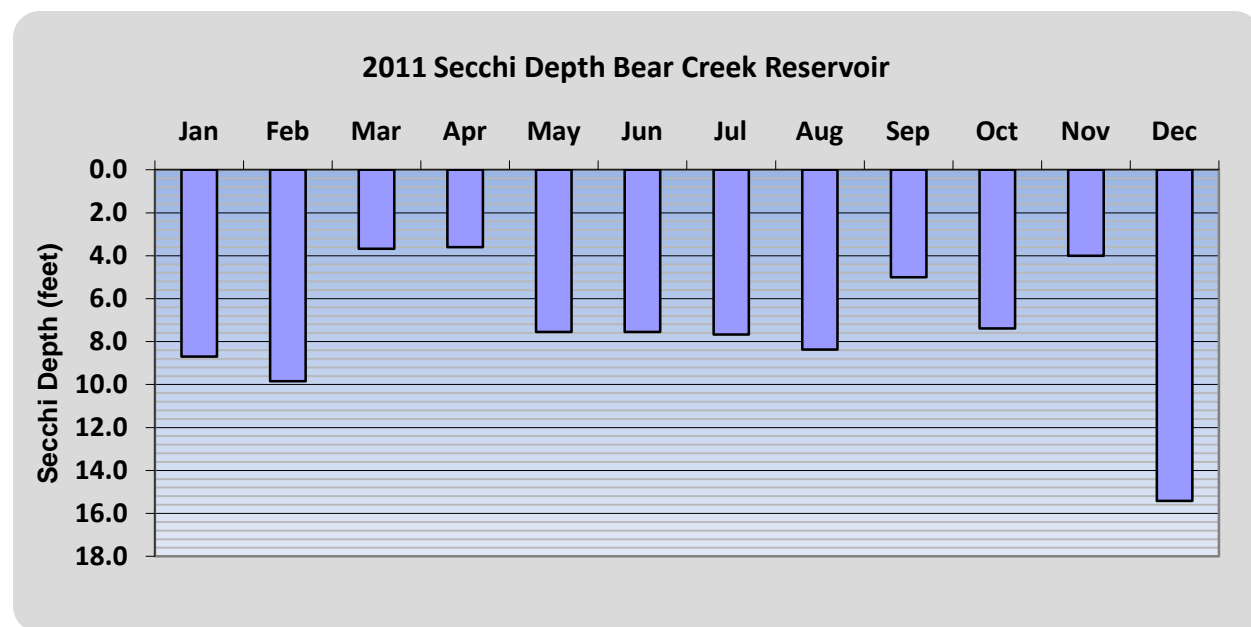
Parameter	Site	Reservoir	
		2011	1991-2011 Mean
Chlorophyll-a (ug/L)	Top	10.8	14.4
	Water Column	10.8	12.6
Nitrate-Nitrogen (ug/L)	Top	158	327.3
	Bottom	186	299.9
	Water Column	172	314.2
Total Phosphorus (ug/L)	Top	28.3	58.6
	Bottom	47.9	84.4
	Water Column	33.6	67.6
Total Suspended Solids (mg/L)	Top	6.2	6.6
	Bottom	10.5	10.5
	Water Column	8	8.2
Secchi Depth (m)	Top	2.2	2.2

**Table 5      Phytoplankton Summary Data**

Phytoplankton Summary	2011					
	25-Jul	8-Aug	12-Aug	22-Aug	12-Sep	26-Sep
<b>Total Density (#/mL):</b>	334	508	335	2,063	1,749	5,708
<b>Total Biovolume (um<sup>3</sup>/mL)</b>	301,053	125,028	89,814	102,122	248,663	6,299,309
<b>Trophic State Index:</b>	41.2	34.9	32.5	33.4	39.8	63.1
<b>Total Density (#/mL):</b>	379	599	311	2,703	1,577	8,812
<b>Total Biovolume (um<sup>3</sup>/mL):</b>	250,004	172,845	57,452	428,547	324,176	8,673,463
<b>Trophic State Index:</b>	39.9	37.2	29.4	43.7	41.7	65.4
<b>Average Total Density (#/mL):</b>	357	554	323	2383	1663	7260
<b>Average Total Biovolume (um<sup>3</sup>/mL):</b>	275,529	148,936	73,633	265,334	286,420	7,486,386
<b>Average Trophic State Index:</b>	41	36	31	39	41	64



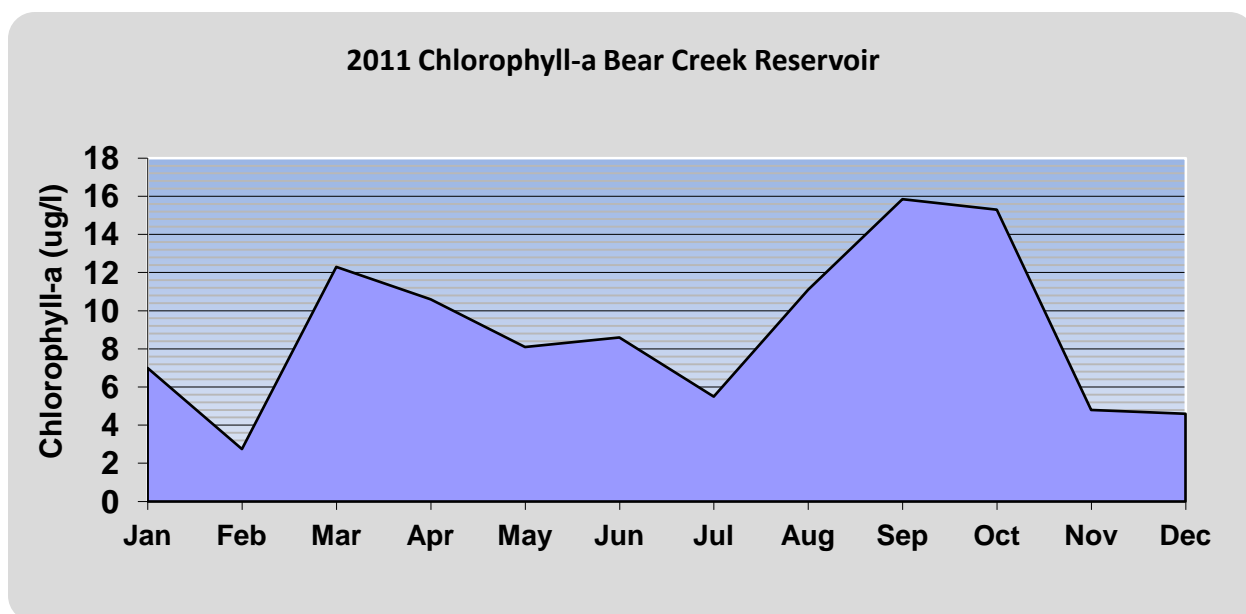
**Figure 18      Phytoplankton Summer Total Density**



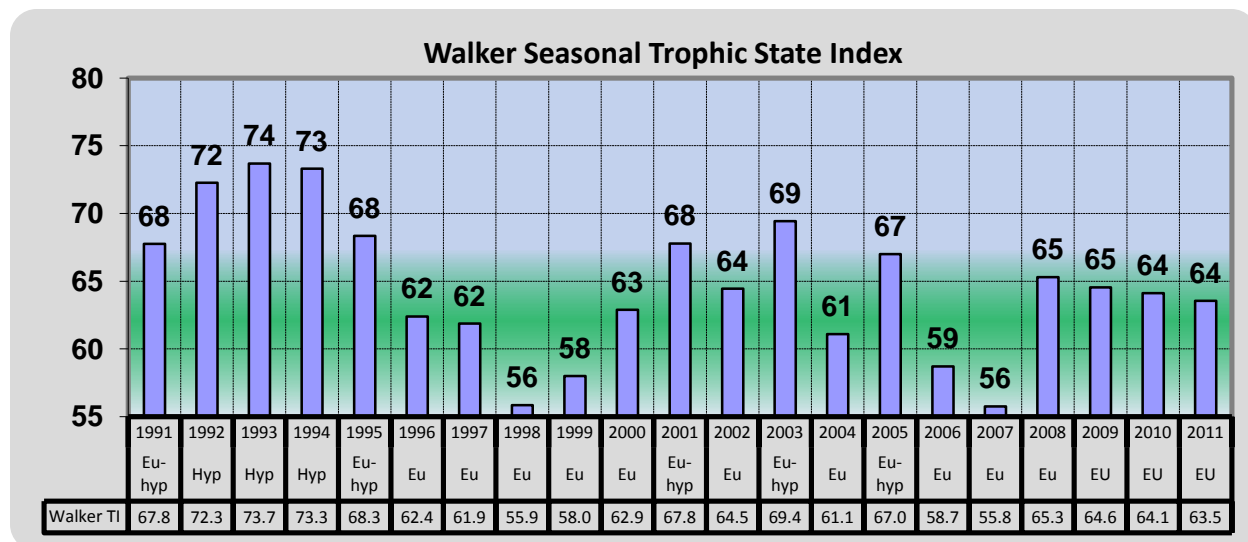
**Figure 19** Secchi Depth Bear Creek Reservoir

The reservoir had several algal blooms in 2011 as evidenced by the peak September chlorophyll concentration of 17.4 ug/l. In 2011, bloom frequency increased in September, as evidenced by the surface chlorophyll concentrations (Figure 20). The peak phytoplankton density in 2011 was 8,417,438  $\mu\text{m}^3/\text{mL}$  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 in 2011 was eutrophic (Walker Index, Figure 21). The Carlson Index shows a similar eutrophic trend. Although external nutrient loads were lower than historic trends, the reservoir continues to have an internal nutrient loading problem, which causes eutrophic water quality conditions.



**Figure 20** Chlorophyll Trend



**Figure 21 Walker Trophic Index Trend Bear Creek Reservoir**

### **Bear Creek Reservoir Aeration Practice Manages Summer Dissolved Oxygen**

The reservoir aeration system reduces chlorophyll productivity, possibly through the partial control of internal nutrient loading that can trigger algal blooms. The Association adopted a policy that makes the reservoir aeration system a permanent reservoir management tool. The Association determined through ongoing monitoring that the de-stratifying aeration system in Bear Creek Reservoir is a necessary and long-term or permanent management practice necessary to protect the quality reservoir fishery (Figure 22) and prevent Dissolved Oxygen standard exceedances during summer months of June 1-September 30. Reservoir aeration is also a necessary management tool in low flow conditions. The current aeration system has been operational since the summer of 2002 and uses a fine-bubble diffusion system with aerators distributed across the hypolimnion. In 2011, the Association and Lakewood operated the aeration system to assure oxygen transfer during phased on-off cycling (Figure 23), with the aeration system phased primarily on in the growing season. The aeration system can increase the Dissolved Oxygen concentrations throughout the water column by about 2 mg/l within a two-week period.



**Figure 22 Fishing Very Popular on Bear Creek Reservoir**



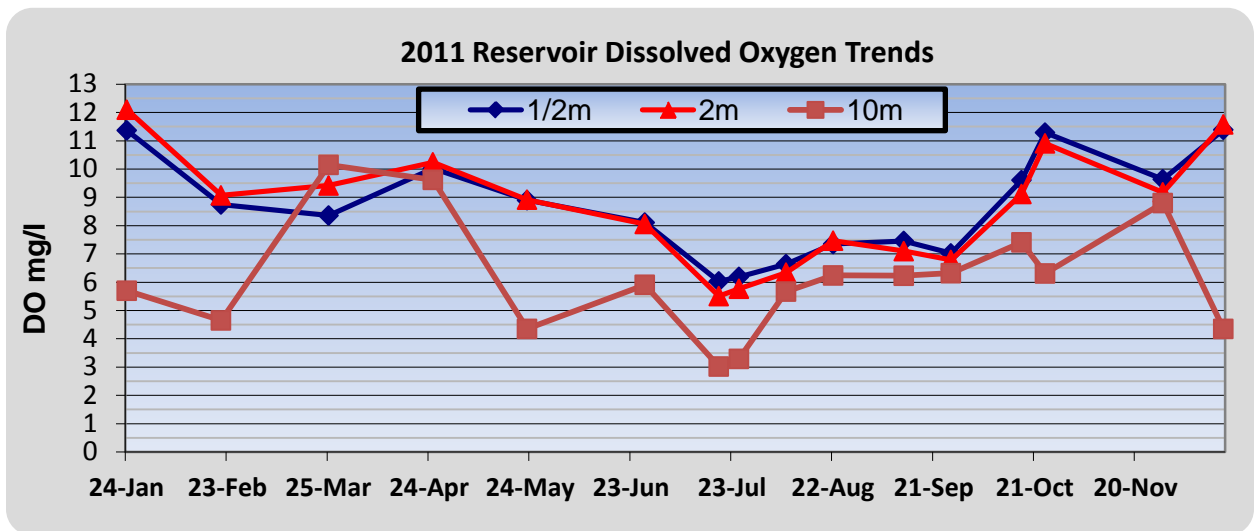


Figure 23 Reservoir Dissolved Oxygen Trend

### Bear Creek Sediment Study

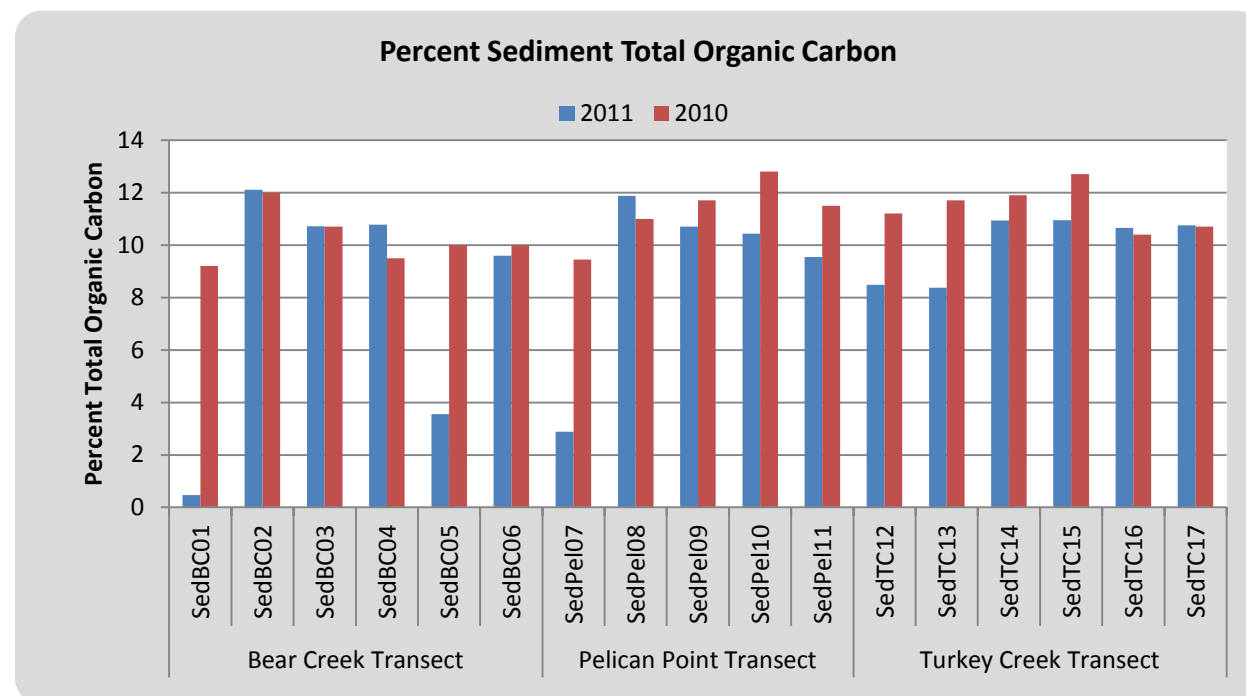
The total suspended sediment load in the reservoir has been generally constant over the historic monitoring period with periodic storm events dumping large volumes of sediment into the reservoir. The Association in 2011 noted no significant change in reservoir depth. Bottom sediments remain a mixture of fine sand, silt and mud.

Field sampled on October 17 and 18, 2011. Bottom samples obtained with a petite Ponar sampler. This sampler takes a grab of the top 5-6 cm of the mud bottom. One dredge drop made at each site resulting in about 0.5 liters of bottom mud. The locations in Figure 24 are estimates. A sub-sample was bagged from the composite mud sampled at the site. The contents of the sample were placed in a drying pan. Samples air dried in a warm room for 48 to 72 hours. A number of the mud samples contained red worms that were about ½ cm long. The number of worms observed ranged from 1-14 per sample where present.



Figure 24 Bear Creek Reservoir Bottom Sample Sites

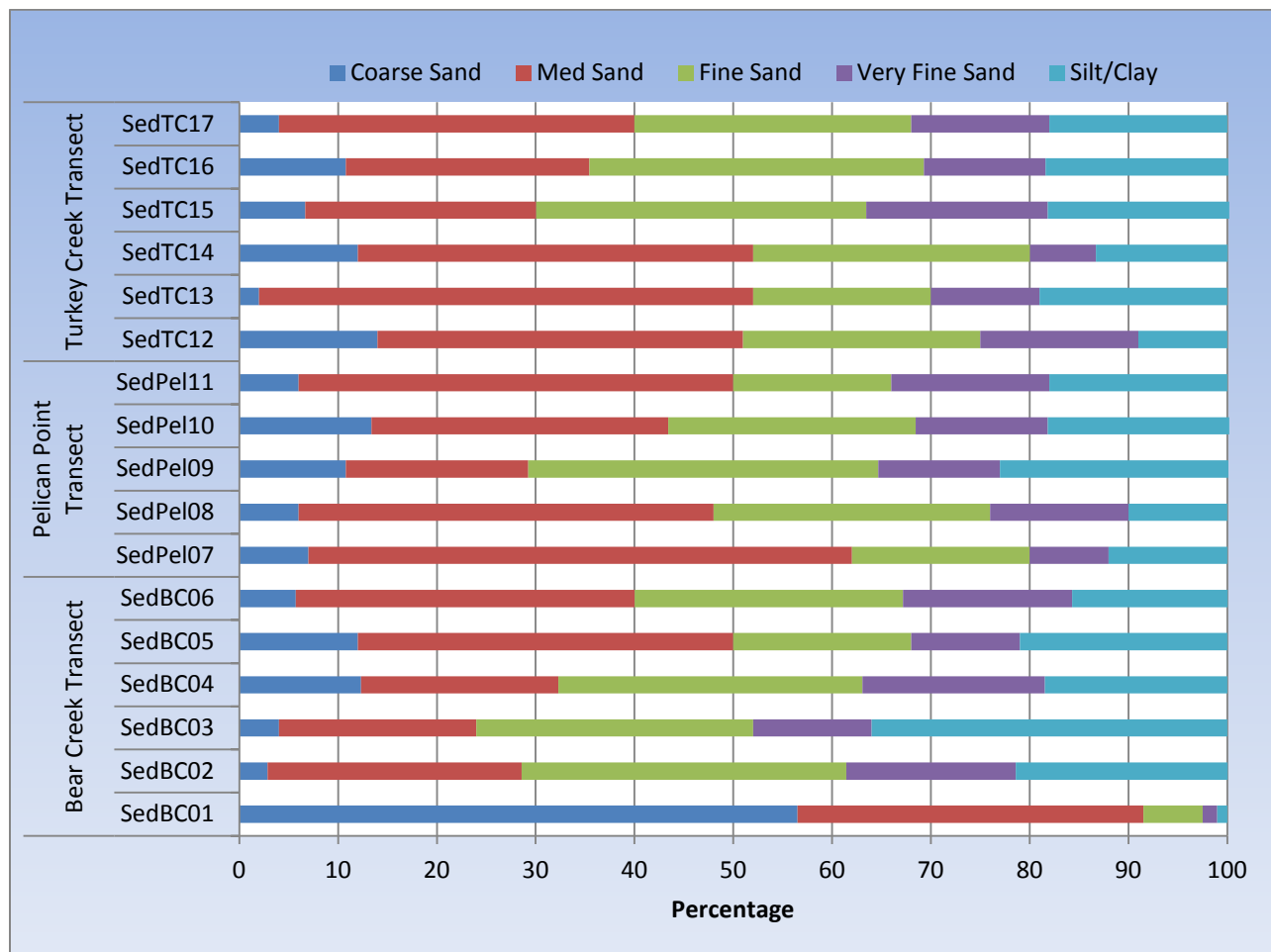
Figure 25 summarizes the total organic carbon (TOC) in bottom sediments. The TOC ranges from 3-13 % within the top 1/4m of the bottom sediments. The Association determined the total phosphorus content of the sediment (mg TP/kg Mud) as shown in Table 6. The Total phosphorus content ranged from 0.5 to 11.5 mg TP/kg Mud. There is a considerable amount of phosphorus within the bottom muds. Figure 26 characterizes the sediment grain-size distribution. The bottom sediment contains about 20% clays and silts. The Association will continue the sediment program in 2012.



**Figure 25 Total Organic Carbon in Bear Creek Reservoir Sediments**

**Table 6 2010 and 2011 Total Phosphorus Results**

Transect	Sample	2011	2010
		mgP/kg Mud	mgP/kg Mud
Bear Creek Transect	SedBC01	2.42	2.64
	SedBC02	4.37	6.43
	SedBC03	6.11	4.12
	SedBC04	2.75	5.32
	SedBC05	5.21	3.50
	SedBC06	1.08	4.09
Pelican Point Transect	SedPel07	4.14	5.39
	SedPel08	3.39	7.47
	SedPel09	11.50	6.25
	SedPel10	2.20	3.13
	SedPel11	6.86	7.71
Turkey Creek Transect	SedTC12	0.52	2.69
	SedTC13	3.22	1.74
	SedTC14	8.11	7.32
	SedTC15	8.15	6.99
	SedTC16	1.91	5.76
	SedTC17	3.18	8.16
Average		4.42	5.22
Stan dev		2.91	2.02
t-test		0.12	



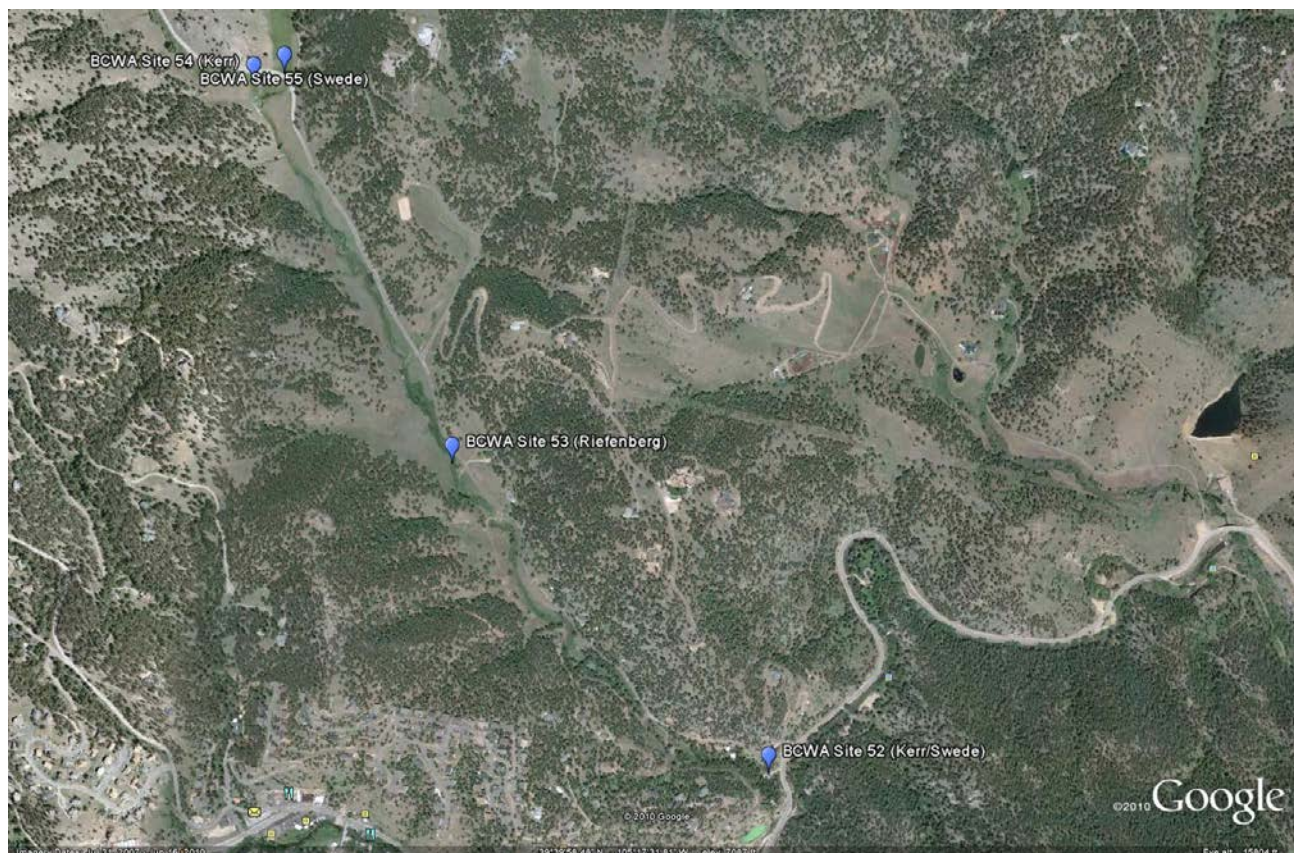
**Figure 26 Grain-Size Distribution in Bottom Muds**

### 2011 Bear Creek Kerr/Swede Gulch E. coli Study

The Colorado 303(d) list lists 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 27). The Division and Association agree this area maybe a good candidate to understand the impact of 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 committed to a 5-years monitoring program to evaluate E. coli 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 27) from January (provided winter flows) through December. The Association also collects data for temperature, pH, specific conductance and Dissolved Oxygen using the field probe. The Association is using the wastewater treatment plant laboratories for the E. coli analyses.

Table 7 shows the 2011 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 is also monitoring nitrogen and phosphorus, flow and standard field parameters. Technical Memorandum 2011.02 (BCWA, March 2012) summarizes all data for this study.



**Figure 27 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 (Cells/100ml)
<b>1/25/2011</b>						
Site 52 - Confluence	9:14	-0.1	8.39	0.767	10.47	6
Site 53 - Riefenberg	9:41	-0.1	7.94	0.773	9.63	4
Site 54 - Kerr	10:04	0	7.86	0.805	8.56	15
Site 55 - Swede	9:56	0.1	7.99	0.867	9.02	12
<b>2/22/2011</b>						
Site 52 - Confluence	9:45	-0.1	8.57	0.877	7.87	43
Site 53 - Riefenberg	10:05	0.0	7.92	0.885	10.25	25
Site 54 - Kerr	10:32	0.0	7.81	0.878	10.26	19
Site 55 - Swede	10:25	0.4	7.64	0.924	10.01	20
<b>3/28/2011</b>						
Site 52 - Confluence	12:00	4.1	7.85	0.789	6.91	1
Site 53 - Riefenberg	12:12	5.3	7.89	0.81	11.52	1
Site 54 - Kerr	12:28	5.7	7.97	0.81	11.37	7
Site 55 - Swede	12:22	4.9	7.66	0.88	11.28	1
<b>4/27/2011</b>						
Site 52 - Confluence	10:08	3.9	7.6	0.84	10.89	1
Site 53 - Riefenberg	10:22	4.9	7.72	0.83	10.91	1
Site 54 - Kerr	10:32	5.6	7.7	0.83	10.57	5
Site 55 - Swede	10:30	6.1	7.51	0.88	9.88	1



<b>5/23/2011</b>						
Site 52 - Confluence	12:20	9.3	8.63	0.79	8.83	19
Site 53 - Riefenberg	12:30	9.8	8.3	0.77	8.39	12
Site 54 - Kerr	12:50	9.5	8.23	0.176	7.11	26
Site 55 - Swede	12:42	9.7	8.05	0.75	8.14	1
<b>6/16/2011</b>						
Site 52 - Confluence	11:00	13.3	8.56	0.84	7.69	11
Site 53 - Riefenberg	11:10	14.7	8.5	0.84	7.26	13
Site 54 - Kerr	11:26	15.4	8.46	0.83	6.46	1
Site 55 - Swede	11:20	165	8.4	0.93	6.42	3
<b>7/25/2011</b>						
Site 52 - Confluence	12:59	18.3	8.5	0.84	7.31	10
Site 53 - Riefenberg	1:14	18.5	8.4	0.83	7.05	2
Site 54 - Kerr	1:32	19.1	8.28	0.87	6.36	2
Site 55 - Swede	1:27	21.4	8.27	0.85	6.14	2
<b>8/23/2011</b>						
Site 52 - Confluence	11:35	14.9	8.34	0.69	7.72	44
Site 53 - Riefenberg	11:48	15.5	8.3	0.7	6.93	15
Site 54 - Kerr	12:05	16.6	8.27	0.7	7.19	1
Site 55 - Swede	12:00	17.5	8.25	0.127	6.77	8
<b>9/26/2011</b>						
Site 52 - Confluence	1:05	11.8	8.22	0.83	8.2	20
Site 53 - Riefenberg	1:18	13.3	8.12	0.82	7.97	112
Site 54 - Kerr	1:34	15.7	8.13	0.78	6.53	4
Site 55 - Swede	1:30	13.6	8.09	0.491	7.47	4
<b>10/25/2011</b>						
Site 52 - Confluence	9:55	4.3	8.39	0.762	10.61	6
Site 53 - Riefenberg	10:10	5	8.65	0.777	10.05	1
Site 54 - Kerr	10:23	5.3	8.47	0.786	9.51	7
Site 55 - Swede	10:18	5.3	8.51	0.773	9.49	1
<b>11/28/2011</b>						
Site 52 - Confluence	12:12	2.2	8.43	0.832	12.08	1
Site 53 - Riefenberg	12:30	1.9	8.07	0.818	11.7	1
Site 54 - Kerr	12:49	0.1	7.99	0.803	11.62	7
Site 55 - Swede	12:44	2.3	7.97	0.836	11.17	6
<b>12/28/2011</b>						
Site 52 - Confluence	13:20	1.2	8.19	0.833	10.8	1
Site 53 - Riefenberg	13:35	0.7	8.1	0.82	10.98	1
Site 54 - Kerr	13:57	0	8.38	0.826	10.75	1
Site 55 - Swede	13:51	0.6	8.23	0.825	10.92	1

**Table 8 E. Coli 2011 Geometric Mean Summary**

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

## 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 9 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. Two reporting facilities exceeded the assigned wasteload allocations (Table 9). Brook Forest Inn complied with the 1.0 mg/l total phosphorus permit limit.

**Table 9 Treatment Facility Wasteload Allocations**

<b>Bear Creek Watershed Wastewater Treatment Plant</b>	<b>Phosphorus Pounds/ year</b>	<b>2011 Phosphorus Pounds/ year</b>
Evergreen Metropolitan District	<b>1,500</b>	<b>199.46</b>
West Jefferson County Metro District	<b>1,500</b>	<b>215.89</b>
Genesee Water and Sanitation District	<b>1,015</b>	<b>289.41</b>
Town of Morrison	<b>600</b>	<b>109.45</b>
Kittredge Sanitation and Water District	<b>240</b>	<b>35.25</b>
Forest Hills Metropolitan District <sup>1</sup>	<b>80</b>	<b>25.73</b>
Conifer Metropolitan District	<b>80</b>	<b>1.42</b>
Aspen Park Metropolitan District	<b>40</b>	<b>6.94</b>
Jefferson County Schools – Mt. Evans Outdoor School	<b>20</b>	<b>1.41</b>
Jefferson County Schools - Conifer High School	<b>110</b>	<b>1.06</b>
Bear Creek Development Corp. - Tiny Town	<b>5</b>	<b>4.32</b>
Bear Creek Cabins (Bruce & Jayne Hungate)	<b>5</b>	<b>10.96</b>
Brook Forest Inn <sup>3</sup>	<b>5</b>	<b>8.01</b>
Geneva Glen <sup>4</sup>	<b>5</b>	<b>0</b>
<b>Total Operational Facilities</b>		<b>909.31</b>
The Fort <sup>2</sup>	<b>18</b>	<b>No Monitoring</b>
Singing River Ranch	<b>30</b>	<b>Not Operational</b>
Reserve Pool	<b>2</b>	<b>Not used 2011</b>
<b>Total Phosphorus Wasteload</b>	<b>5,255 lbs/year</b>	

- 1 Forest Hills Metro District has trade agreement with West Jefferson County Metro District and complies with permit. 88.5 pounds was added into the West Jefferson County allocation, which was 190.21 pounds for a total West Jefferson County Metro District discharge of 278.69 pounds.
- 2 Permit; No established monitoring
- 3 Brook Forest Inn reporting is under new owner/operator
- 4 The Geneva Glen treatment system land applies, dry lysimeters



### Permit Compliance and Plant Expansions/Actions

Table 10 shows permitted wastewater treatment facilities in the watershed, status of wastewater planning, and reported permit compliance problems. All wastewater treatment plants in the watershed are minor facilities using the WQCD permit classification system. The Association worked on planning and review efforts for Forest Hills Metro District and Town of Morrison.

**Table 10 Wastewater Planning Status**

Facility	Wastewater Utility Plan	Any Updates, Lift Station, or Amendments	Facility Upgrades [2011-2015]	Compliance Problems
Evergreen Metropolitan District	Yes	Lift Stations	Yes	No
West Jefferson County	Yes	No	No	No
Genesee	Yes	Lift Station Complete	Yes	No
Kittredge	Yes	No	No	No
Morrison	Yes	Updated Utility Plan, planned upgrades 2012/2013	Yes	No
Jefferson County Schools Conifer High School	Yes	Lift Station Complete	Yes	No
Jefferson County Schools Mt Evan Outdoor	Yes	New facility Design	Yes	Yes
Forest Hills Metropolitan District	No	New Plant	Yes	No
Conifer Sanitation Association	Yes	No	Yes	No
Aspen Park Metro District	Yes	Infiltration gallery, Outfall	Yes	Yes, Gallery Operation
Conifer Metro District (CMD)	Yes	No	No	Chloride -3-yr window to correct problem
The Fort	Yes	New Treatment Works, Monitoring	Yes	No
Bear Creek Development	No	No	No	No
Bear Creek Cabins	No	No	Yes	Yes, Phosphorus Conc. Pounds
Singing River Ranch	No	Plugged Influent	No	No
Brook Forest Inn	No	Yes, new upgrades	Yes	Yes, TP Pounds
Geneva Glen	Yes	No	No	No

### 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 11 lists all Association trades. The reserve pool remained at 2 pounds and no changes made in 2011. The trades in the watershed remain consistent with the total wasteload allocations listed in Table 9.

**Table 11 Phosphorus Trading Activity in Bear Creek Watershed**

Involved Agencies	Type of Trade	Active Trading in 2011
Forest Hills Metro District (FHMD) has trade agreement with West Jefferson County	Point Source to Point Source	Yes (reflected in WLA; see Table 9)

Involved Agencies	Type of Trade	Active Trading in 2011
Metro District(WJCMD) <sup>1</sup>		
City of Lakewood Coyote Gulch Project	Nonpoint source trade credits	Under data collection/ review by Association; trade credit calculated in 2011
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

<sup>1</sup>The trade agreement is between WJCMD and FHMD for phosphorus removal. FHMD is allowed to discharge PO<sub>4</sub> at a concentration of 1.0 mg/L. WJCMD agrees to remove the remainder. The calculations are as follows:

- Total lbs of PO<sub>4</sub> FHMD is allowed to discharge is calculated by Flow X 1.0 mg/L X 8.34
- mg/L is subtracted from the FHMD reported average monthly concentration
- This is the concentration of PO<sub>4</sub> WJCMD agrees to remove
- Total lbs of PO<sub>4</sub> WJCMD removes is calculated by FHMD flow X calculated concentration X 8.34
- The total lbs of PO<sub>4</sub> discharged by WJCMD is calculated by the total of WJCMD + Excess FHMD PO<sub>4</sub> pounds

### **Regulated Stormwater Management**

The City of Lakewood has a municipal separate storm sewer permit. Lakewood supports many stormwater management programs in the watershed, including the *Rooney Road Recycling Center*, which also serves as watershed prevention BMP. Lakewood collected waste products for proper disposal (includes oil, paint, antifreeze, misc. chemicals, and solid wastes) from an Evergreen area collection in 2011. 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 separate storm sewer system permittee activities contained CDPS Stormwater Permit Annual Report for 2011 (City of Lakewood, April 1, 2012).

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

Jefferson County also maintains an erosion and sediment control program as part of their MS4 permit. The county maintains a small-site erosion control manual that explains the basic principles of erosion control and illustrates techniques to control sediment from small development sites. Jefferson County has an inspection program for illicit discharges, construction activities, and includes post-construction Inspections (Table 12).

**Table 12 Jefferson County Storm Water 2011 Activities and Actions**

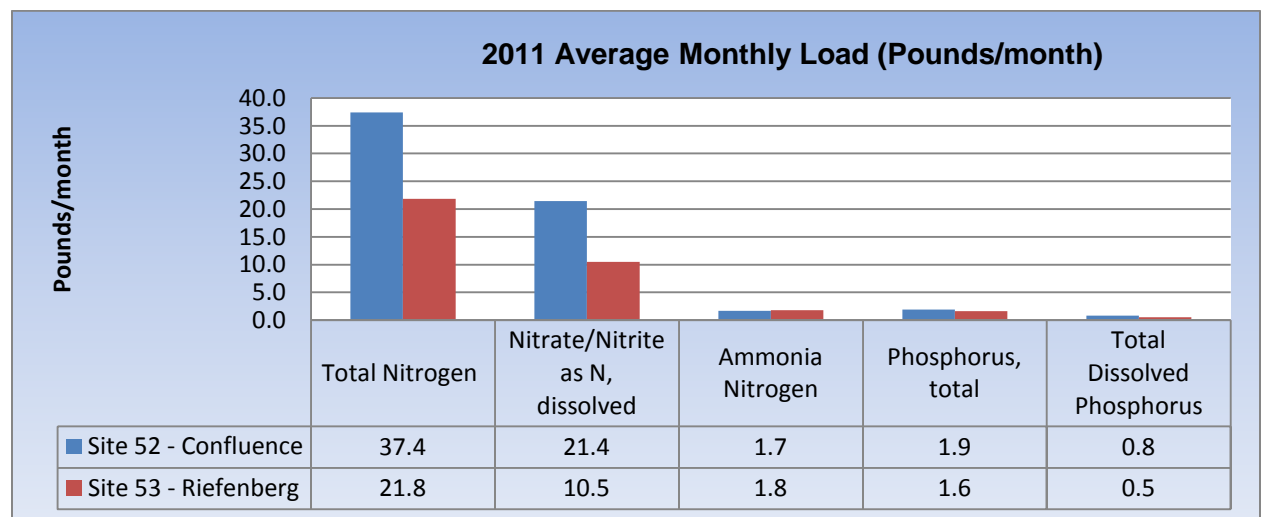
Activity	Inspections/ Action
Illicit Discharge Verbal Notification of Violation	3
Illicit Discharge Monetary Penalty/Fine	0
Construction Sites Covered by Program	62
Construction Inspections	562
Enforcement Verbal Notification of Violation	110
Post-Construction Inspections	2
Storm drain marking program	Ongoing

## Nonpoint Source Loading and Appropriate Best Management Practices

### Septic System Management

In 2011, the Association continued limited discussions with Jefferson County Health Department based on previous presentations made to the Jefferson County Board of Health and the Jefferson County Commissioners. Jefferson and Clear Creek counties reviewed their septic system regulations. The Association predicts onsite wastewater systems in a number of specific areas in the Bear Creek Watershed contribute to water quality degradation. There are estimated 27,000-onsite systems in the watershed.

The Association has two special monitoring efforts in progress to determine surface water quality affected from areas on septic systems: Kerr/Swede Gulch and Cub Creek. The Kerr/Swede Gulch focus on a limited number of septic systems (<35) that potential add nutrients to the lower portion of the drainage between site 52(Confluence) and site 53 (Riefenberg) (Figure 28). The monitoring program suggests there is a nutrient load that potentially is related to septic system discharge.



**Figure 28 Comparison of Nutrients Between Sites 52 and 53**

The Association is also monitoring upstream and downstream on Cub Creek where there are > 1,000 septic systems. The total phosphorus load distinctly increases from upstream to downstream by 257% on average. However, the nitrogen increase is moderate in comparison (4%).

### Watershed Nonpoint Source Program Elements

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.

The Association will increase monitoring of stormwater loadings in select locations in the middle section of the watershed. The Association has identified a number of potential project locations requiring corrective land use controls. The Association has worked with several local businesses that caused minor nonpoint source runoff from their business sites with the implementation of runoff controls. These runoff control programs were very successful. The Association is actively accesses a number erosion areas for potential future projects.

### **Association Land-Use Review**

The Association has a limited number of “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 five referrals in 2011 that addressed issues related to erosion, septic management, land disturbance, re-zoning, water quality degradation and appropriate use of best management practices.

### **Denver Water Department Special Study**

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).

### **Coyote Gulch Nonpoint Source Restoration**

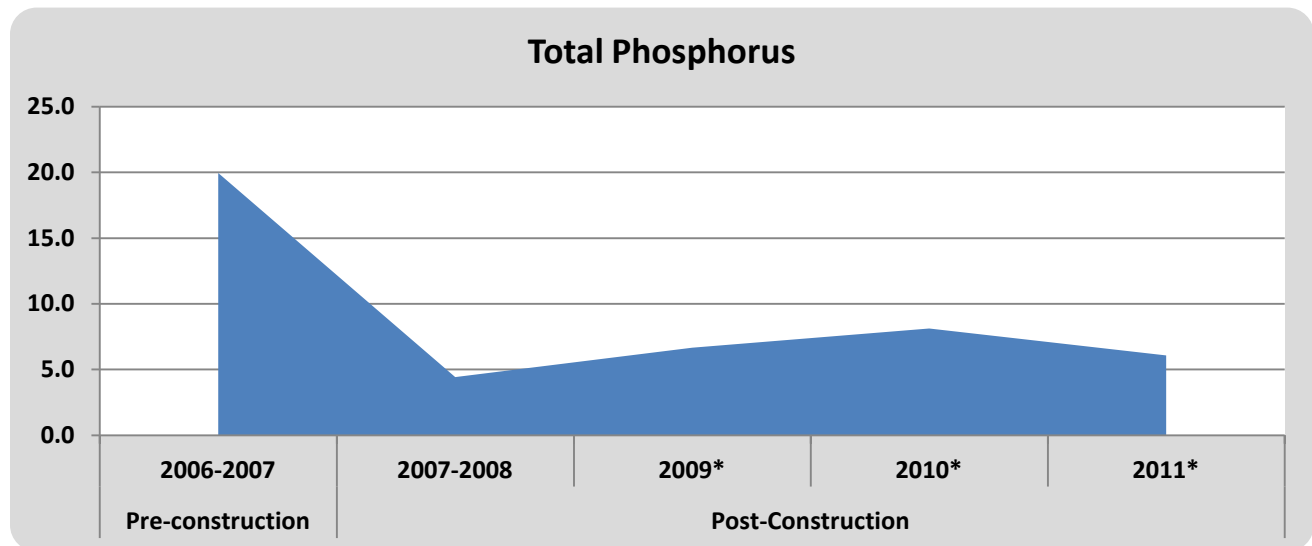
The Association is involved in a nonpoint source project sponsored by the City of Lakewood that restored a severely eroded section of Coyote Gulch. Coyote Gulch revegetation began in June 2007 and became well established in 2008. The Association has a paired water-sampling program, which allows a determination on the effectiveness of the restoration effort at phosphorus reduction (Table 13). The Association has monitored flow and limited chemistry since March 2006 in Coyote Gulch. The Association Technical memorandum Coyote Gulch Summary January 2012 (TM 2011.01) provides a detailed summary of the monitoring and data. Table 14 identifies the annual available total phosphorus trade pounds consistent with the Association trade program. The total phosphorus reduction for the project is shown in Figure 29.

**Table 13      Average and total pounds per month at monitoring sites as base load (all data)**

		Monthly Average Loading Pounds By Year			
		Reservoir		Above Project	
		Nitrate	T Phos	Nitrate	T Phos
Pre-construction	<b>2006-2007</b>	200.7	20.0		
Post-Construction	<b>2007-2008</b>	128.7	4.4	160.9	5.2
	<b>2009*</b>	142.0	6.7	185.9	8.9
	<b>2010*</b>	203.7	8.1	222.3	8.5
	<b>2011*</b>	103.0	6.1	163.9	7.0
		Loading Pounds After Stable			
		Reservoir		Above Project	
		Nitrate	T. Phos	Nitrate	T Phos
Total Pounds		<b>7,383</b>	<b>518</b>	<b>9,025</b>	<b>579</b>
Average		<b>164</b>	<b>12</b>	<b>201</b>	<b>13</b>
Median		<b>88</b>	<b>5</b>	<b>137</b>	<b>6</b>
2009*/2010*/2011* average loadings per year excludes April storm loadings					

**Table 14      Annual Available Total Phosphorus Trade Pounds**

<b>Total Phosphorus Trade Pounds</b>				
	Total Base Flow		Trade Ration Pounds	
	Monthly	Annual	Monthly	Annual
Average	6.3	75.9	6.8	<b>81.8</b>
Median	6.4	76.5	6.8	<b>81.5</b>
Monthly TRP=PC Base Load-TBF Monthly Pounds/2				
The base trade ratio is 2:1 for Association Trade Projects				
Base Flows Exclude April Storm Loadings				
Annual Trade Pounds Available = 81.8 pounds Total Phosphors				



**Figure 29      Total Phosphorus Reduction**

### **Regional Parks Recycling Efforts**

The City of Lakewood is in their 8<sup>th</sup> year of recycle and litter management at their regional parks, including Bear Creek Park. In 2011, the program recycled motor oil (10 gallons), aluminum (516 pounds scrap and 611 pounds of cans), steel and tin (8,980 pounds), glass (8 cubic yards), plastic and paper products (18 cubic yards), light bulbs, tires, all batteries (60 pounds), paints, and other chemical, which disposed at the Rooney Road Recycling Center. The city continues trash clean up along Bear Creek and Turkey Creek drainages and around the reservoirs. In 2011, volunteers did erosion control, willow planting, park clean-up, trail work and vegetation management. Recycle your fishing string program was implemented to help keep shorelines clean (received eco-award)

### **Aspen Park/ Conifer Waste Recycling Program**

The Conifer Area Council has maintained a “Recycling / Sustainability Committee”, which supported community-recycling efforts in 2011. Information from this committee 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, Westminster 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 5 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. Fire mitigation efforts and pine beetle infestation bolstered the Rooney Road Organic Recycling Program. The organic recycling program improved their site expanding capacity for yard waste, tree branches, leaves, grass clippings, sod and construction waste from residents. An estimated 70 million pounds or 90,000 cubic yards of material were 100% recycled.

### **Invasive Species Protection Program**

#### **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. Overall, the park did > 2,250 standard inspections with two high-risk inspections and no positive samples.

#### **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 Evergreen Metropolitan District and Evergreen Park & Recreation District conducted a harvest and compost project to remove over 17 dump-truck loads of the invasive algae species *Elodea canadensis* from Evergreen Lake (Figure 30). The algal material was composted by the City of Lakewood at the Bear Creek Regional Park and the compost was beneficially recycled.



**Figure 30**      **Harvesting Elodea from Evergreen Lake**



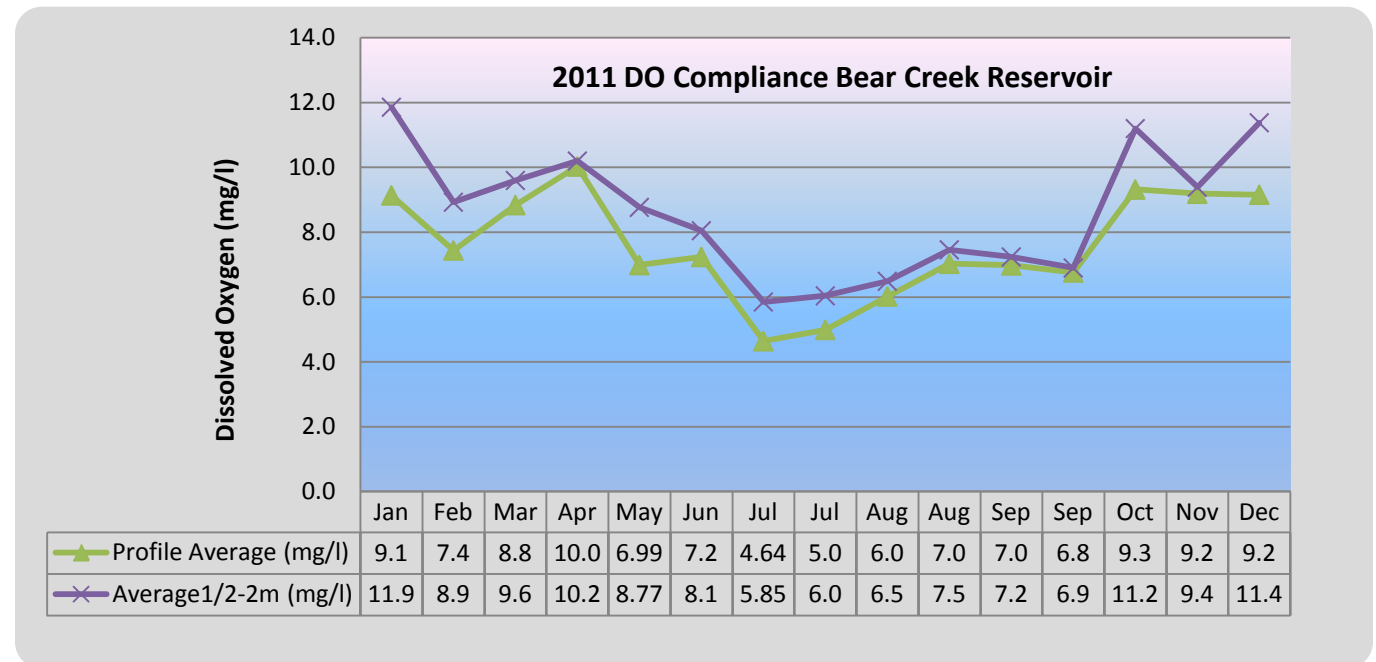
## Meeting Water Quality Goals and Standards for the Watershed

### Dissolved Oxygen Compliance in Bear Creek Reservoir

Bear Creek Reservoir is on the Colorado monitoring list for Dissolved Oxygen. As such, 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 2003-2011 for Bear Creek Reservoir shows over 99% compliance with the standard for the upper water column (surface through the mixed layer). The Dissolved Oxygen values in the mixed layer in 2011 were greater than 6 mg/l except for a 1-week period in July (Table 16, Figure 31). The aeration system was not operating when the Dissolved Oxygen dropped below 6.0 mg/l. The aeration system raised the Dissolved Oxygen above 6.0 mg/l within 5-days. Data collected in the 2011 growing season shows the aeration system adds a maximum of 2.5 mg/l dissolved oxygen to the water column when under normal operation. Generally, the aeration system increases water column dissolved oxygen by about 1 mg/l, which results in dissolved oxygen compliance within the mixed layer.

**Table 15 2011 DO Compliance in Bear Creek Reservoir**

Reservoir Site 40	2011 DO Compliance Bear Creek Reservoir														
	Jan	Feb	Mar	Apr	May	Jun	Jul	Jul	Aug	Aug	Sep	Sep	Oct	Nov	Dec
Total Depth Profile (m)	11.8	10.2	10.7	10.6	11	10.9	11	10.7	10.7	10.7	10.8	10.7	10.7	10.9	10.6
Average 1/2- 2m (mg/l)	11.9	8.9	9.6	10.2	8.8	8.1	5.9	6.0	6.5	7.5	7.2	6.9	11.2	9.4	11.4
Profile Average (mg/l)	9.1	7.4	8.8	10.0	7	7.2	4.6	5.0	6.0	7.0	7.0	6.8	9.3	9.2	9.2



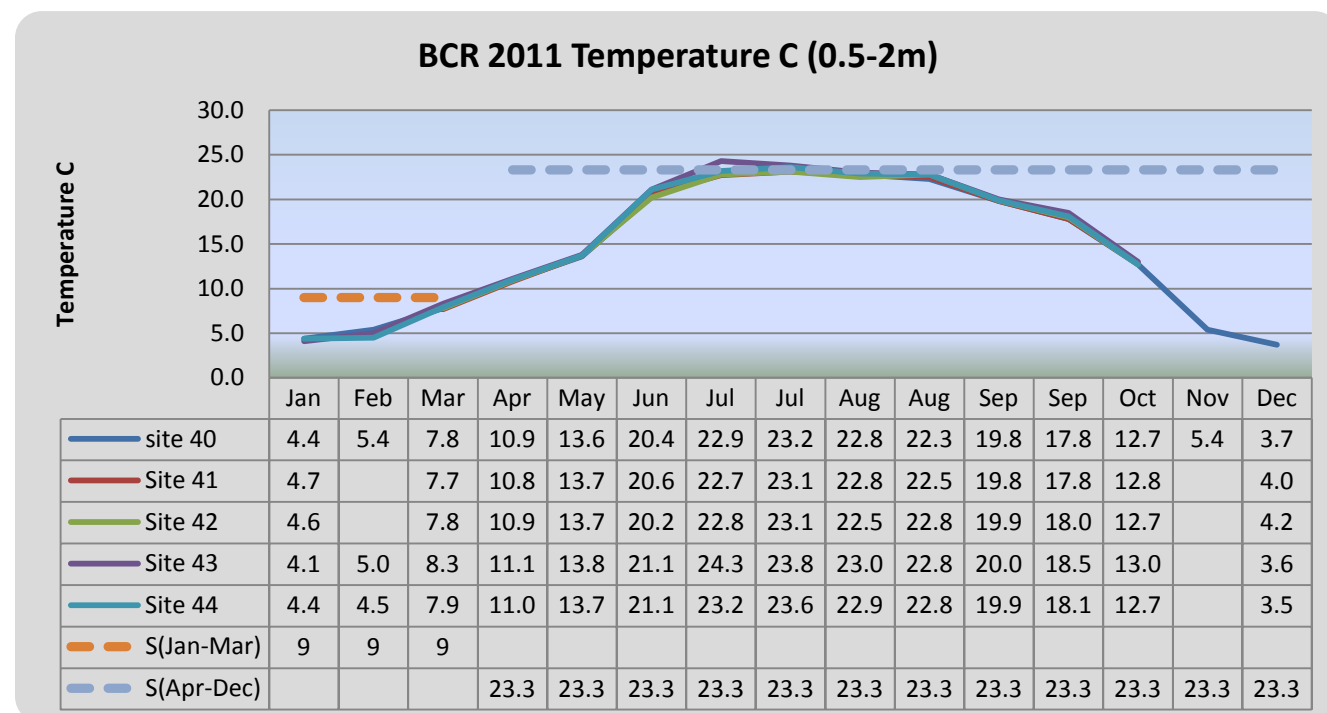
**Figure 31 DO Compliance Bear Creek Reservoir**

### Bear Creek Reservoir Temperature Compliance

The Association takes multiple profile readings at five profile stations in the reservoir to determine temperature compliance. Figure 32 show temperature standards and the compliance record for Bear Creek Reservoir. Site 43 in early July slightly exceeded the temperature standard.

## 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 2011 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.



**Figure 32 Temperature Compliance Bear Creek Reservoir.**

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, at 44 sites. Stream and lake temperature dataloggers located at 33 Sites, including the Evergreen Lake profile station and Bear Creek Reservoir profile station, excluding the five-wastewater treatment plants.

Eight sites have dataloggers temperatures from January 1 through December 30. The 25 remaining sites have temperature data from May through September. Manual flows measured at 24 sites during the July to September timeframe. The warm-season and cold-season temperature compliance summary is shown in Table 18. There was a number of temperature compliance problems recorded in both the warm and cold seasons.

**Table 16 Watershed Temperature Compliance Summary Warm/ Cold Seasons**

	For Stream Loggers Only(NO WWTP DATA)			
BASIN SEGMENT	COLD SEASON		WARM SEASON	
Segment 1a(CS-I)	9.0°C WAT	13.0°C DM	17.0 WAT	21.2 DM
# of Exceedances	2	13	0	1
# of Measurements	40	303	57	405
% Compliance	95.00	95.71	100.00	99.75

	<b>For Stream Loggers Only(NO WWTP DATA)</b>			
<b>BASIN SEGMENT</b>	<b>COLD SEASON</b>		<b>WARM SEASON</b>	
<b>Segment 1b(CS-II)</b>	<b>9.0°C WAT</b>	<b>13.0°C DM</b>	<b>19.3°C WAT</b>	<b>23.8°C DM</b>
# of Exceedances	0	0	4	1
# of Measurements	36	237	87	637
% Compliance	100.00	100.00	95.40	99.84
<b>Segment 1c(CLL)</b>	<b>9.0°C WAT</b>	<b>13.0°C DM</b>	<b>24.0°C WAT</b>	<b>26.0°C DM</b>
# of Exceedances			3	27
# of Measurements			144	1028
% Compliance			97.92	97.37
<b>Segment 1d(CLL)</b>	<b>9.0°C WAT</b>	<b>13.0°C DM</b>	<b>18.2°C WAT</b>	<b>23.8°C DM</b>
# of Exceedances			6	0
# of Measurements			120	848
% Compliance			95.00	100.00
<b>Segment 1e(CS-II)</b>	<b>9.0°C WAT</b>	<b>13.0°C DM</b>	<b>19.3°C WAT</b>	<b>23.8°C DM</b>
# of Exceedances	0	0	0	0
# of Measurements	70	527	171	1227
% Compliance	100.00	100.00	100.00	100.00
<b>Segment 2(WS-II)</b>	<b>13.7°C WAT</b>	<b>14.3°C DM</b>	<b>27.5°C WAT</b>	<b>28.6°C DM</b>
# of Exceedances	0	0	0	0
# of Measurements	13	97	38	243
% Compliance	100.00	100.00	100.00	100.00
<b>Segment 3(CS-I)</b>	<b>9.0°C WAT</b>	<b>13.0°C DM</b>	<b>17.0 WAT</b>	<b>21.2 DM</b>
# of Exceedances	0	12	0	0
# of Measurements	12	95	17	122
% Compliance	100.00	87.37	100.00	100.00
<b>Segment 5(CS-II)</b>	<b>9.0°C WAT</b>	<b>13.0°C DM</b>	<b>17.0 WAT</b>	<b>21.2 DM</b>
# of Exceedances	0	0	0	0
# of Measurements	6	52	89	635
% Compliance	100.00	100.00	100.00	100.00
<b>Segment 6a(CS-II)</b>	<b>9.0°C WAT</b>	<b>13.0°C DM</b>	<b>18.2°C WAT</b>	<b>23.8°C DM</b>
# of Exceedances	0	0	0	0
# of Measurements	33	259	27	213
% Compliance	100.00	100.00	100.00	100.00
<b>Segment 6b(CS-I)</b>	<b>9.0°C WAT</b>	<b>13.0°C DM</b>	<b>17.0 WAT</b>	<b>21.2 DM</b>
# of Exceedances	0	12	0	5
# of Measurements	12	95	17	122
% Compliance	100.00	87.37	100.00	95.90
<b>Segment 7(CS-I)</b>	<b>9.0°C WAT</b>	<b>13.0°C DM</b>	<b>17.0 WAT</b>	<b>21.2 DM</b>
# of Exceedances	0	0	0	0
# of Measurements	1	13	19	136
% Compliance	100.00	100.00	100.00	100.00
<b>Segment 10(CL)</b>	<b>9.0°C WAT</b>	<b>13.0°C DM</b>	<b>17.0 WAT</b>	<b>21.2 DM</b>
# of Exceedances			42	37
# of Measurements			128	920

	For Stream Loggers Only(NO WWTP DATA)			
BASIN SEGMENT	COLD SEASON		WARM SEASON	
% Compliance			67.19	95.98
<b>TOTAL # of Exceed.</b>	<b>2</b>	<b>37</b>	<b>55</b>	<b>71</b>
<b>Total # of Measurements</b>	223	1678	914	6536
<b>% COMPLIANCE</b>	<b>99.10</b>	<b>97.79</b>	<b>93.98</b>	<b>98.91</b>

Low Dissolved oxygen value in the upper water column were measured in Evergreen lake and Genesee Reservoir. An aeration system is being designed for Evergreen lake for installation in the summer of 2012. There were no other water chemistry exceedances of standards measured in the 2011 watershed-monitoring program.

### Other Projects/ Programs Planned or Implemented By BCWA

The Association is assembling a comprehensive water quality, biological and physical characterization data set to define reference sites and conditions. The Association continues data collection efforts to quantify technical components necessary for watershed management. The Association involved, planned or implemented projects not otherwise described in this annual report include:

1. Increased Stormwater Monitoring. 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.
2. Evergreen Park & Recreation District provides maintenance around Evergreen Lake. These efforts all aid in maintaining good water quality. The District maintains the wetlands located on the west end of the lake, works on repairs and improvements to the retaining walls and rocks structure that support the road and walking paths. This work helps to minimize erosion of the area, which contributes to silt and sand accumulations in the lake. The District also contracts with a company that periodically removes rooted vegetation located on the shoreline.
3. Evergreen Metro District and Evergreen Park & Recreation District Algal Removal in Evergreen Lake in 2011 with new equipment ordered for future removal. The districts had Grass Carp introduced into the reservoir with 100 fish at 20 inches.
4. Evergreen Metro District planning aeration system for Evergreen Lake.
5. Evergreen Metropolitan District's Collections and Distribution Department monitors and maintains a storm sewer catch basin at Evergreen Lake. The catch basin is located near the inlet to Evergreen Lake and installed by CDOT to reduce the amount of road grit entering into Bear Creek. The Association will also monitor the performance of this catch basin and determine if the installation of additional catch basins along Bear Creek Canyon would of benefit to the watershed.
6. Evergreen Trout Unlimited conducts spring and fall cleanout operations in Evergreen lake, Bear Creek downtown, O'Fallon. ETU collected over 12 cubic yards of trash and debris.
7. The treatment plants sent notice of pharmaceutical recycling programs
8. Sanitary Sewer Incentive Programs in the Evergreen Area. The Evergreen Metropolitan District and Upper Bear Creek Water and Sanitation District is offering a 50% discount to the current

sewer tap fee to property owners within the District Boundaries connected to Individual Septic Disposal Systems (ISDS) willing to connect. Tanks must be completely drained and removed, filled or collapsed after the property connects to the public collections system. The West Jefferson County Metropolitan District is also offering a discount of \$9,000 to the current sewer tap fee to property owners within the District Boundaries connected to ISDS. Tanks must be drained and removed, filled or collapsed after the property connects to the collections system.

9. Ongoing Education. Annually, the fourth grade classes at Wilmot Elementary School in Evergreen participate in a one-day class centered on the ecology of Evergreen Lake. This is a day of 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 Metro District Water Treatment Facility. Association members are involved in numerous educational and training efforts for schools, clubs, and local agencies and often assist with seminars and conferences.
10. Evergreen High School Junior Watershed Managers Program. The Association has established a pilot program with the high school that provides educational opportunities related to watershed and water quality management. The Association has a “Watershed 101” training course. The Association is working with students to develop several monitoring and restoration projects on the school property and along Wilmont Creek.
11. Evergreen High School Rain Garden. BCWA helped students complete a rain garden.



12. The Association participates with Evergreen Earthday Activities and Programs - The Association provides information to the community on water quality management and environmental issues and supports educational programs. The Association supported the Evergreen Chamber with the Duck Races. Clear Creek water festival.
13. New Signage Kiosk program. The Association is developing and installing new educational signage in the watershed.
14. Partnership Programs - The Association works with Evergreen Trout Unlimited in identifying and implementing new stream restoration projects/programs.
15. Stream Staff gages and Involvement of Members to Gather Stream Data.



16. Collect Data Compatible For Modeling - The Association obtains water quality data for future stream modeling and predictions. Additional evaluation and modeling of the temperature information is necessary to determine a management strategy for the watershed. The Association collected temperature monitoring on Turkey Creek drainages in preparation for potential site-specific standards.
17. Continue Fishery and Stream Characterizations – Support Division of Parks and Wildlife fishery surveys. Characterize how trout populations respond to both natural and human induced alterations. Collect macroinvertebrate data. Conduct additional stream flow studies. Maintain Fishery Analysis and Protocols Guidance.



18. Continued Evaluation of Management Strategies for Watershed Implementation.
19. Community Plan Development and Development Reviews – The Association supports Jefferson County and Clear Creek County in the update and development of community plans for select portions of the watershed. The Association is an active referral agency to these counties.
20. Denver Water Department. The Denver Water Department completed a watershed study in cooperation with the Association.

### **Additional Association Annual Reporting**

The Association produces an annual data summary as a *2011 Master Data Spreadsheet (February 2011)* that includes data analyses, and raw data (Association website [www.bearcreekwatershed.org](http://www.bearcreekwatershed.org)). The Association transmits this data report to the Water Quality Control Division Staff. The watershed-monitoring program summarized in an Association data report (Bear Creek Watershed Association Data Report, June 2012). All of the Association annual reporting documents are available electronically and posted on the website. The Association provides multiple reporting documents designed to meet the multiple functions of various groups. The reporting helps member entities with reporting to their respective boards, commissions and groups. There is also a citizen interest in the watershed and reporting helps keep the public informed. Many educational groups visit the watershed and it has become a widely used outdoor classroom. The Association supplies water quality and environmental materials for these various educational uses.