

# Bear Creek Watershed Report 2004:

## *Annual Report & Water Quality Summary Sheets*

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The Bear Creek Watershed Association is a water quality management agency for the Bear Creek Watershed. The Association implements the *Bear Creek Reservoir Control Regulation* (Regulation #74). The control regulation assures watershed point and nonpoint source water quality compliance consistent with adopted Colorado stream standards and classifications.

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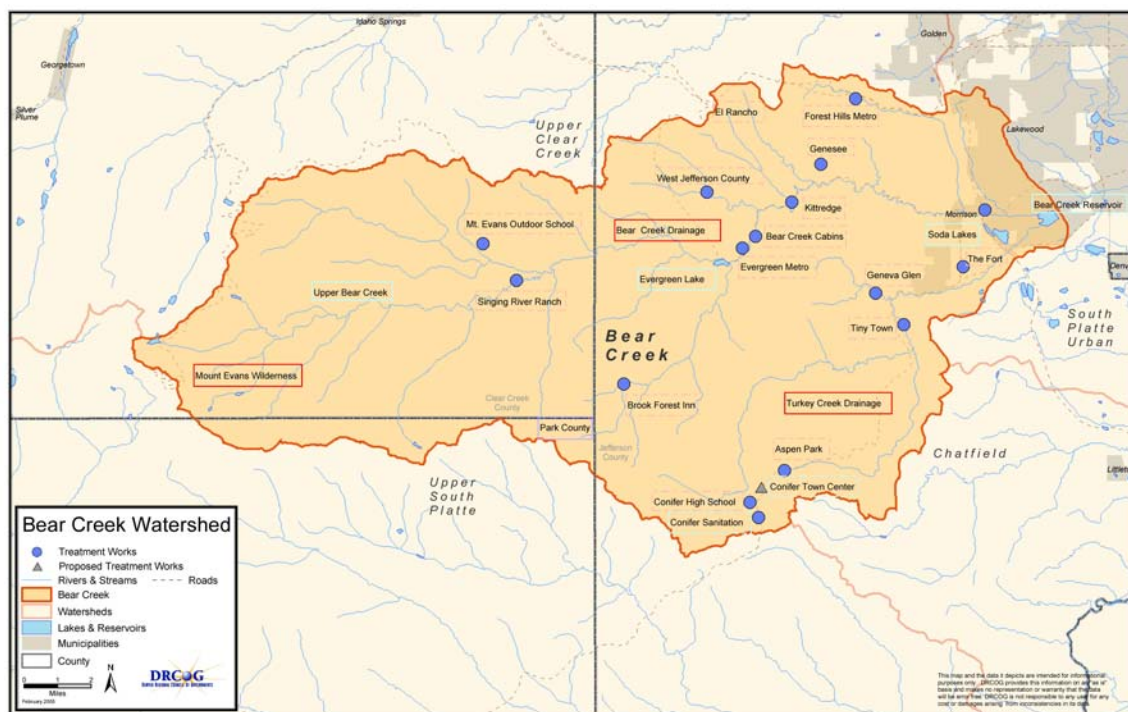
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## Introduction

The Bear Creek Watershed Association (Association) is the designated water quality management agency for the Bear Creek Watershed (Figure 1) as recognized by the Denver Regional Council of Governments in *the Metro Vision 2020 Clean Water Plan* (DRCOG 1998). Water quality data was originally collected as part of an intense one-year *Bear Creek Reservoir Clean Lake Study* (DRCOG 1989). A generally continuous collection of surface quality data has been done in the watershed and reservoir beginning in 1990. Data collection has included specific chemical, physical and biological parameters.

**Figure 1 Bear Creek Watershed**



The Bear Creek Reservoir Control Regulation (Regulation #74) defines the water quality goal, wasteload allocation for total phosphorus, monitoring program and other control strategies for the Bear Creek Watershed. The Association is responsible for implementing the control regulation. The Association provides summary data for the Water Quality Control Commission and Water Quality Control Division.

The long-term management strategies of the Association have improved water quality at the reservoir and within the watershed, including Turkey Creek (Figure 2) and Bear Creek (Figure 3). The trophic status of the reservoir (Figure 4) has shifted from hypertrophic-eutrophic toward the eutrophic-mesotrophic boundary. All major

wastewater treatment plants are in compliance with the control regulation and meet specific wasteload allocations. Several plants had compliance problems and/or lack of reporting to the Association. Overall, the point source nutrient loading to the reservoir is well controlled. Nonpoint source reductions of total phosphorus will be a major focus in the near future. Watershed restoration activities of the Association are limited due to funding limitations and other resource constraints.

Association Web Site

In order to make the Association information and data more accessible to the public and membership, the Association developed and maintains a Web Site: [www.bearcreekwatershed.org](http://www.bearcreekwatershed.org). The web site characterizes water quality monitoring activities, data tabulation, and general trends in the Bear Creek Watershed including water quality and wastewater management efforts.

**Figure 2 Lower Turkey Creek at Morrison**



**Figure 3 Upper Bear Creek at Evergreen**





**Figure 4      Bear Creek Reservoir**



### Bear Creek Reservoir Control Regulation

The Association is responsible for implementing the Bear Creek Reservoir Control Regulation # 74. The control regulation assures watershed point and nonpoint source water quality compliance is consistent with adopted Colorado stream standards and classifications. The Association maintains a water quality-monitoring program designed to assure compliance with adopted standards and classifications and the Bear Creek Reservoir Control Regulation #74.

### Total Maximum Annual Load

The Bear Creek Reservoir Control Regulation #74 incorporates the total maximum annual load (TMAL) that controls total phosphorus wasteload allocations for point sources and the allowable nonpoint source load for the Bear Creek Watershed (Figure 1). The TMAL, which is consistent with a total maximum daily load, results in the Bear Creek Reservoir meeting designed beneficial uses and classifications as listed in regulation #38. The reservoir has a narrative standard based on established trophic indices. The TMAL describes prohibitions, standards, concentrations, and effluent limitations on the extent of specifically identified pollutants that may discharge into the watershed. The elements of the Bear Creek TMAL as approved by Region VIII Environmental Protection Agency and the Water Quality Control Commission are shown in Table 1. The total maximum annual load distributions of total phosphorus by sources are based on the following formula:

*Total Maximum Annual Load (TMAL) = Chatfield Watershed (reservoir base-load + background sources + wasteload allocation) + Upper South Platte River Watershed (reservoir base-load + background sources) + Margin of Safety (MOS).*

**Table 1 Bear Creek Watershed TMAL Elements**

<b>Allocation</b>	<b>Endpoints</b>	<b>Target</b>
Point Source Wasteload Allocation	Total phosphorus effluent poundage limit	The total wasteload allocation for all point sources of phosphorus in the Bear Creek Watershed is 5,255 pounds per year. Each individual discharger is limited to an annual wasteload of total phosphorus (pounds per year), except under trading provisions. Reserve pool maintained for future dischargers.
	Total phosphorus effluent concentration limit	Point source discharges can't exceed a total phosphorus effluent concentration of 1.0 mg/l as a 30-day average, except under trading provisions.
Margin of Safety (MOS)	Implicit MOS	A margin of safety is built into the wasteload and nonpoint source allocations as an implicit MOS.
Nonpoint Source Load Allocation	Reservoir narrative standard	Jefferson County, Clear Creek County, Park County, municipalities, and districts in the Bear Creek Watershed will implement best management practices for control of erosion and sediments.
	Monitoring trophic status indicators	At a minimum, local entities in the watershed will ensure that water quality monitoring is conducted on Turkey Creek, Bear Creek, and in Bear Creek Reservoir on a monthly basis to measure the phosphorus loading reaching the reservoir and other factors which affect the water quality, as well as the attainment of beneficial uses for the reservoir, including meeting the reservoir narrative standard. Data results must be reported to the Water Quality Control Commission and Water Quality Control Division.

### **Update of Control Regulation**

In 2004, the Association in cooperation with Water Quality Control Division staff began drafting recommended changes to the control regulation for a rulemaking hearing scheduled for March 2005. Association and Division proposed changes included:

- Addition of new definitions;
- Adjusting the wasteload allocations for total phosphorus;
- Recognizing three new wastewater treatment facilities;
- Adding wastewater treatment facility trading provisions;
- Clarifying nonpoint source control responsibilities for onsite wastewater management regions;

- Removal of Appendix A on monitoring and replacing it with a quality assurance project plan;
- Changing annual reporting requirements; and
- Requiring wastewater treatment facilities with discharge permits to be part of the Association and pay a pro rata share of monitoring costs.

## **Reservoir Trophic Indicators**

The reservoir-monitoring program provides data for use in assessing compliance with the reservoir narrative standard. Therefore, monitoring parameters are also trophic state indicators. The watershed program evaluates nutrient loading trends and balances for nitrogen and phosphorus species. Secchi depth and total suspended solids characterize the clarity of the water column. Algal productivity is measured by chlorophyll a samples and phytoplankton characterization. Since the growing season is critical for reservoir compliance as defined in the Bear Creek Reservoir Control Regulation (Regulation #74), then monitoring program targets additional sampling during this season. Table 2 depicts critical reservoir trophic parameters and associated 2004 data.

## **Listing Issues And Special Efforts**

### Segment 1a Bear Creek

Based on a recommendation by the Association, Bear Creek segment 1a was placed on the 2002 Colorado monitoring and evaluation list. Decreased flows in 2001 supposedly began to stress resident trout populations, based on local reporting claims made to the Water Quality Control Division, but not presented to the Association. In 2002, Bear Creek was subjected to worst drought on record for the stream with stream flow dropping below measurable values in the middle of the summer. The Association recognized the naturally caused low flow affected trout populations. Consequently, the Association implemented special instream monitoring efforts beginning in the summer of 2001 and continuing through 2004 to obtain scientifically defensible data to characterize the potential chemical changes at low flow conditions. The Association focused this special monitoring on in-situ temperature, ammonia and pH.

Bear Creek segment 1a is on the 2004 Colorado Monitoring and Evaluation List (Regulation #94) for continued evaluation of the listed parameters of concern associated with aquatic life use, ammonia and temperature. The Association has collected over 15,000 water quality data records for various parameters in the watershed at a cost of about \$450,000. This extensive data record has been used to assess the watershed's compliance with conditions listed in regulation #74. The Association has used a watershed-based approach with specific emphasis on water quality within Bear Creek Reservoir. Loading from the watershed has been treated as a reservoir load. However, the Association has and will continue to be protective of water quality throughout the watershed.



**Table 2 Bear Creek Reservoir 2004 - Selected Trophic Indicators**

Trophic Indicator	Reservoir
<b>Chlorophyll</b>	
Average Growing Season Chlorophyll-a [ug/l (surface waters only)]	8.5
Peak Chlorophyll-a [ug/l]	15.2
<b>Phosphorus</b>	
Average Annual Total Phosphorus [ug/l]	31.9
Seasonal Annual Total Phosphorus [ug/l]	40.3
Peak Annual Total Phosphorus [ug/l]	126.5
Average Annual Ortho Phosphorus ug/l]	10.4
Seasonal Average Ortho Phosphorus [ug/l]	16.1
Peak Annual Ortho Phosphorus [ug/l]	81.4
<b>Nitrogen</b>	
Average Annual Nitrate-Nitrogen [ug/l]	247
Seasonal Average Nitrate-Nitrogen [ug/l]	175
Peak Annual Nitrate-Nitrogen [ug/l]	769
<b>Clarity</b>	
Average Annual Secchi Depth (m)	2.6
Seasonal Average Secchi Depth [meters]	2.0
<b>Total Suspended Sediments</b>	
Annual Average Total Suspended Sediments [mg/l]	5.8
Seasonal Average Total Suspended Sediments [mg/l]	6.1
Peak Total Suspended Sediments [mg/l]	21.8
<b>Phytoplankton Species</b>	
Phytoplankton Species Co-dominant Species	Diatom - <i>Asterionella formosa</i>
	Diatom - <i>Aulacoseira italica</i> var. <i>tenuissima</i>
	Green – <i>Chlorella minutissima</i>
	Green - Choricystis minor
	Green – <i>Monomastrix</i> sp
	Cryptophyta- <i>Plagioselmis nannoplanctica</i>
	Chrysophyta - <i>Chromulina</i> sp.
	Bluegreen - <i>Aphanizomenon flos-aquae</i>
	Bluegreen - <i>Aphanothece smithii</i>
	Bluegreen - <i>Microcystis wesenbergii</i>
	Bluegreen - <i>Pseudanabaena mucicola</i>
	Bluegreen - <i>Woronichinia naegeliana</i>
	Bluegreen - <i>Anabaena flos-aquae</i>
Peak Phytoplankton Density	29,200 cells/ml (July)

The Association supplemental water quality-monitoring program for Bear Creek segment 1a is incorporated into the base watershed routine monitoring program. Appendix A is a supplemental monitoring summary report for 2004 data collected in segment 1a. A separate data file containing all stream monitoring data and information is available electronically from the Association. The Association is applying the same rigorous quality control and quality assurance program to this supplemental monitoring effort as used in the base monitoring program. As long as Bear Creek segment 1a is on the monitoring and evaluation list, the Association will continue supplemental monitoring

and data analysis and evaluation. It is not appropriate or scientifically accurate to list the stream segment for aquatic life, temperature or ammonia impairment based on available long-term water quality data record. The Association's long-term water quality monitoring program data record, supported by a Water Quality Control Division approved water quality assurance and quality control plan, does not support an impaired stream status based on water chemistry for temperature or ammonia nitrogen.

### Trout Studies

The suspected aquatic life impairment is based on trout stress in one out of nine years of available shocking information collected by the Colorado Division of Wildlife. The 2002 trout population stress and decline was caused by the lowest flow conditions ever recorded for Bear Creek segment 1a segment with 100-years of flow record available at the downstream Morrison U.S. Geological Survey gauging station.

Chadwick Ecological Consultants completed a report titled *Update Of The Status Of Trout Populations In Bear Creek, Jefferson County, Colorado 1994-2003* (Chadwick 2003). The report evaluated historic trout populations using data collected by the Colorado Division of Wildlife. The report concludes that the drought of 2002 interrupted many established spatial and temporal trout populations in Bear Creek. The report shows the general downstream migration of Brown and Rainbow Trout caused by low flow conditions. The number of adult trout was reduced in 2002 at the upper survey sites. The number of adult trout remained low at the upper two sites in 2003. The report shows good classes of young of the year in both 2002 and 2003.

The trout population in 2003 was recovering with the total density of trout per acres, based on Division of Wildlife surveys, higher than in most previous years. Adult trout began to migrate back upstream and new classes of young trout were found throughout segment 1a. The long-term purported decline in native trout population is not supported by fish surveys. The Colorado Division of Wildlife analysis fish surveys do not support the purported decline in trout populations prior to 2002 drought conditions. In fact, the surveys show a very health population of reproduction Brown Trout and a good population of Rainbow Trout. The 2002 drought season stressed the trout populations in the upper reaches of Segment 1a where flows were reduced to zero or near zero. The survey indicated a general downstream migration of trout into those lower reaches with some flow.

Trout surveys were completed by the Colorado Division of Wildlife in 2004. The Colorado Division of Wildlife performed an electro-fishing fish counts in Segment 1a on September 14-15, 2004. Five locations were surveyed (moving upstream to downstream): Bear Creek Cabins, O'Fallon Park, Lair o' the Bear Park, below Idledale and at the west end of Morrison. The good return of fish density and numbers as reported by the Division of Wildlife in 2004 is a strong indicator that the stream segment will have a natural recovery from the drought stress. Consequently, it is not accurate to claim that fish populations have been permanently impacted by stream water quality. In

fact, the temporary decline in trout populations simply occurred due to lack of stream flow caused by severe drought conditions.

### Macroinvertebrate Assessment

The macroinvertebrate integrity of Bear Creek segment 1a was assessed by collecting macroinvertebrate at four sites along Bear Creek on June 11, 2004: Bear Creek Park, Lair o' the Bear Park, O' Fallow Park, and Upstream Evergreen wastewater treatment plant effluent outfall. Association members used a Surber Stream-bottom sampler (After Brewer and McCann, 1982) and standard sampling protocol. A new fact sheet summarizes the macroinvertebrate data in segment 1a.

### Segment 1c Bear Creek Reservoir

The Bear Creek Watershed Association and the City of Lakewood (member of the Association) maintain separate water quality monitoring programs on Bear Creek Reservoir segment 1c. The Association monitoring program is designed to assess the trophic state of the reservoir and compliance with the Bear Creek Reservoir Control Regulation # 74. The Association is responsible for implementing the control regulation. The City of Lakewood maintains an aeration system in the reservoir as part of the control strategies to restore and enhance the reservoir water quality consistent with the control regulation. The Lakewood monitoring program has been designed to determine the effectiveness of their aeration system. These two monitoring programs are complimentary and essential to the water quality management goals of the Association.

The Association and Lakewood are addressing three water quality topics of interest within the reservoir:

1. Low Dissolved Oxygen - The 2002 and 2003 Colorado Monitoring and Evaluation Lists have identified Bear Creek Reservoir as potentially impaired due to low dissolved oxygen concentrations in the water column during the growing season. Lakewood installed a new expanded aeration system to resolve the dissolved oxygen problem. The Association and Lakewood are documenting this success and will provide evidence for delisting of this problem from the 2006 list.
2. Elevated Reservoir pH - The 2003 and 2003 routine water quality-monitoring programs maintained by the Bear Creek Watershed Association and the City of Lakewood monitoring program measured several water column pH values in excess of the Colorado State upper limit standard of 9.0 pH units. No pH problems recorded in 2004 monitoring program. Elevated pH values are generally indicative of excess algal primary productivity in shallow reservoir systems. A more detailed collection of pH data with a greater temporal and special distribution of samples was done by Lakewood in 2004 to determine the magnitude of this potential problem. A wider fluctuation in pH readings shows in recent data sets and maybe related to algal productivity caused by internal

nutrient loading from reservoir bottom sediments. The Association and Lakewood will continue monitoring evaluations.

3. Reservoir Temperatures Not Supportive of Cold Water Classification - The near surface temperatures in the reservoir have shown an increasing trend over the last five years with numerous measurements in excess of 20 degrees centigrade (C), which is the upper limit for a cold water class 1 waterbody in Colorado. The water column in 2004 from June through August was above 20 C. Additional evaluation and modeling of the temperature information is necessary to determine a management strategy for the reservoir. A question the Association needs to query is if the reservoir classification is correct.

## Water Quality Monitoring

### **Routine Monitoring Program**

The monitoring program characterizes water quality inflow into Bear Creek Reservoir from Bear Creek and Turkey Creek, outflow from Bear Creek Reservoir as a tail-water discharge and downstream water quality. The reservoir is monitored at a single representative station located in the central pool beyond the Bear Creek and Turkey Creek inlets. The monitoring program was reviewed in 2001 and updated as the *2002-2005 Bear Creek Watershed: Sample Analysis Plan (SAP) And Quality Assurance Project Plan (QAPP)* (Bear Creek Watershed Association 2001). This monitoring plan provides the basis for all monitoring activities in the Bear Creek Watershed. A complete copy of the monitoring plan is maintained on the Association web site: [www.bearcreekwatershed.org](http://www.bearcreekwatershed.org).

### Monitoring Sites

The five routine monitoring stations and reservoir station are as follows (*2002-2005 Bear Creek Watershed: Sample Analysis Plan (SAP) And Quality Assurance Project Plan (QAPP)*, Bear Creek Watershed Association 2001):

1. Mainstem of Turkey Creek prior to discharge into Bear Creek Reservoir, within Bear Creek Park, adjacent to the City of Lakewood Maintenance Yard;
2. Mainstem of Bear Creek prior to discharge into Bear Creek Reservoir, within Bear Creek Park, adjacent to the bridge at the western edge of the park;
3. Tail-water discharge from Bear Creek Reservoir in the concrete channel which starts the lower Bear Creek;
4. Mainstem of Bear Creek about 1-mile below Bear Creek Reservoir; and
5. Bear Creek Reservoir, center of main pool beyond the Bear Creek and Turkey Creek Inlets.

## Parameters and Sampling Program

The monitoring program provides necessary data to make statistical water quality trend assessments and verify the effectiveness of control and alternative management programs. The minimum required physical, chemical and biological components listed in the control regulation and shown in Table 2.

## Sample Frequency

The routine watershed-monitoring program focuses on inputs to and outputs from Bear Creek Reservoir. There are 16 reservoir and stream samples taken per calendar year with biweekly monitoring in May, June, July and August, and monthly for other months. There may be some sample periods in the winter where Bear Creek Reservoir cannot be sampled due to poor ice conditions. The stream sampling program is conducted without reservoir sampling. The stream input and output-sampling program targets data collection for all months within a calendar year. A maximum of 16 stream data sets will be collected per year. If a winter reservoir monitoring set cannot be taken due to unsafe conditions, then the reservoir monitoring set will be added at a later time period to the annual monitoring program, which will result in a total of 16 monitoring sets per calendar year within the reservoir.

**Table 3      2002-2005 Water Quality Parameters**

Parameter (units)	Watershed Inflows	Reservoir	Reservoir Outflow/ Downstream
<b>Physical/Field</b>			
Discharge (cu m/s)	X		X
Specific Conductance (umhos/cm)	X	(Profile)	X
Secchi (meters)		(Single measurement)	
Dissolved Oxygen (mg/l)	X	(Profile)	X
Temperature (C)	X	(Profile)	X
Total Suspended Sediments (mg/l)	X	(3 Depths)	X
pH (standard unit)	X	(3 Depths)	X
<b>Biological</b>			
E. Coli (cts/100ml)	(April to October)	(March to November)	(April to October)
Chlorophyll a (ug/l)		(Surface Sample)	
Phytoplankton		(Surface Sample)	
Zooplankton		(Vertical Tow)	
<b>Nutrients</b>			
Ammonia (ug/l)	X		X
Nitrate (ug/l)	X	(3 Depths)	X
Total Particulate Phosphorus (ug/l)	X	(3 Depths)	X
Total Dissolved Phosphorus (ug/l)	X	(3 Depths)	X
Ortho-Phosphorus (ug/l)	X	(3 Depths)	X



Parameter (units)	Watershed Inflows	Reservoir	Reservoir Outflow/ Downstream
Total Phosphorus (ug/l)	X	(3 Depths)	X

## Segment 1a Permanent Monitoring Station

The Bear Creek Watershed Association at their April 14, 2003 Association meeting established the Bear Creek segment 1a monitoring station called *Lair O' The Bear* open space park. This monitoring station will provide a good water quality characterization of upper Bear Creek. The monitoring station switch began for the May 2003 sampling set. There were no changes to the monitoring parameters, quality controls or sampling procedures. The Association's quality assurance plan is modified to show this sample location change.

## Segment 1a Supplemental Monitoring

The Bear Creek supplemental monitoring program collects a data record in the summer growing season of the diurnal fluctuation of temperature at multiple sites within selected sections of Bear Creek. The 2004 Bear Creek sampling and monitoring plan for temperature/pH/dissolved oxygen/conductivity and ammonia is outlined below:

### Temperature Datalogger Monitoring Locations (14) (Continuous hourly measurements, June-September)

- Above Evergreen Lake (at gaging station)
- Evergreen Lake, near dam—Surface, 10' down
- Above EMD WWTP effluent
- EMD WWTP effluent
- WJCMD WWTP effluent
- O'Fallon Park (east end-above Kittredge WWTP effluent)
- KSWD WWTP effluent
- Lair o' the Bear Park (west end-above GWSD WWTP effluent)
- GWSD WWTP effluent
- Below Idledale (at McGoldrick Bridge)
- Morrison gaging station (west end of town, above Harriman Diversion)
- Above Morrison WWTP effluent (start of Bear Creek Segment 1b)
- Morrison WWTP effluent

### Weekly pH/DO/Temperature/Conductivity Manual Monitoring Locations (15) (Alternating weekly morning/afternoon monitoring)

- Above Evergreen Lake (at gaging station)
- Evergreen Lake, near dam—Surface, 10' down
- Evergreen Lake, middle
- Above EMD WWTP effluent
- Below Bear Creek Cabins
- Below Troublesome Gulch
- O'Fallon Park (West end)
- O'Fallon Park (east end-above Kittredge WWTP effluent)
- Kerr Gulch (at Hwy 74 bridge)
- Lair o' the Bear Park (west end-above GWSD WWTP effluent)
- Above Idledale (west end of town)

- Below Idledale (at McGoldrick Bridge)
- Morrison gaging station (west end of town, above Harriman Diversion)
- Above Morrison WWTP effluent (start of Bear Creek Segment 1b)

**Weekly Ammonia Sampling Locations (12)**  
(Sampling coordinated with WWTP effluent ammonia sampling)

- Above Evergreen Lake (at gaging station)
- Above EMD WWTP effluent
- Below Bear Creek Cabins
- Below Troublesome Gulch
- O'Fallon Park (west end)
- O'Fallon Park (east end-above Kittredge WWTP effluent)
- Kerr Gulch (at Hwy 74 bridge)
- Lair o' the Bear Park (west end-above GWSD WWTP effluent)
- Above Idledale (west end of town)
- Below Idledale (at McGoldrick Bridge)
- Morrison gaging station (west end of town)
- Above Morrison WWTP effluent (start of Bear Creek Segment 1b)

**Plan Summary**

- Evergreen Metropolitan District (EMD) will be responsible for sampling and data collection at locations listed above. EMD, West Jefferson County Metropolitan District (WJCMD), Kittredge Water and Sanitation District (KWSD), Genesee Water and Sanitation District (GWSD) and the Town of Morrison will be responsible for providing effluent data collected at their respective WWTP's, including analytical results.
- Interval frequency for temperature dataloggers is once per hour (24 per day). This frequency allows for approximately 75 days of data collection. The dataloggers in wastewater plant discharges shall remain for approximately 60 days, while dataloggers located in the stream will be retrieved and downloaded on a monthly basis.
- Frequency of manual pH/Temperature/DO/Conductivity data collection will be weekly at the temperature datalogger locations (all sites except WWTP effluents) and other sites noted above. Manual monitoring will be performed morning/afternoon in an alternating weekly schedule. Morning data collection will begin at approximately 07:00 in Evergreen and ending in Morrison at approximately 13:00. Afternoon data collection will begin at approximately 12:00 in Evergreen and ending in Morrison at approximately 18:00. Weekly monitoring also provides for checking the integrity of the dataloggers.
- Frequency of manual pH/Temperature/DO/Conductivity data collection in Evergreen Lake will be weekly at the temperature datalogger locations at the dam and at a location defined as the middle of the Lake.
- WWTP effluent data will be collected as part of the typical plant process control performed daily. Effluent pH/Temperature/DO will be recorded and ammonia sampling performed in accordance with the requirements of each WWTP discharge permit. Total ammonia will be analyzed for WWTP effluents by the method allowing for the lowest detection limit. Parameters will then be factored in to determine unionized ammonia.
- Stream ammonia sampling will be performed concurrently with weekly pH/Temperature/DO/Conductivity data collection, with analyses for total ammonia performed by an approved analytical laboratory. Unionized ammonia values will be calculated. Locations for weekly ammonia sampling are listed above. Additionally, stream ammonia sampling will be performed concurrently with pH/Temperature/DO/Conductivity data collection at sites other than listed above, as deemed useful for baseline information. The scheduled stream sampling day will coincide with effluent sampling performed by WWTP.
- Additional stream/lake samples will be obtained for manganese, iron and other analytes for background information.
- Two in-stream locations (O'Fallon Park and Lair o' the Bear Park) will be profiled for pH, Temperature, DO and Conductivity over a 24-hour period. Hourly measurements will be taken. This monitoring will be performed on a weekly schedule, alternating between sites.

- An EPA Bioassessment will be performed to help determine aquatic life use status. In-stream parameters including a macroinvertebrate study, substrate analysis, aquatic vegetation evaluation and fish counts will be incorporated to evaluate aquatic life. District staff will perform some sampling and evaluation, while other parameters will be sampled and identified by ecological consultants. Algae identification will also be performed in Evergreen Lake. Ecological consultants will summarize the bioassessment data gathered.
- Flow measurement will be obtained by gages above Evergreen Lake and above the Town of Morrison. Weekly gage graphs will be downloaded and printed. Manual flow measurements will be obtained as deemed necessary, if flows drop below a predetermined setpoint above Evergreen Lake. Flow locations will include the gaging station above Evergreen Lake, above EMD's WWTP discharge, the O'Fallon Park pedestrian bridge and Corwina Park. Staff gages will be installed as indicators of rising or dropping flows, not substitutes for actual measurements.
- Weather data (High/low temperature, precipitation) from the NWS station at the EMD WWTP will be obtained on a monthly basis.
- Emergency situation: In the event of a fish kill that is reported to EMD or other Association members, monitoring for pH/Temperature/DO/Conductivity will be performed above the event site, at the site and a location 1-2 miles downstream, and ammonia sampling will be performed at the same locations. Upstream WWTP operations will be evaluated to determine potential influence.
- Calibrations of portable equipment will be documented prior to each use and Certificates of Calibration for all equipment will be obtained.
- GPS points will be obtained for all sampling and monitoring locations.
- NIST certifications and Certifications of Compliance will be obtained for each temperature datalogger used in the study.
- The tentative study dates for extensive data collection will be June 1 through September 30.
- An ecological consultant will generate a report and provide expert comment and testimony, as required, for BCWA.

## Management Program

### **Purpose of Association**

The Association includes the City of Lakewood, Town of Morrison, Clear Creek County, Jefferson County, Park County, Evergreen Metropolitan District, West Jefferson County Metropolitan District, Genesee Water and Sanitation District, Kittredge Sanitation and Water District, Willowbrook Water and Sanitation District, Forest Hills Metropolitan District, Jefferson County Schools, Conifer Center Sanitation Association, West/Brandt Foundation (also called Singing River Ranch), Brook Forest Inn, Bear Creek Development Corporation (Tiny Town), Bear Creek Cabins, Geneva Glen, Aspen Park Metropolitan District, Conifer Metropolitan District (Conifer Town Center) and The Fort Restaurant.

The Association provides the framework and opportunity for joint participation in planning, coordinating and review activities for the purpose of implementing a continuing area wide water quality and wastewater management program for the Bear Creek Watershed. Membership entities are general-purpose governments, special districts and all other National Pollutant Discharge Elimination System (NPDES) dischargers within the Bear Creek Watershed as permitted by the Water Quality Control Division. The Association's memorandum of understanding and by-laws describe the roles, responsibilities and meeting requirements of the management agency, operating

agencies and general-purpose governments as related to water quality management activities in the Bear Creek Watershed.

The management agency implements water quality and management strategies, decides on the need for and specific characteristics of wastewater treatment processes and details implementation within specified parameters (Table 1). A watershed Association approach provides an opportunity to coordinate water quality activities at a local level. The Association provides three primary benefits:

1. Ensures an effective watershed level water quality management program consistent with the *Bear Creek Reservoir Control Regulation* and the *Metro Vision 2020 Clean Water Plan*;
2. Ensures cost effective local wastewater management systems within the parameters of the *Metro Vision 2020 Clean Water Plan* and wastewater discharge permits; and
3. Identifies activities that meet water quality compliance.

## **Community Outreach**

### Earthday

The Association helps with Evergreen Earthday activities and provides information to the community on water quality management and environmental issues. The Association develops and distributes educational materials on request. Members of the Association are available for local presentations and training programs.

### Community Plans for Aspen Park Village Center and Evergreen

Jefferson County Planning and Zoning Division has benefited from the support of the Bear Creek Watershed Association respect for recommendations in the community plans. The Association and its members have held public meetings to review development proposals and worked with the community to write a strategy for wastewater treatment in the Aspen Park-Conifer Village Center. The Evergreen community has benefited from the attendance and expertise that Bear Creek Watershed members have provided in the land use planning meetings. Water quantity and quality are the two most important issues that the community plan participants discussed. Thanks to the review and continued interest of the Bear Creek Watershed Association, the County's more recent plan updates recommend strategies to protect the water quality in the southern mountains of Jefferson County.

### Colorado Geological Survey

Special study by Karen Berry (Colorado Geological Survey) assessing the transferability of a water erosion model. Karen is working with the NRCS, Jefferson County, and other local agencies to gather slope, detailed soils, drainage, rangeland

and other land use parameters. The data is used to develop model input files for Turkey Creek. The Association is a supporting group for the study and will value the completed model for use in watershed management.

As part of the Central Plains Community Plan, the Colorado Geological Survey defined hazards. Jefferson County has mapped many of the hazards and constraints in the county with assistance from the Colorado Geological Survey, United States Geological Survey, Colorado State Forest Service, and the Federal Emergency Management Agency. Geologic hazards have been classified into Low, Moderate, and High categories. Hazards should be identified, eliminated, mitigated and/or avoided to prevent the loss of life, property, or costly remediation and to protect the public health and environment. Potential problems need to be identified early in the planning and development process before economic losses and environmental damage occur.

### Highway Reconstruction

The Association works with CDOT and Jefferson County to monitor water quality in Bear Creek during highway reconstruction projects. The Association tries to assure that a project will cause only minor short-term water quality degradation during construction.

### Long-Range Planning and Jefferson County Reviews

The Association works closely with Jefferson County planning and actively reviews any development proposal that could affect watershed environmental or water quality. The Association is a referral agency for Jefferson County.

### Coyote Gulch Nonpoint Source Project

The erosion problem on Coyote Gulch is persistent and the erosion area is not stable as evidenced by the amount of lateral erosion that occurred during an about 10-year runoff event in the end of June. Entire sections of cut banks were eroded into the reservoir.



The reservoir showed substantial additional sediment deposition at the mouth of Coyote Gulch. The Association recommends a full reconstruction/ restoration level project targeted for 2006. The Association and Lakewood will be responsible for water quality studies and characterization. The potential annual total phosphorus reduction from full restoration of lower Coyote Gulch is estimated at 2,042 pounds.



## **Water Quality Monitoring and Fact Sheets**

The water quality-monitoring program is characterized in a series of fact sheets. These fact sheets are designed to provide specific information about the water quality and management program that can be used for multiple purposes independent of the other fact sheets. The fact sheets denote both the 2004 water quality within the watershed and Bear Creek Reservoir, as wells, the long-term trends.

## **Wastewater Treatment Facilities**

Major operating agencies in the watershed include the Town of Morrison, Evergreen Metropolitan District, West Jefferson County Metropolitan District, Genesee Water and Sanitation District, Kittredge Sanitation and Water District, Forest Hills Metropolitan District, Jefferson County Schools, Conifer Center Sanitation Association, West/Brandt Foundation, Conifer Town Center, and Aspen Park Metropolitan District. The minor operating agencies include Brook Forest Inn, Bear Creek Development Corporation, Bear Creek Cabins, The Fort, and Geneva Glen.

The total phosphorus wasteload allocation for all point sources in the Bear Creek Watershed is 5,255 pounds per year. The reporting point source total annual phosphorus discharges are shown fact sheet 9. The Association believes the intent of the control regulation is clear in requiring all treatment facilities to be in compliance and report this information to the Association for incorporation into the annual report. Major reporting treatment facilities are well within their wasteload allocations.

## **Wastewater Discharge Impacts To Fishery**

The municipalities along Bear Creek divert water from Evergreen Lake and Bear Creek, and discharge wastewater treatment plant effluent back to the stream. The report, *Evaluation Of The Effects Of Wastewater Treatment Plants On Trout Populations In Bear Creek, Jefferson County, Colorado, 1994-2001* [Chadwick Ecological Consultants, Inc., 2002], presents historical fish population data available for Bear Creek, identifies spatial trends in trout populations and shows temporal trends from year to year. The data evaluation assessed status of trout populations to determine changes associated with reported fish kills and temperature effects of wastewater discharges. Brown and rainbow trout populations for Bear Creek decline in density and biomass from upstream near Evergreen downstream to near Morrison. However, this trend was reversed during the 2002 drought year due to the downstream migration of both Rainbow and Brown Trout. The general trend occurs in all sampling years, except 2002. The trend relates to the transition of the stream from a coldwater mountain stream to a warm-water plains stream below Morrison. Trout density in 1999 was relatively low at all sites. In 2000 and 2001, trout density and biomass were higher than previous years. A substantial increase in trout density and biomass at all sites occurred between 1999 and 2000. Trout biomass in Bear Creek is consistently above average for Rocky Mountain streams at almost all sites and in most years, and exceeds the biomass criterion for Gold Medal Trout Waters in Colorado during recent years.

The presence of healthy trout populations at sites downstream of treatment plant discharges indicates no adverse effect on trout populations. Modeling of water temperature indicates discharge of wastewater effluent has a slight cooling effect on Bear Creek. The important factor determining trout population density and abundance is related to the magnitude of spring runoff. In years with high runoff, there are fewer trout, and in years of low runoff, trout populations increase. The presence of very strong year classes of both brown and rainbow trout in 2000 indicates conditions during the summer of 2000 were suitable to sustain resident trout populations, including sensitive young trout. The severe drought of 2002 resulted in low flow conditions and elevated temperatures in sections of Bear Creek 1a. This combination of low water with elevated temperatures clearly stressed resident trout populations of Bear Creek. However, the reality is that high quality wastewater discharges provide most of the flow, which allowed resident fish population to survive an extreme natural disaster.

### **Stormwater Management**

The Association is concerned with the quality of dry-weather and stormwater runoff associated with significant development sites. Significant development sites are generally related to urban development construction activities. The Association has developed a project specific monitoring guidance report (BCWA 1996c). However, the Association has no direct responsibility for regulating development activities or implementing site-specific water quality or stormwater control facilities. The Association works with its members through local review processes to ensure that development follows the watershed water quality management strategy using the best available management practices. The Association reviews BMPs and makes recommendations as requested by local governments. Jefferson County and the City of Lakewood began stormwater-permitting programs in 2003. Fact sheet 24 defines the Lakewood stormwater program.

The Board of County Commissioners approved staff to research a utility fee for unincorporated residents and businesses related to capital improvement projects, development design review, and storm sewer maintenance. The county created a flyer for sediment and erosion control and a Jefferson County stormwater management brochure. These are handed out to citizens getting building permits or inquiring about land development. In addition, there is a display on the 3rd floor near planning and zoning on erosion and sediment control samples. The display is titled, "Drought, Landscaping, and Water Quality - Where do you fit in?" The display includes erosion control blanket samples, rice wattle, invisible structures products, and silt fence with pictures of proper use. The county hands out Xeriscape information to interested citizens.

### **Onsite System Management Plan**

Water quality impacts are occurring from onsite wastewater systems in a number of specific areas in the Bear Creek Watershed. However, the presence and nature of

these problems is not well verified or rigorously documented in the watershed. In fact, few well-documented studies have been done in Colorado that directly link water quality or health risks with onsite wastewater systems. Examples of identified impacts include elevated nitrate and/or bacteria levels in ground water used for drinking water, and nutrient loadings adversely affecting surface waters. Researchers from Colorado State University identified many mountain homes potentially using bacterial laden well water caused by misplacement of leach fields (*How Safe Is Mountain Well Water*, CSU 1972). Other studies done by the Colorado State University and local health department document elevated nitrates in groundwater for specific locations.

Although few site-specific studies have been completed, it appears that substantial cumulative loadings of nutrients to Bear Creek Watershed waters are likely occurring in some areas where there are a significant total number and density of onsite wastewater systems. There are areas of known nitrate contamination and increased nitrate levels in ground water in areas of high density (lots less than one acre) and a significant number of homes.

In some surface water basins, phosphorus loadings from onsite wastewater systems are a potentially significant water quality factor. Phosphorus loading into Bear Creek Reservoir has caused adverse water quality impacts that have led to the development of a control regulation to control phosphorus loadings. Water quality monitoring in the Bear Creek Watershed over a 15-year period has shown that there is a phosphorus-loading problem in Bear Creek Reservoir. Screening surveys completed by the Association show elevated levels of phosphorus in areas with a higher density of on-site wastewater systems, such as the community of Idledale (Bear Creek Watershed Association, 1998; 1997 Bear Creek Watershed Association Annual Report; Bear Creek Watershed Association, 1997a, *Management Program Review and 1990-1995 Water Quality Summary*).

The Association recognizes the need for a comprehensive septic management plan for the watershed that addresses the nutrient loading issue. The county members of the Association should take the lead in developing a septic management program. The Denver regional Council of Governments is in the process of developing a septic management plan guidance document. Once this guidance document is accepted the Council's Board of Directors, the guidance can be used to assess the septic management program needs of the watershed.

### **City of Lakewood Reservoir Aeration Operation**

The City of Lakewood maintains a reservoir aeration program. This aeration system increases the amount of dissolved oxygen throughout the water column. The program helps support the fishery goal of the Association for the reservoir. This aeration effort has proven to be a successful management practice and the continued operation is necessary to maintain quality in the reservoir. The aeration system was replaced with a more efficient system that is designed to de-stratify the reservoir water column and introduce more uniform aeration within the reservoir main pool.

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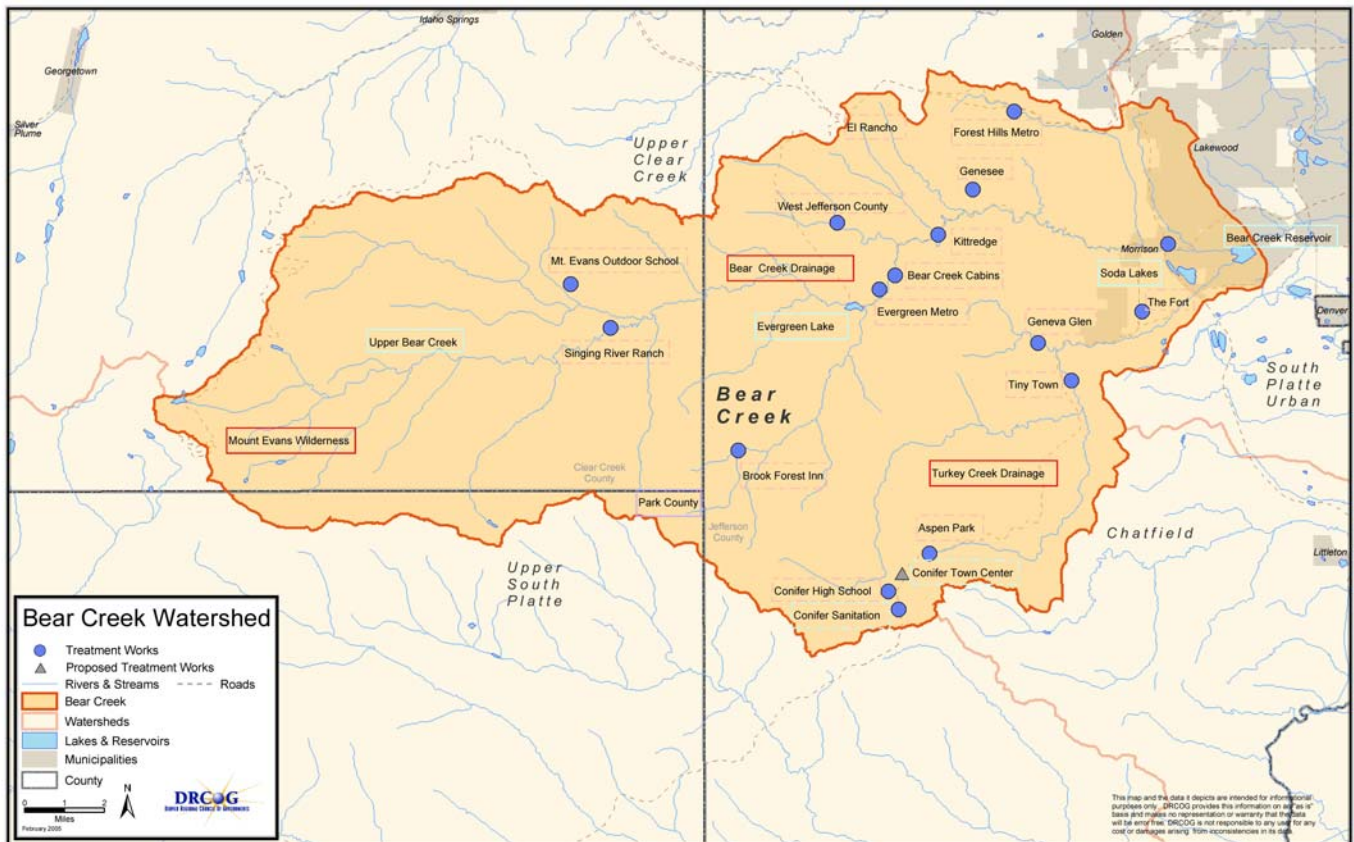
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## Fact Sheet 1. Bear Creek Watershed

Bear Creek Reservoir receives drainage from the Bear Creek and Turkey Creek with drainage from Park County, Clear Creek County and Jefferson County. The total watershed area is 83,665 acres. The reservoir is at an elevation of 5600 feet, while the mountains that form the upper boundary are at an average elevation of 10,000 feet. The watershed contains the Town of Morrison and the communities of Evergreen, Genesee, Kittredge, El Rancho, Idledale, Indian Hills, Tiny Town, Bergen Park, Conifer, Aspen Park, Brook Forest, Sprucedale, Marshdale and Brookvale.



**Bear Creek Reservoir, Jefferson County**

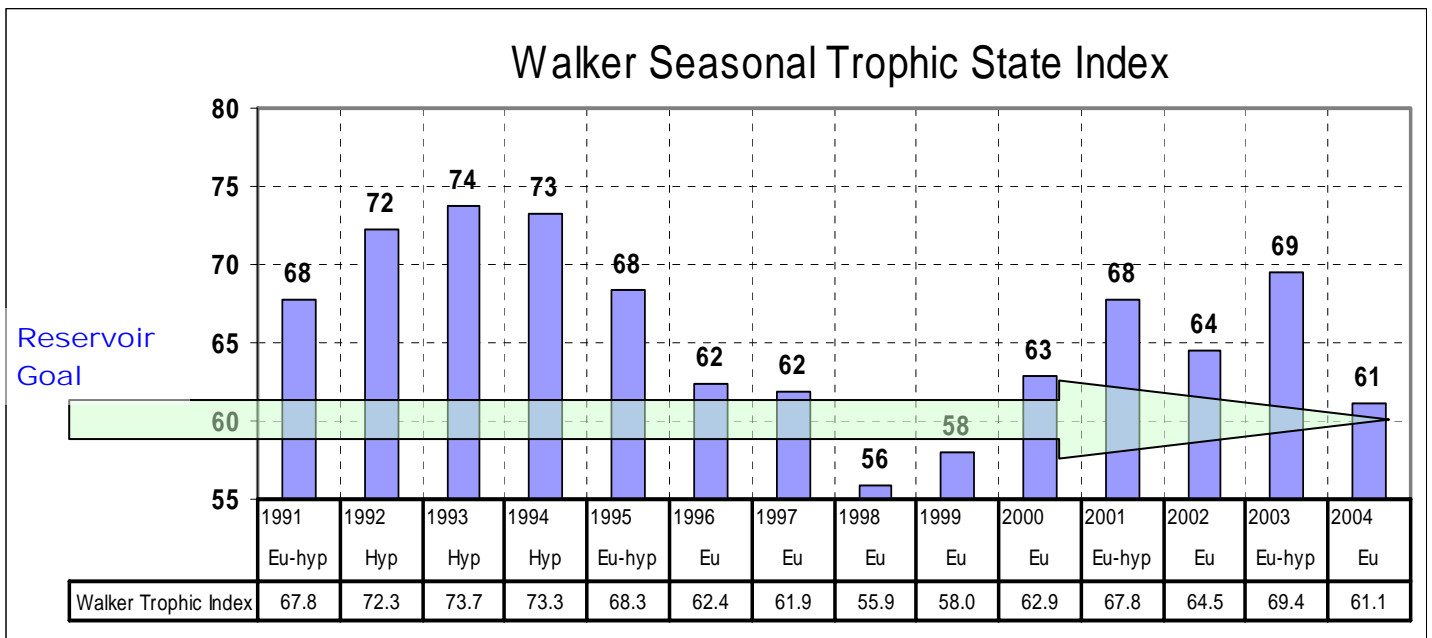


## Fact Sheet 2. Water Quality Goal and Narrative Standard for Bear Creek Reservoir

Bear Creek Reservoir has a water quality goal established by the Water Quality Control Commission instead of a numeric standard. The reservoir goal, defined as a site-specific narrative standard, reads as follows:

*Concentrations of total phosphorus in Bear Creek Reservoir shall be limited to the extent necessary to prevent stimulation of algal growth to protect beneficial uses. Sufficient dissolved oxygen shall be present in the upper half of the reservoir hypolimnion layer to provide for the survival and growth of cold-water aquatic life species. Attainment of this standard shall, at a minimum, require shifting the reservoir trophic state from a eutrophic and hypereutrophic condition to a eutrophic and mesotrophic condition, based on currently accepted limnological definitions of trophic states.*

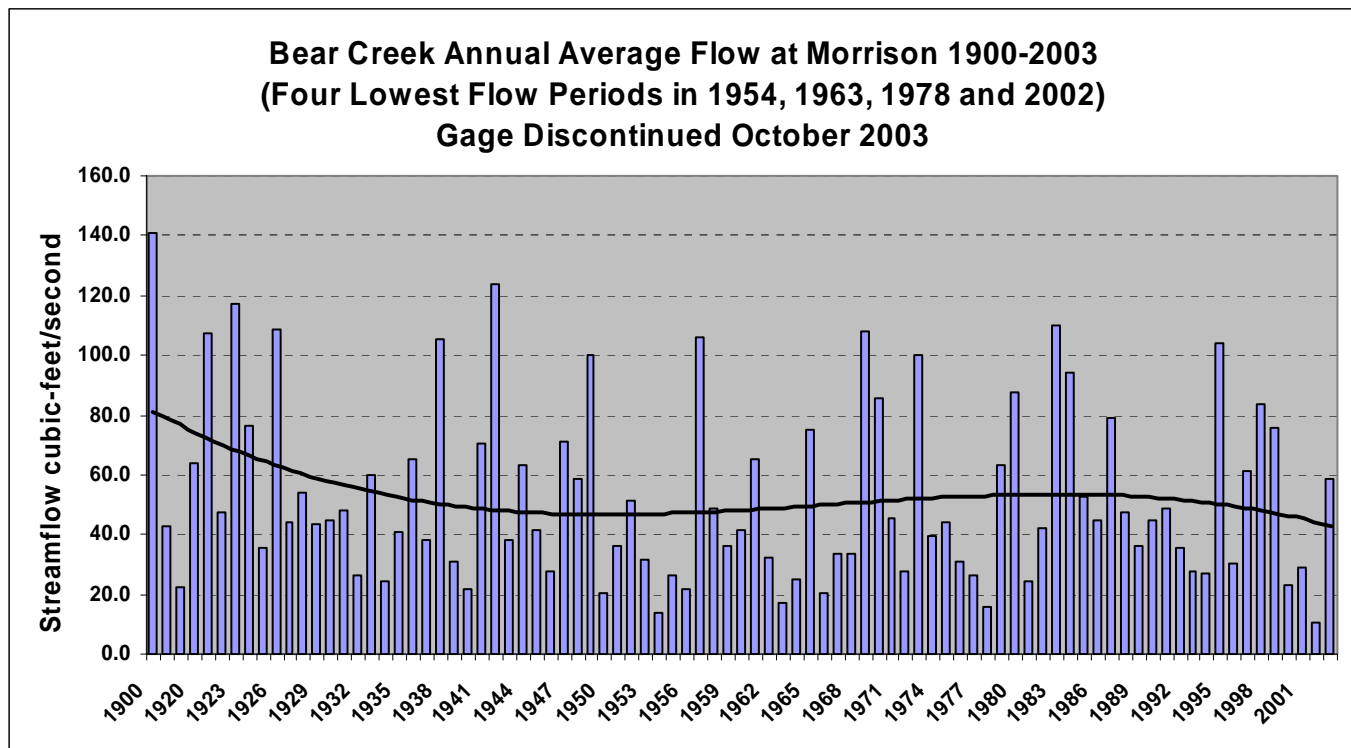
The Bear Creek management program has reduced average total phosphorus concentrations entering the reservoir. Effective point source controls with a sediment and erosion control program by Jefferson County are responsible for this phosphorus reduction. The trophic status (overall measure of quality) has moved toward a desirable mesotrophic-eutrophic range. The goal for the reservoir is to balance the trophic state based on either the Walker Seasonal Trophic model (developed for reservoir in Clean Lakes Study as goal) or the Carlson index in the lower eutrophic range. In terms of the Walker index shown below, the long-range goal is to maintain an index value of less than 60 as a composite Walker trophic index during the growing season. Since many factors influence the trophic state, it requires a long-term management program to change a reservoir quality toward the mesotrophic-eutrophic boundary.





## Fact Sheet 3. USGS 1900-2004 Bear Creek at Morrison Drought Review

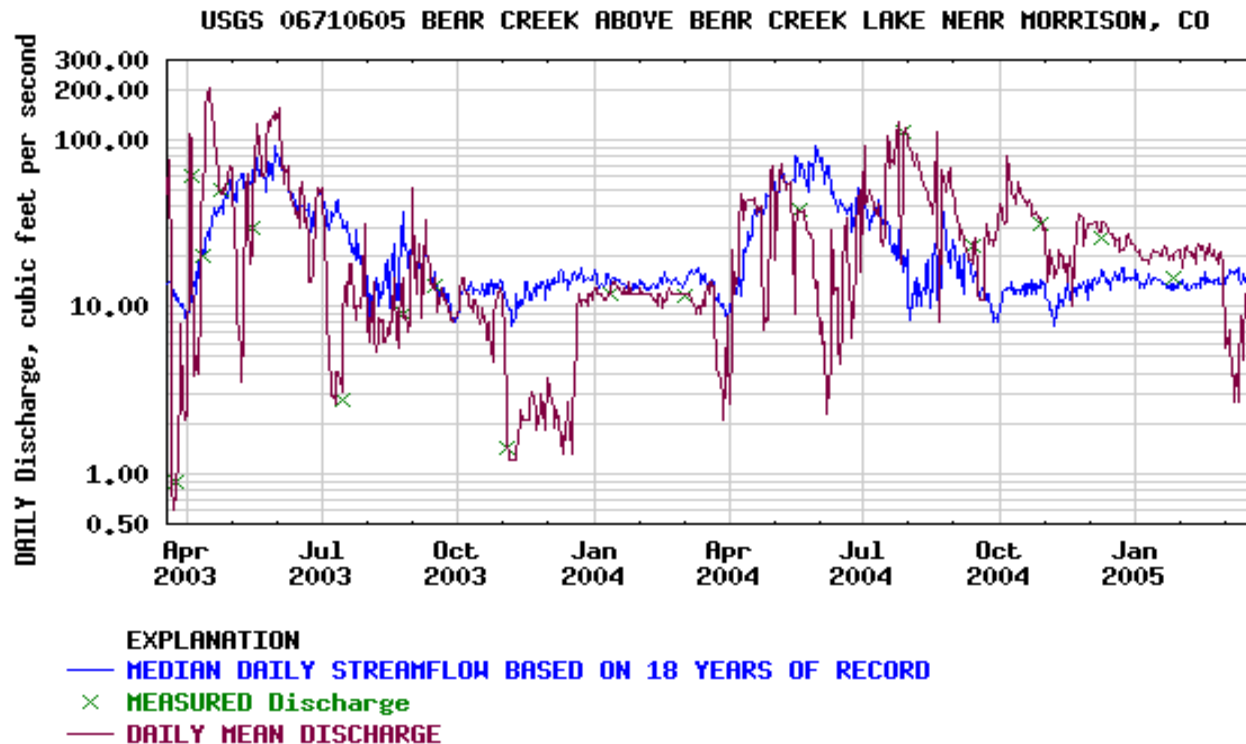
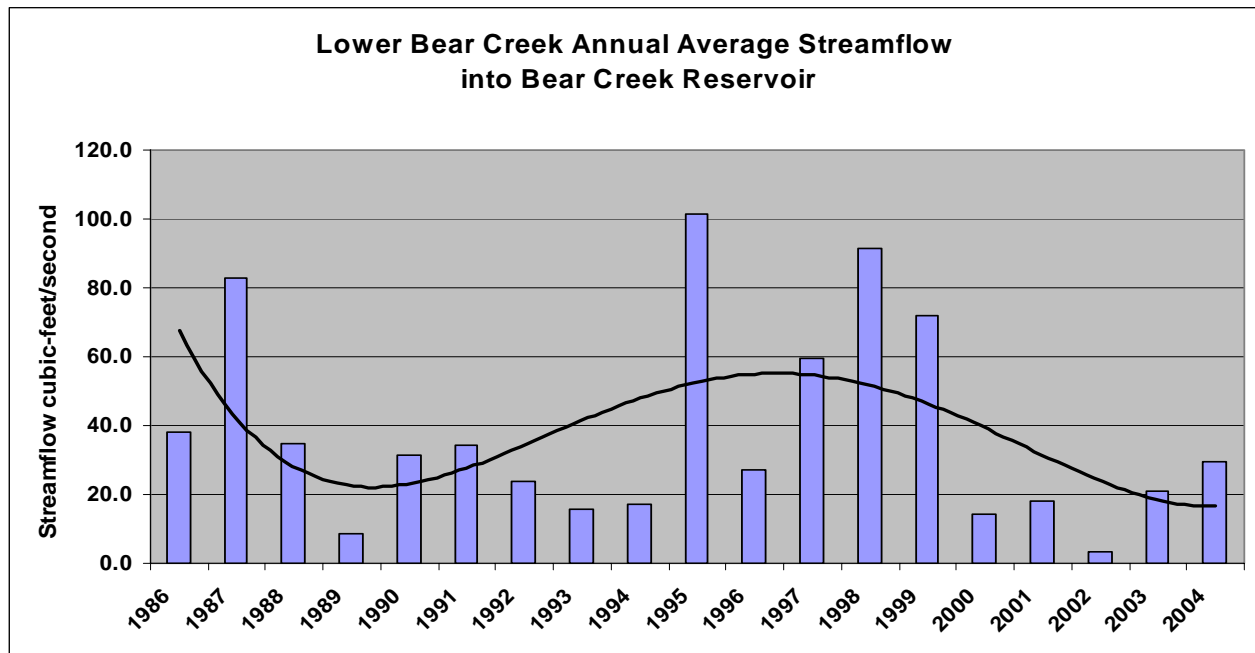
The graph shows 1900-2003 flow records near Morrison on Bear Creek. The station was discontinued in October 2003. However, this site best depicts the long-term flow trend in Bear Creek. 2002 was the lowest flow on record for lower Bear Creek segment 1a in over 100 years of record with other low periods in 1954, 1963, and 1978. The 2003-streamflow record shows a recovery to near normal flows. 2004 continued the drought recovery trend; however, several months of 2004 streamflow data were well below normal conditions. The streamflow record at Morrison shows a weak long-term cycle with 10-20 years between lower flow events. Generally, low flow periods are followed by several years of increased flows. Consequently, fish species in Bear Creek are subjected to very divergent flow patterns over a decade period.





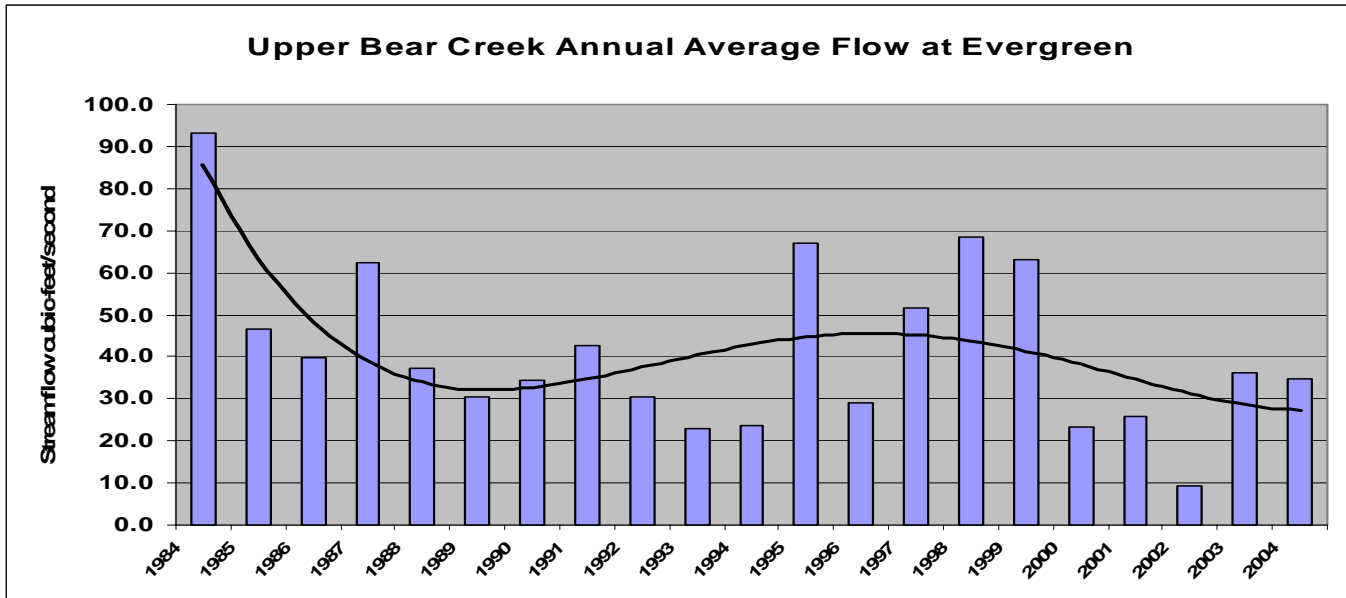
## Fact Sheet 4. USGS Lower Bear Creek Streamflow Records (Segment 1b)

The top graph shows 1986-2004 flow records and the lower graph show 2003 to recent daily mean discharge in Bear Creek. While Bear Creek demonstrates flow recovery in 2004, the system remains low compared with the wetter mid 1990's period.



## Fact Sheet 5. USGS Bear Creek at Evergreen Stream Flow Records

The top graph shows 1984-2004 flow records and the lower graph show 2004 daily mean discharge in Bear Creek above Evergreen. Improved flow conditions are evident in the upper portions of Bear Creek. The 2004 flows (blue line) were near the median daily streamflow (16 years of total record).

**USGS 06710385 BEAR CREEK ABOVE EVERGREEN****EXPLANATION**

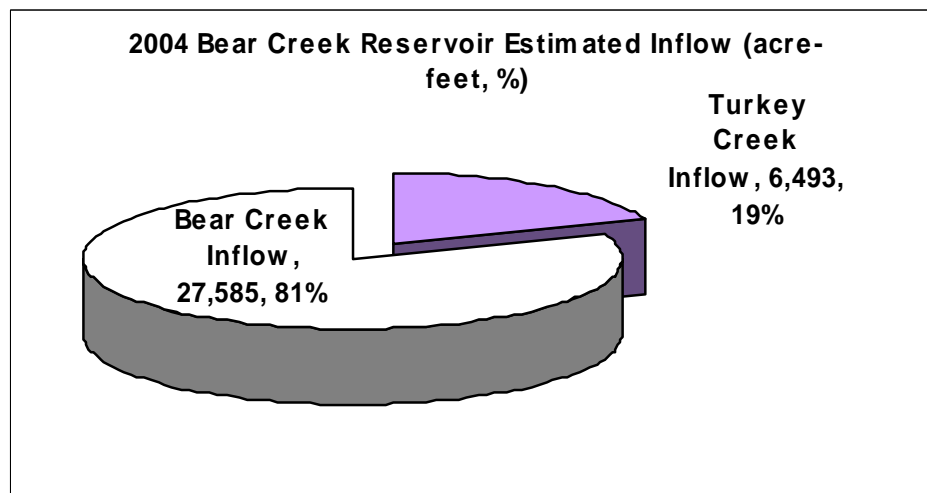
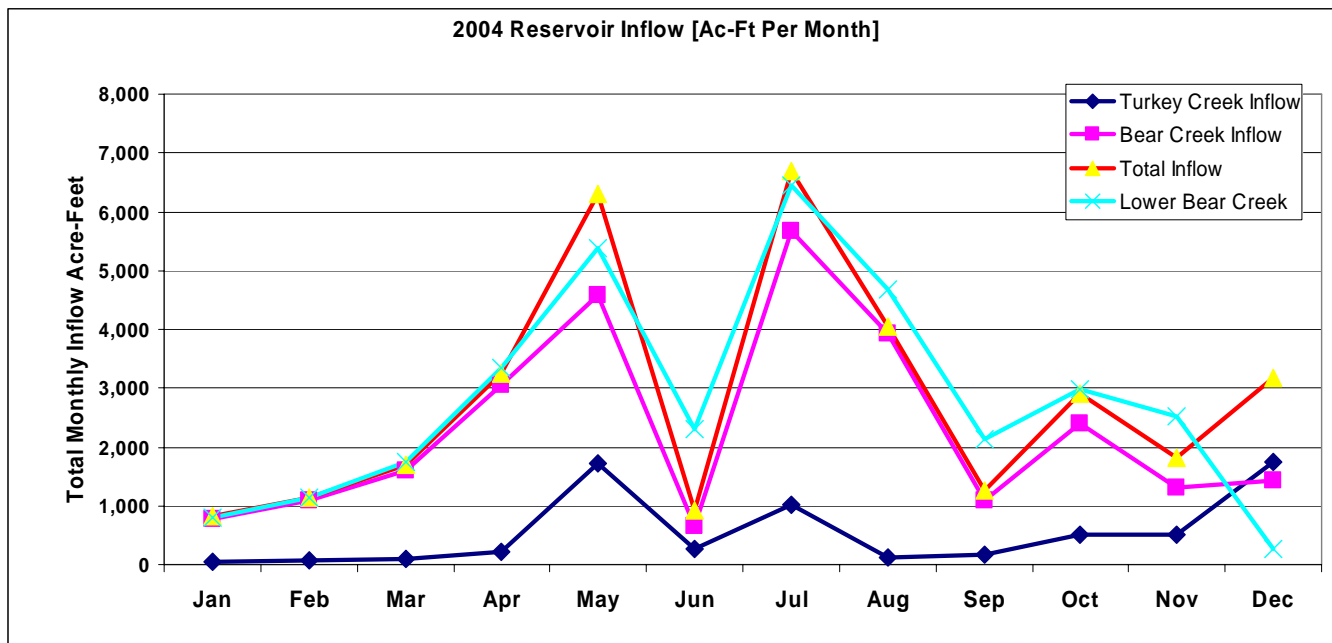
- **MEDIAN DAILY STREAMFLOW BASED ON 20 YEARS OF RECORD**
- × **MEASURED Discharge**
- **DAILY MEAN DISCHARGE**
- **Flow at station affected by ice**

**Provisional Data Subject to Revision**

## Fact Sheet 6. Bear Creek Reservoir Inflow Flow Records

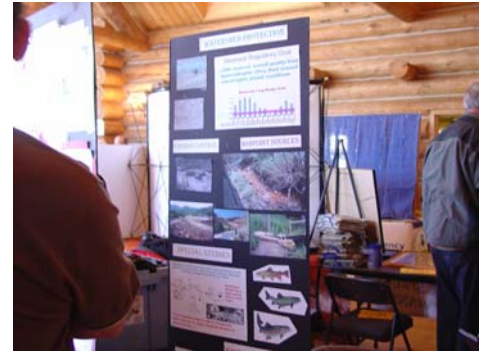
2004 was a drought recovery year and the Bear Creek Watershed was characterized by near average flows. The estimated inflow into Bear Creek Reservoir was 34,078 acre-feet.

	Ac-ft/month Bear Creek Reservoir												Annual ac-ft/yr
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Turkey Creek Inflow	43.4	63.8	97.8	211.5	1713.5	277.7	1022.0	131.5	167.9	504.3	513.8	1745.5	6,493
Bear Creek Inflow	780.9	1079.6	1609.7	3045.3	4582.2	642.6	5662.3	3925.8	1101.1	2405.7	1309.7	1440.6	27,585
Total Inflow	824.2	1143.4	1707.5	3256.9	6295.7	920.3	6684.3	4057.3	1269.1	2910.0	1823.4	3186.0	34,078



## Fact Sheet 7. Bear Creek Watershed Association Management Activities

The Association provides the framework and an opportunity for joint participation in planning, coordinating and reviewing activities to implement a continuing water quality and wastewater management program for the Bear Creek Watershed. Membership entities are general-purpose governments, special districts and holders of discharger permits. The Association's memorandum of understanding and by-laws describe the roles, responsibilities and meeting requirements of the management agency, operating agencies and general-purpose governments as related to water quality management.



Management Activity	Status
<b>Wastewater Management</b>	
Compliance by wastewater treatment facilities and control regulation	Major facilities met permit limits; small facilities still have a reporting and compliance problem
Wastewater utility planning	Development & review of wastewater utility plans & management strategies; coordination; information exchange; utility plans for Evergreen, West Jefferson, Kittredge, Conifer Sanitation; Conifer Metropolitan District, Morrison; Aspen Park Metro District; The Fort Restaurant; Aspen Park Metro District, Conifer Metro District, Cragmont
Aspen Park & Conifer Management Plan	Aspen Park wastewater treatment plant for Aspen Park area; Revised wastewater management strategy Conifer Town Center/ Metropolitan District new wastewater treatment plant;
<b>Reservoir and Regional Park Management</b>	
Hypolimnetic aeration in reservoir; operating during growing season	City of Lakewood manages system; provides an annual report to Association; operated new aeration system; supplemental reservoir monitoring and dissolved oxygen evaluation
Park facilities support recreational uses	Park management program; sediment & erosion control
<b>Water Quality Monitoring</b>	
Long-term trend monitoring program for reservoir inputs, reservoir and output	Monitoring program with periodic review by Association and WQCD; annual data report; model support; trend studies
Special Studies	Fishery and temperature Segment 1a [special reports]
Nonpoint Source Assessment	Coyote Gulch total phosphorus contributions; sediment load
Lakewood Reservoir & Park Monitoring	Dissolved Oxygen Studies; nutrient load; sediment & erosion
<b>Data Management</b>	
Database maintenance	Data base maintained in spreadsheet for membership
Web Site	Monthly Data reported on Web Site <a href="http://www.bearcreekwatershed.org">www.bearcreekwatershed.org</a> .
<b>Watershed Management</b>	
Construction project review and recommendations	Reviewing construction actions and providing appropriate comments; develop and review site-specific BMPs
Membership involvement and review; Management program effectiveness	Monitoring program review; membership involvement processes Public Processes – Earthday, Newspaper
<b>Stormwater Management</b>	
Jefferson County & City of Lakewood Stormwater Management Programs	Public education; mapping; resource allocations; local partnerships

## Fact Sheet 8. Bear Creek Watershed Nonpoint Source Management Strategy



The management of nonpoint sources in the Bear Creek Watershed is a component of the planning and management program and a tool for implementing the adopted total maximum annual load control strategy for total phosphorus. Based on water quality monitoring data, point source controls have significantly reduced their phosphorus loading to Bear Creek Reservoir. However, phosphorus reduction from nonpoint sources will be required to maintain the reservoir goal at the mesotrophic and eutrophic boundary as measured by modeled trophic indexes. A series of management strategies are used to help address nonpoint

source problems. The implementation of a nonpoint source program is severely limited by available resources. The Association pursues a limited nonpoint source control program. The Association membership has limited nonpoint source implementation authority. The Association is involved in a nonpoint source project to help restore severe erosion on Coyote Gulch (Shown in Photograph). Coyote Gulch could be contributing up to 2,000 pounds of total phosphorus per year directly into Bear Creek Reservoir.

Summary of Management Strategies	Summary Of Implementation Tools
1. Local support	1. Local involvement in associated programs & activities; presentations; information source
2. Stable funding source	2. Seek nonmember funding and grants
3. Provide recommendations to WQCD/ WQCC	3. Data & annual reports; triennial review of control regulation
4. Characterize trends in water quality	4. Maintain a trend water quality monitoring network to measure inputs & output from the reservoir
5. Track nutrient loading by Bear Creek & Turkey drainage systems	5. Characterize nutrient loading by the two major drainage systems
6. Maintain watershed & reservoir models	6. Maintain & use reservoir models (Trophic index, Secchi depth and nutrient loading) developed during the Clean Lake Study
7. Annually review water quality management program & best management practices	7. Maintain a list of appropriate best management practices for review
8. Involved in total maximum daily load allocations	8. Conduct appropriate TMDL screenings using established methods, as required
9. Develop & implement water quality education efforts & technology transfer	9. Develop & maintain list of stakeholders; provide information and assistance as requested
10. Actively promote the implementation of water quality projects & activities	10. Maintain a repository of documents, data & other information; support local water quality plans and efforts as feasible
11. Maintain a nonpoint source/stormwater management program	11. Maintain an education implementation plan; support County processes; review documents as appropriate
12. Support other watershed efforts and groups	12. Continued involvement in Turkey Creek groundwater study, ISDS regulation review & sediment & erosion control regulation review

## Fact Sheet 9. Wasteload Allocations &amp; 2004 Total Phosphorus Pounds

The total wasteload allocation for all point sources of phosphorus in the Bear Creek Watershed is 5,255 pounds per year. Each individual discharger in the Bear Creek Watershed is limited to an annual wasteload of total phosphorus, which can't be exceeded, except as provided for in trading provisions. Point source discharges can't exceed a total phosphorus effluent concentration of 1.0 mg/l as a 30-day average except as provided in trading provisions. All point source dischargers are required to meet the 1.0 mg/l total phosphorus concentration effluent limitation and the annual total phosphorus allocation established in the Bear Creek Reservoir Control Regulation.

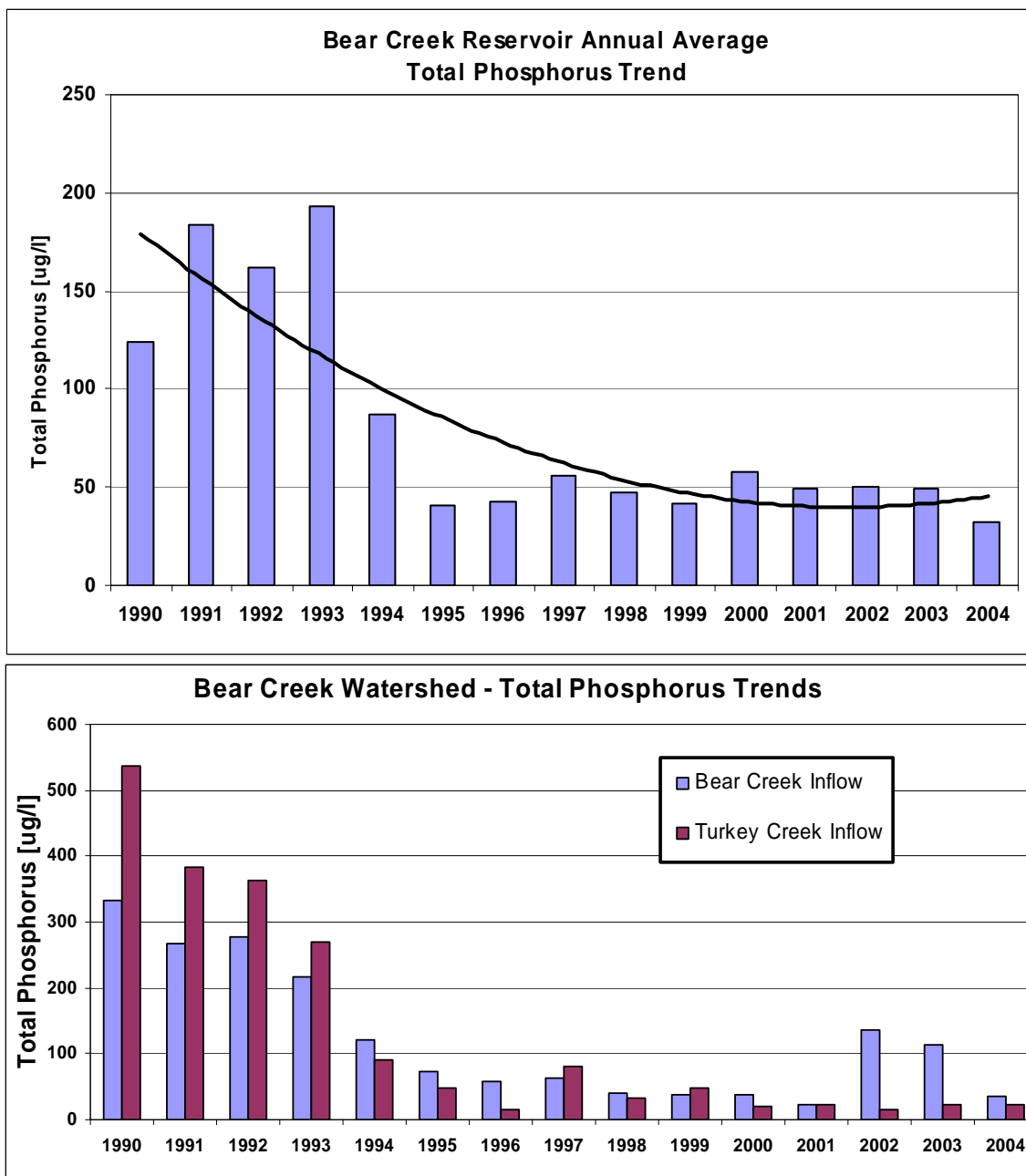


Treatment Plant	TMAL Phosphorus Pounds/ year	2004 Phosphorus Pounds/ year
Evergreen Metropolitan District	1,500	665
West Jefferson County Metro District	1,500	592
Genesee Water and Sanitation District	1,015	253
Town of Morrison	600	47
Kittredge Sanitation and Water District	240	92
Forest Hills Metropolitan District	80	51 <sup>1</sup>
Jefferson County Schools - Conifer High School	110	2
Conifer Center Sanitation Association	40	11
West/Brandt Foundation - Singing River Ranch	30	Out of Service
Mary Ann Gallagher - Brook Forest Inn	5	No Report
Bear Creek Development Corp. - Tiny Town	5	1
Jefferson County Schools – Mt. Evans Outdoor School	20	3
Bear Creek Cabins (Bruce & Jayne Hungate)	5	1
Geneva Glen	5	0 <sup>4</sup>
Aspen Park Metropolitan District	40	0 <sup>5</sup>
The Fort	18	0 <sup>6</sup>
Conifer Town Center	40	0 <sup>7</sup>
Reserve Pool	2	
<b>Total Point Source Phosphorus Wasteload</b>	<b>5,255 lbs/year</b>	<b>1,718</b>

- 1- Forest Hills Metro District has trade agreement with West Jefferson County Metro District and complies with permit.
- 2- NR - No Report Provided to Association.
- 3- The Bear Creek Cabins exceeded total phosphorus monthly allocations 5 times in two years and may have exceeded the annual total phosphorus allocation.
- 4- The Geneva Glen treatment plant is not discharging as reported to the Association.
- 5- Site Approval and permit; treatment plant under construction.
- 6- Septic system over 2,000 gallons per day; site application in progress; No established monitoring
- 7- Site Approval; treatment plant design and permit drafting in progress

## Fact Sheet 10. Total Phosphorus Trends for Watershed &amp; Reservoir

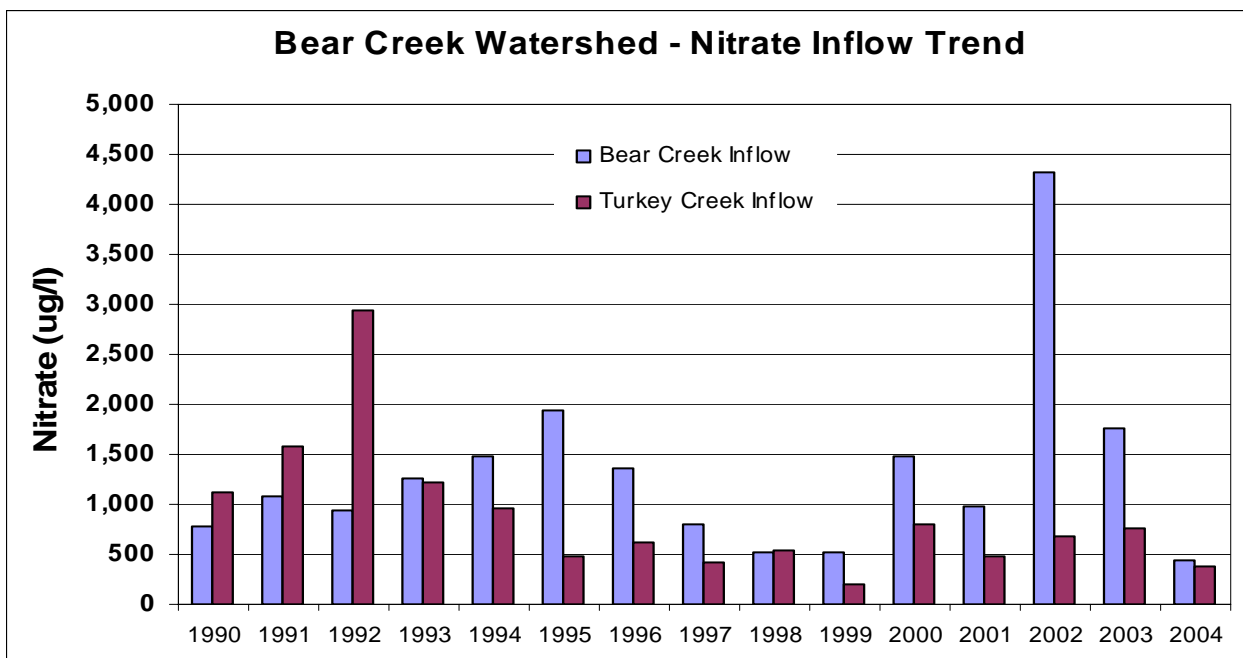
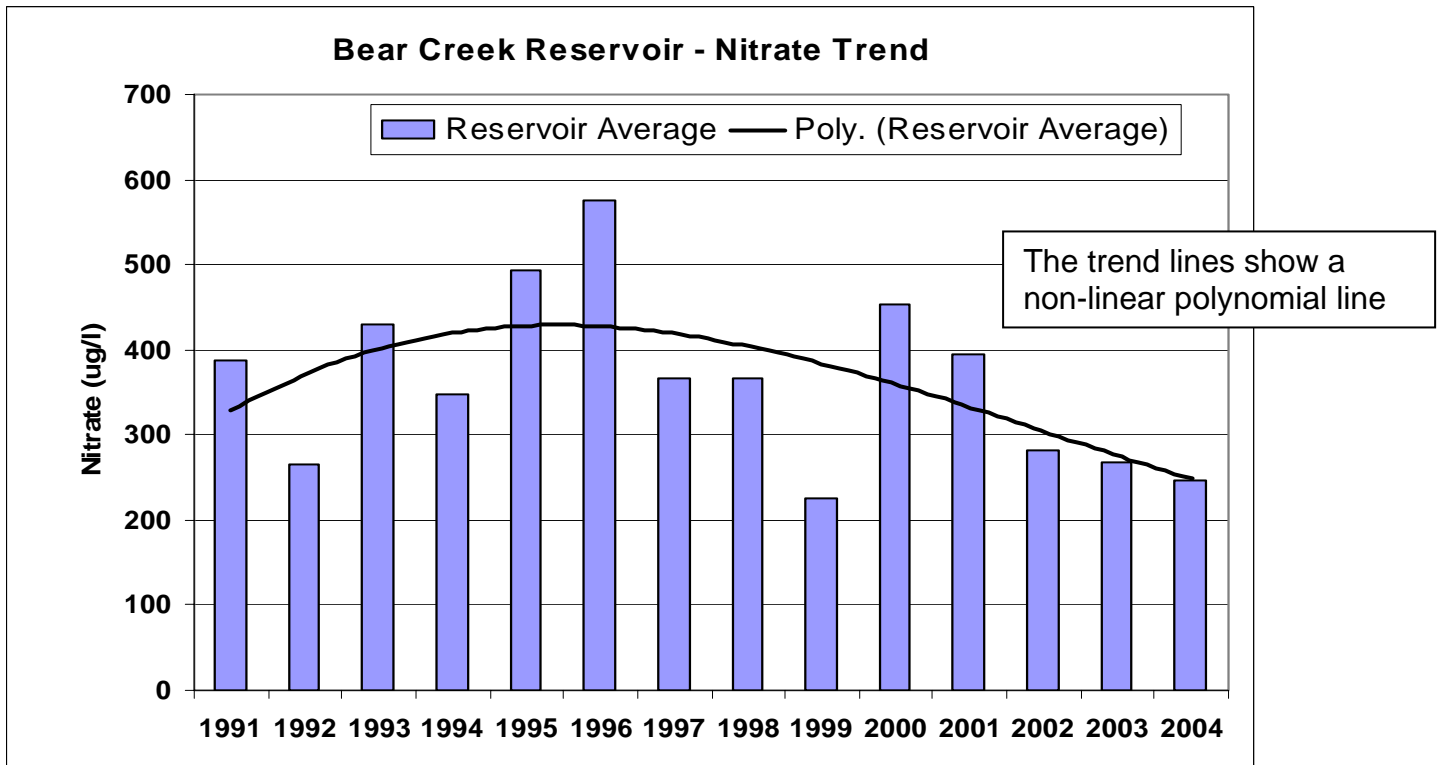
The monitoring program measures total phosphorus into Bear Creek Reservoir and within the water column. The total phosphorus target for the reservoir is to maintain the water column average below 60 ug/l. This target goal has been achieved through point source management from 1995-2004. Controlling total phosphorus source inputs is also a control strategy for reducing chlorophyll levels in the reservoir and meeting the reservoir narrative standard. The reduced total phosphorus loading in 2004 meets the Association management goal.





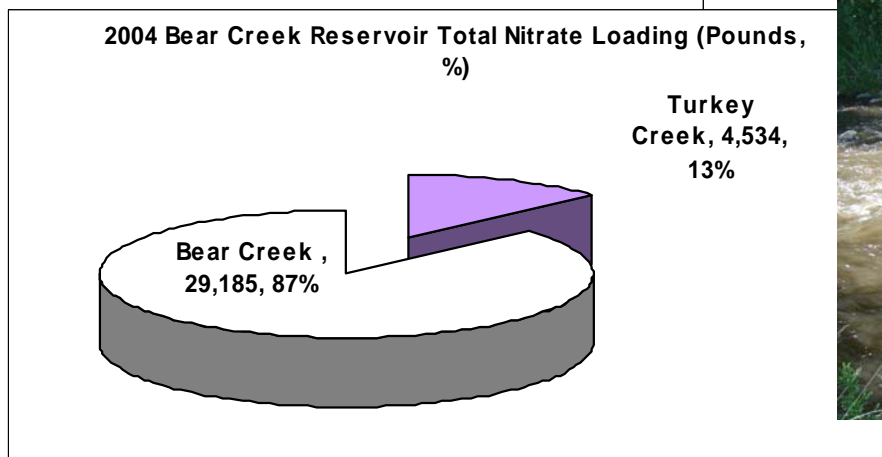
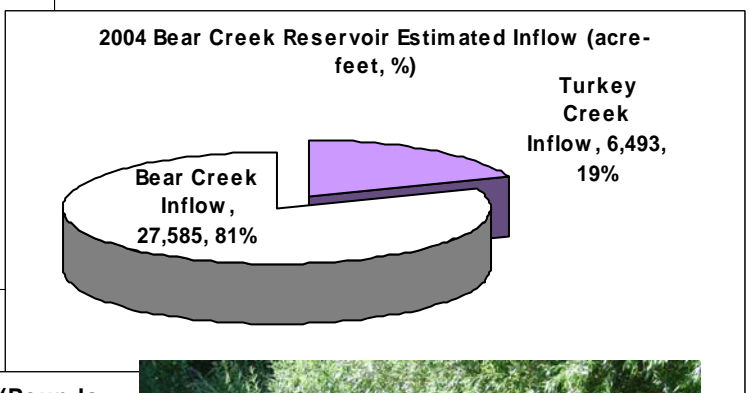
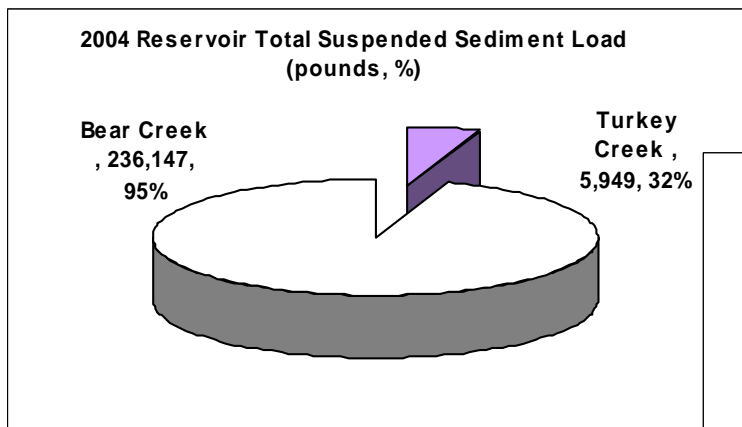
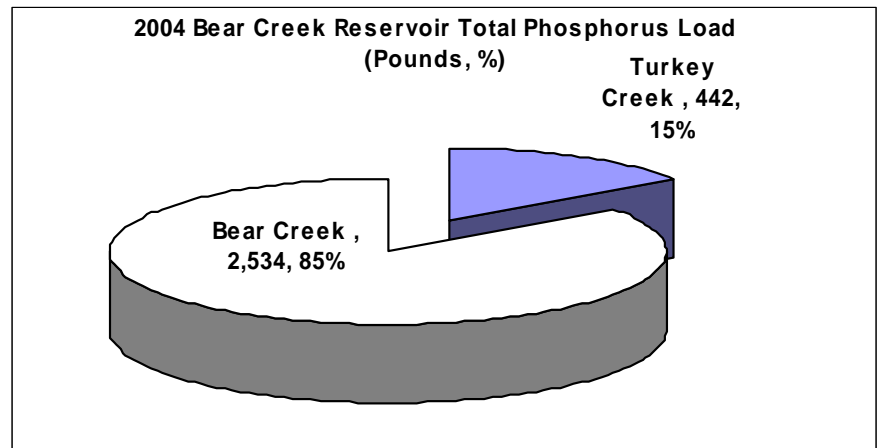
## Fact Sheet 11. Nitrate Trends for Watershed and Bear Creek Reservoir

The monitoring program measures inflow nitrate from Turkey Creek and Bear Creek and within Bear Creek Reservoir. In recent years, the concentrations of nitrate reaching the reservoir have increased particularly from the Bear Creek drainage (Lower graphic). However, the total nitrate load into the reservoir has remained relatively constant over the monitoring program. Nitrate is not a water quality problem in the reservoir. The high 2002-2003 nitrate levels in Bear Creek were associated with low flows and drought conditions. The nitrate loading decreased as flow returned to Bear Creek and Turkey Creek.



## Fact Sheet 12. Phosphorus, Nitrate &amp; Total Suspended Sediment Loads Trends

The monitoring program measures loading into Bear Creek Reservoir from Bear Creek and Turkey Creek. Wastewater treatment plants and a combination of nonpoint sources within the watershed produce the total phosphorus load. The total phosphorus load in 2004 from all sources reaching the reservoir was 2,976 pounds at a flow of 34,078 acre-feet. Although the point source discharges of total phosphorus were about 2,000 pounds, the water diversions above the reservoir are removing most of this phosphorus load and inflow water before it reached the reservoir. The nitrate (33,720 pounds) and suspended sediment (250,000 pounds) loading decreased over 2003 conditions. There were no nutrient or sediment loading problems in 2004.



## Fact Sheet 13. Bear Creek Reservoir 14-Year Data Summary



The reservoir program evaluates nutrient (nitrogen and phosphorus) concentrations, chlorophyll-a, total suspended sediments and Secchi depth as key trophic state indicators. These parameters are used to determine compliance with the narrative standard adopted for the reservoir. The summarized reservoir data from 1991 through 2004 are below. The control program for the watershed has targeted the reduction of total phosphorus reaching the reservoir on an annual basis. The data supports the success of this management effort.

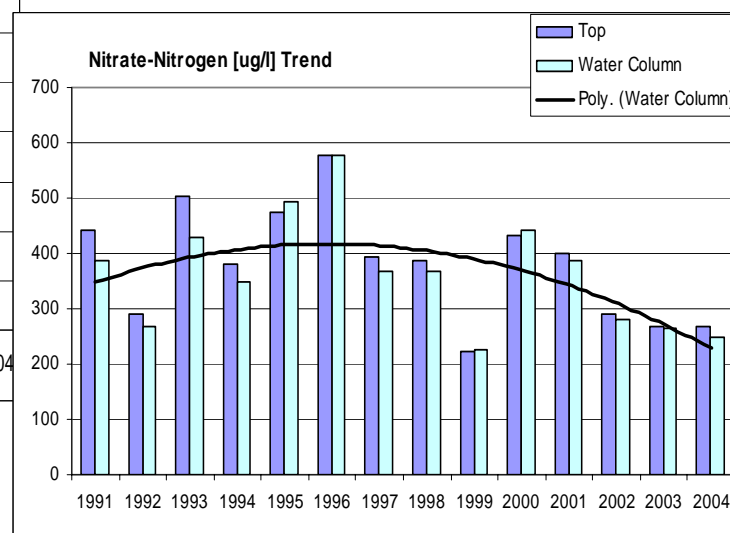
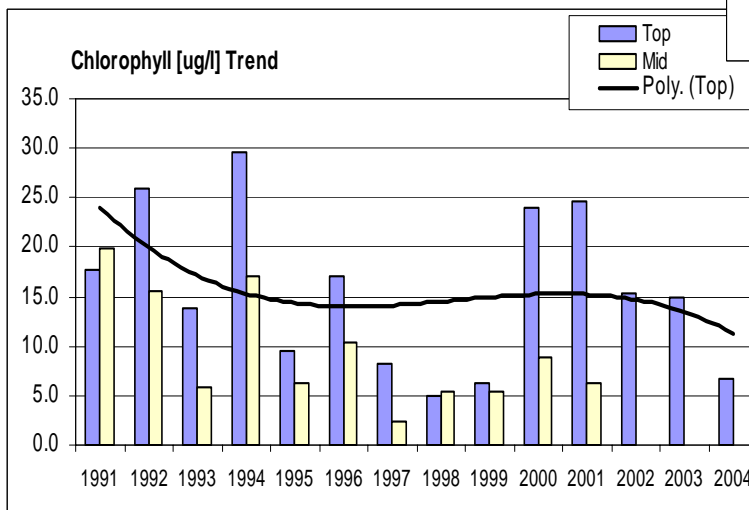
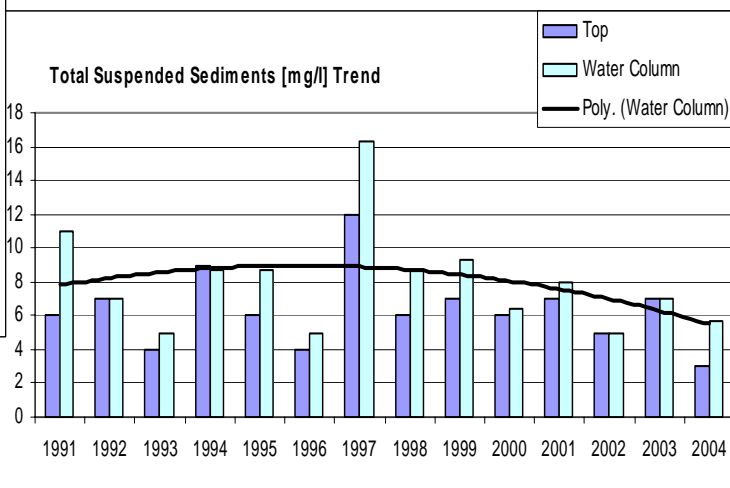
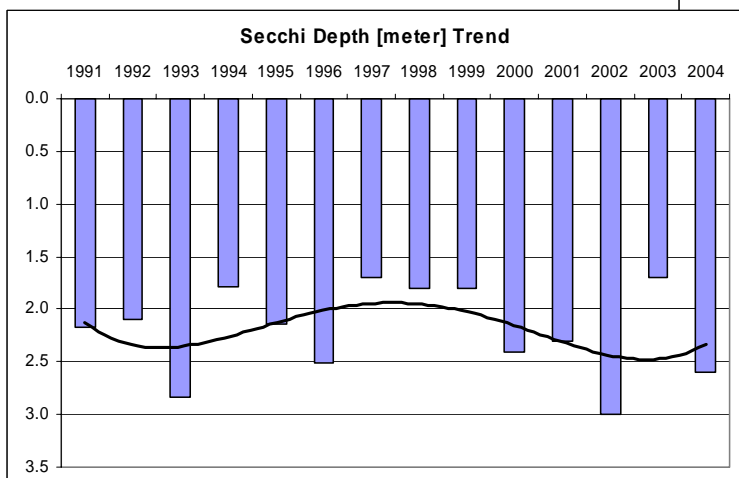
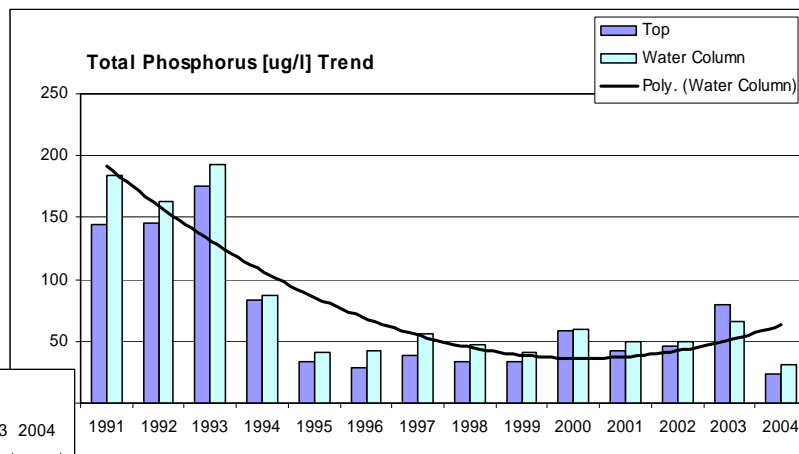
While the nitrogen data has fluctuated over the years, no clear pattern has emerged. However, the surface Chlorophyll concentration declined in 2004. A fully functional reservoir aeration system appears effective. This suggests an internal nutrient loading problem triggering algal blooms can be controlled through reservoir aeration. This is evident by the increased average chlorophyll concentrations in surface waters during 2000 to 2003 when the aeration system was upgraded. Future monitoring and some special studies will address the algal production problem in the reservoir. The total suspended sediment load in the reservoir has been generally constant over the monitoring periods with periodic storm events dumping large volumes of sediment into the reservoir. The average depth of the reservoir has declined by over 3 meters (10-11 feet) since 1991. Bottom sediments are fine sand, silt and mud.

Bear Creek Reservoir Mean Annual Concentrations 1991-2004

Parameter	Site	Reservoir Annual Average Concentrations														
		1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	91-04 Mean
Chlorophyll-a (ug/L)	Top	17.7	26.0	13.7	29.7	9.4	17.1	8.2	4.9	6.2	23.9	24.6	15.4	14.8	6.6	15.6
	Mid	19.8	15.5	5.9	17.0	6.2	10.3	2.4	5.4	5.5	8.9	6.3				9.4
	Water Column	18.7	20.8	9.8	23.4	7.8	13.7	5.3	5.2	5.9	14.1	14.6	15.4	14.8	6.6	12.6
Nitrate-Nitrogen (ug/L)	Top	442	289	504	382	474	578	393	388	224	431	401	289	268	268	381
	Mid	381	282	451	356	502	589	365	372	220	443	395	288	271	249	369
	Bottom	341	228	333	308	503	561	341	342	231	483	390	268	259	224	344
	Water Column	388	266	429	349	493	576	366	367	225	441	387	282	266	247	363
Total Phosphorus (ug/L)	Top	144	146	175	83	34	29	38	33	34	59	42	46	79	24	69
	Mid	138	140	164	79	37	33	45	40	37	57	42	49	63	27	68
	Bottom	270	201	240	99	52	66	86	69	54	56	64	56	56	44	101
	Water Column	184	162	193	87	41	43	56	47	42	60	50	50	66	32	80
Total Suspended Solids (mg/L)	Top	6	7	4	9	6	4	12	6	7	6	7	5	7	3	6
	Mid	8	6	6	8	7	4	15	8	9	5	7	5	6	5	7
	Bottom	19	8	5	9	13	7	22	12	12	8	10	5	8	9	11
	Water Column	11	7	5	9	9	5	16	9	9	6.4	8	5	7	6	8.0
Secchi Depth (m)	Top	2.17	2.1	2.84	1.79	2.14	2.51	1.7	1.8	1.8	2.4	2.3	3	1.7	2.6	2.2

## Fact Sheet 14. Bear Creek Reservoir Long-Term Water Quality Trends

The reservoir program evaluates seasonal, annual and long-term changes in nutrient (nitrogen and phosphorus) concentrations, chlorophyll-a, total suspended sediments and Secchi depth. The reservoir trends from 1991 through 2004 are graphically summarized below. The trend lines show non-linear polynomial curve fits to the data.




## Fact Sheet 15. Trophic Indicators For Bear Creek Reservoir

Since the management goal is to change Bear Creek Reservoir from a poorer quality hypereutrophic system to a better quality mesotrophic-eutrophic system, the various trophic indicators provide a means to evaluate progress toward this goal. Reservoir water quality models use total phosphorus, Secchi depth and chlorophyll- $\alpha$  levels as indicators of the trophic state of the reservoir. The biological integrity of Bear Creek Reservoir is assessed by monitoring changes in plant (phytoplankton) and animal (zooplankton) communities. The increased abundance within a reservoir of certain types of algae or plants (e.g., blue-green algae or Cyanophyta) indicates declining water quality. Implementation of the watershed management program has affected water quality in the reservoir and generally helped improve the overall reservoir quality.

Algal production decreased under the 2004 recovery conditions; even though the total phosphorus loading was low. The algal production

consumed most of the nitrate within the water column over the growing season. The growing season Chlorophyll-a concentration is indicative of declining quality or eutrophic-hypertrophic conditions. The following trophic indicators and values are used in the reservoir Walker and Carlson water quality models and a Secchi depth quality prediction model to evaluate the reservoir response to water quality management. The dominate phytoplankton species are typical nuisance species.

Bear Creek Reservoir 2004 - Selected Trophic Indicators

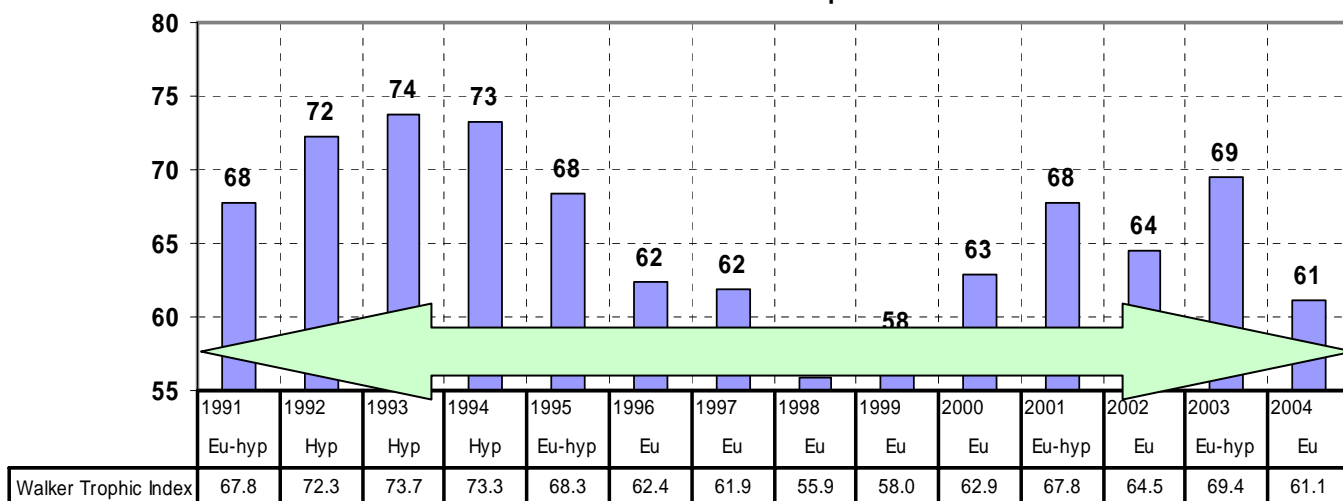
Trophic Indicator	Reservoir
<b>Chlorophyll</b>	
Average Growing Season Chlorophyll-a [ug/l (surface waters only)]	8.5
Peak Chlorophyll-a [ug/l]	15.2
<b>Phosphorus</b>	
Average Annual Total Phosphorus [ug/l]	31.9
Seasonal Annual Total Phosphorus [ug/l]	40.3
Peak Annual Total Phosphorus [ug/l]	126.5
Average Annual Ortho Phosphorus ug/l]	10.4
Seasonal Average Ortho Phosphorus [ug/l]	16.1
Peak Annual Ortho Phosphorus [ug/l]	81.4
<b>Nitrogen</b>	
Average Annual Nitrate-Nitrogen [ug/l]	247
Seasonal Average Nitrate-Nitrogen [ug/l]	175
Peak Annual Nitrate-Nitrogen [ug/l]	769
<b>Clarity</b>	
Average Annual Secchi Depth (m)	2.6
Seasonal Average Secchi Depth [meters]	2.0
<b>Total Suspended Sediments</b>	
Annual Average Total Suspended Sediments [mg/l]	5.8
Seasonal Average Total Suspended Sediments [mg/l]	6.1
Peak Total Suspended Sediments [mg/l]	21.8
<b>Phytoplankton Species</b>	
Phytoplankton Species Co-dominant Species	Diatom - <i>Asterionella formosa</i>
	Diatom - <i>Aulacoseira italica</i> var. <i>tenuissima</i>
	Green - <i>Chlorella minutissima</i>
	Green - <i>Choricystis minor</i>
	Green - <i>Monomastrix</i> sp
	Cryptophyta- <i>Plagioselmis nannoplanctica</i>
	Chrysophyta - <i>Chromulina</i> sp.
	Bluegreen - <i>Aphanizomenon flos-aquae</i>
	Bluegreen - <i>Aphanothece smithii</i>
	Bluegreen - <i>Microcystis wesenbergii</i>
	Bluegreen - <i>Pseudanabaena mucicola</i>
	Bluegreen - <i>Woronichinia naegeliana</i>
	Bluegreen - <i>Anabaena flos-aquae</i>
Peak Phytoplankton Density	29,200 cells/ml (July)

## Fact Sheet 16. Carlson &amp; Walker Reservoir Trophic Models

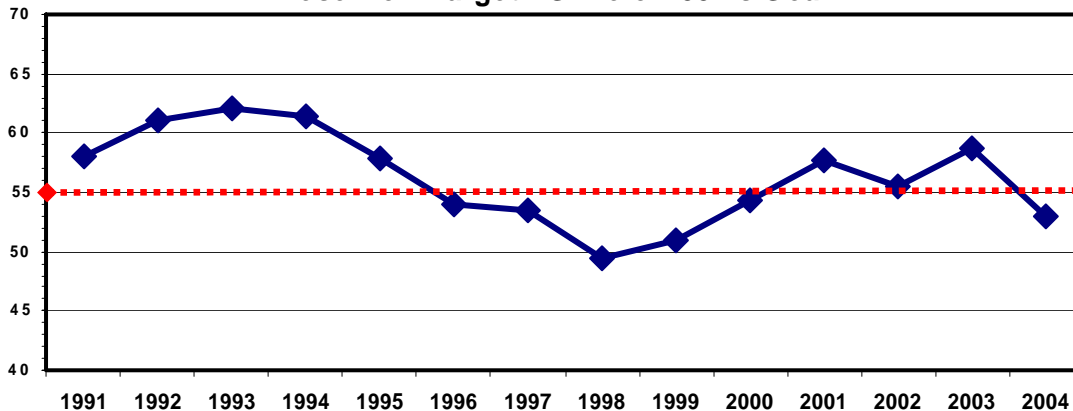
Models are used to evaluate the current trophic state: Walker (annual and seasonal); and Carlson (annual and seasonal). Both models use the total phosphorus, Secchi depth and chlorophyll- $\alpha$  levels for the evaluation. The Carlson and Walker models both show the reservoir quality has improved from historic conditions by having the trophic status shift toward the eutrophic-mesotrophic boundary, but the reservoir remains a eutrophic waterbody. Although the point sources are in compliance with the control regulation, the reservoir quality remains in flux. Based on the nonpoint source loading, additional nonpoint source load reductions are needed to stabilize the reservoir at the mesotrophic boundary.

Walker Trophic Index	
25-30	Oligotrophic-Mesotrophic
30-45	Mesotrophic
45-50	Mesotrophic-Eutrophic
50-65	Eutrophic
65-70	Eutrophic-Hypereutrophic
>70	Hypereutrophic

Walker Seasonal Trophic State Index

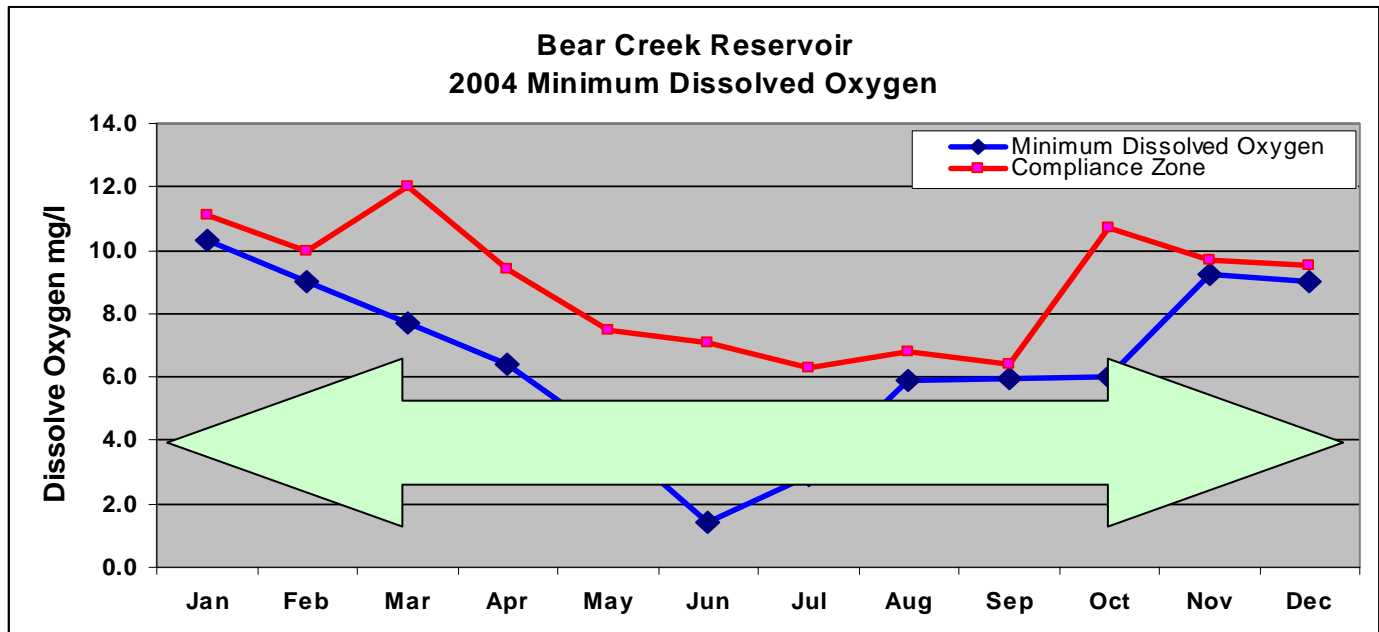


Carlson Seasonal Trophic Status Index [Average TSI]  
Reservoir Target TSI Below 55 As Goal



## Fact Sheet 17. Bear Creek Reservoir Dissolved Oxygen Trends

The dissolved oxygen concentrations in the water column are profiled in 1-meter intervals at the central sampling site. Dissolved oxygen is a reservoir trophic indicator, where dissolved oxygen concentrations below 5 mg/l indicate a potential water quality and biological problem. Low dissolved oxygen concentrations stress aquatic life species.



Oxygen levels that remain below 1-2 mg/l for a few hours can result in fish kills. Since fish within the reservoir can migrate to better-oxygenated water, the amount of water column with low dissolved oxygen is an important trophic indicator. Low dissolved oxygen concentrations have commonly occurred below 4 meters (about 14 feet) beginning in June and extending through November. Generally, dissolved oxygen concentrations in the water column zero out between 10-13 meters (33-43 feet). However, the dissolved oxygen standard applies to the middle mixing zone (metalimnion) and surface (epilimnion) waters of the reservoir (generally above 4 meters). The low dissolved oxygen values in bottom waters are not a standard exceedence problem. The red line in the graphic represents the minimum dissolved oxygen concentrations measured within the reservoir compliance zone. The arrow indicates the zone of low dissolved oxygen associated reservoir bottom waters, which occurs during the growing season.

To resolve the low oxygen problem, the City of Lakewood re-established in August of 2002 a new reservoir aeration system in the reservoir. The system extends aeration lines throughout the reservoir to reduce dead spots. The system uses a fine bubble diffuser system to increase total water column aeration with oxygen supplied by an on-shore pump station. This aeration system has reduced or eliminated reservoir water column stratification, which raises a potential concern about increasing water column temperature. The system is monitored to determine changes to temperature and dissolved oxygen. Based on 2004 data, this new aeration addresses the oxygen problem, doesn't affect temperatures and reduces the potential for stress of aquatic species.

**The Basic Standards And Methodologies For Surface Water (5 CCR 1002-31, Regulation #31)** - The dissolved oxygen criterion is intended to apply to the epilimnion and metalimnion strata of lakes and reservoirs. Dissolved oxygen in the hypolimnion may, due to the natural conditions, be less than the table criteria. No reductions in dissolved oxygen levels due to controllable sources are allowed. "Existing quality" shall be the 15th percentile for dissolved oxygen.

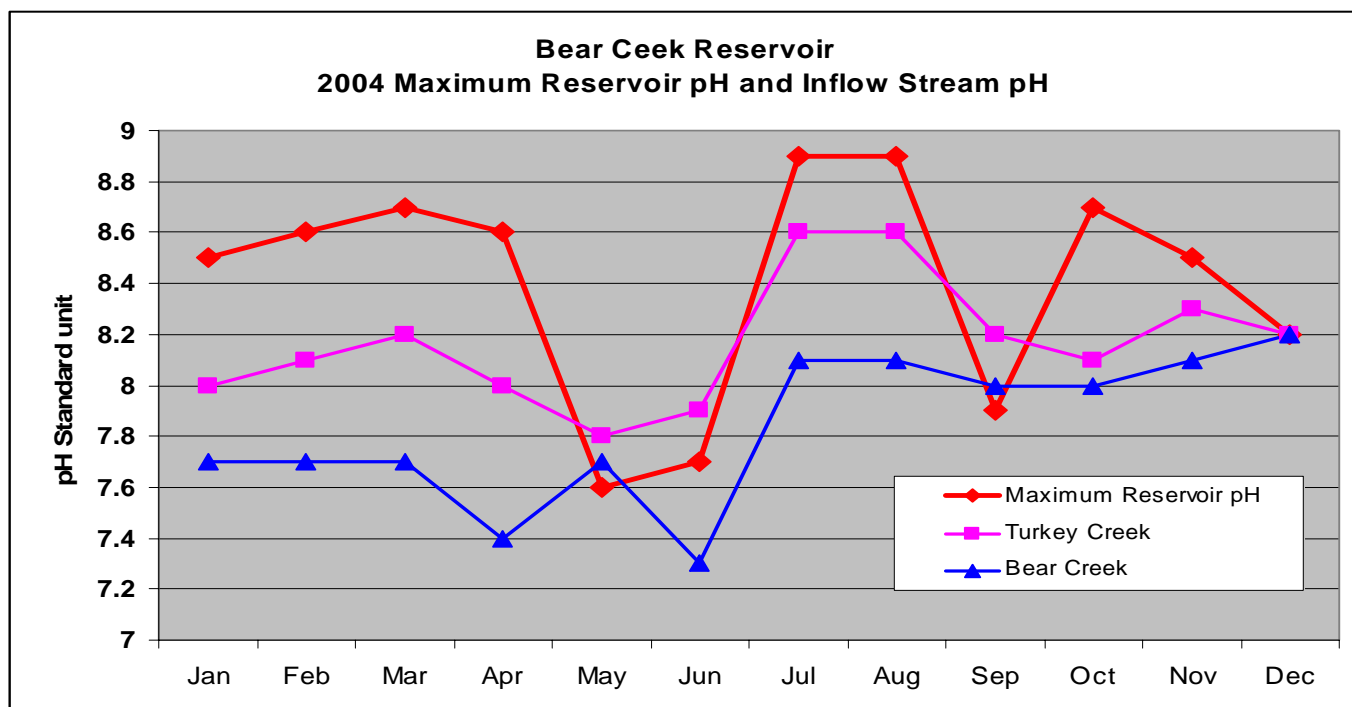


## Fact Sheet 18. Bear Creek Watershed and Reservoir pH Trends



The pH values in the water column are profiled in 1-meter intervals at the central sampling site. Water column pH can be a reservoir trophic indicator measure, where pH values above 9.0 indicate a potential water quality and biological problem. The pH scale measures relative quantities of the hydroxyl and hydrogen ions on a scale of 0 to 14. Where the hydrogen ion predominates in acidic solutions [measured as 0 on the scale] and hydroxyl ions predominate in very alkaline solutions [measured as 14 on the scale]. At around pH 7 the numbers of both species present are equal and the water is said to be neutral. The pH scale is a logarithmic

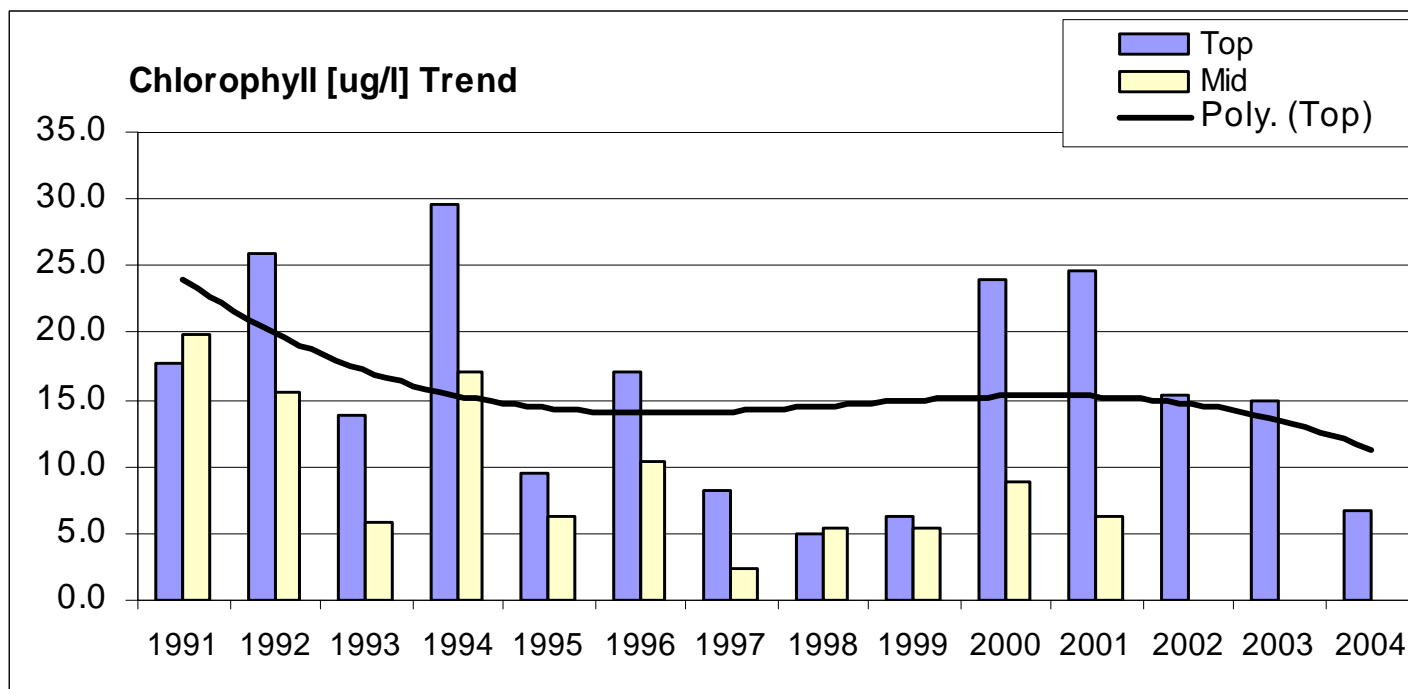
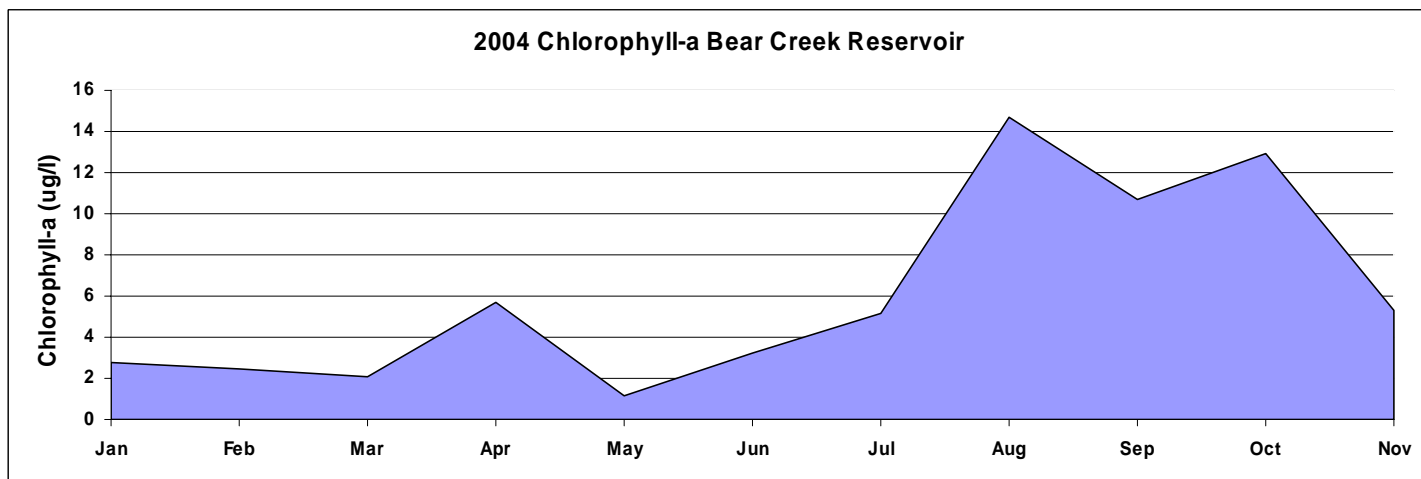
measurement of the concentration of hydrogen ions, which means that each one-unit change in the scale equals a ten-fold increase or decrease. Plant photosynthesis is the main cause of high pH and diurnal pH fluctuations. High alkalinity water [pH > 9.0] can cause direct physical damage to fish skin, gills and eyes. Prolonged exposure of aquatic life to sub-lethal pH levels can cause severe stress or result in death of species with a narrow pH tolerance.



The reservoir pH did not exceed 9 units 2004. The inflow water from Bear Creek and Turkey Creek was within expected values and consistent with historical data. Consequently, the factor raising the reservoir pH is an internal mechanism. The elevated pH measurements in the reservoir are associated with algal production or phytoplankton biomass. The new aeration system hasn't completely eliminated this water quality problem. Operational adjustments of the aeration system could help reduce the pH fluctuations. The Association is monitoring reservoir pH conditions in 2005-06 to determine cause and affect.

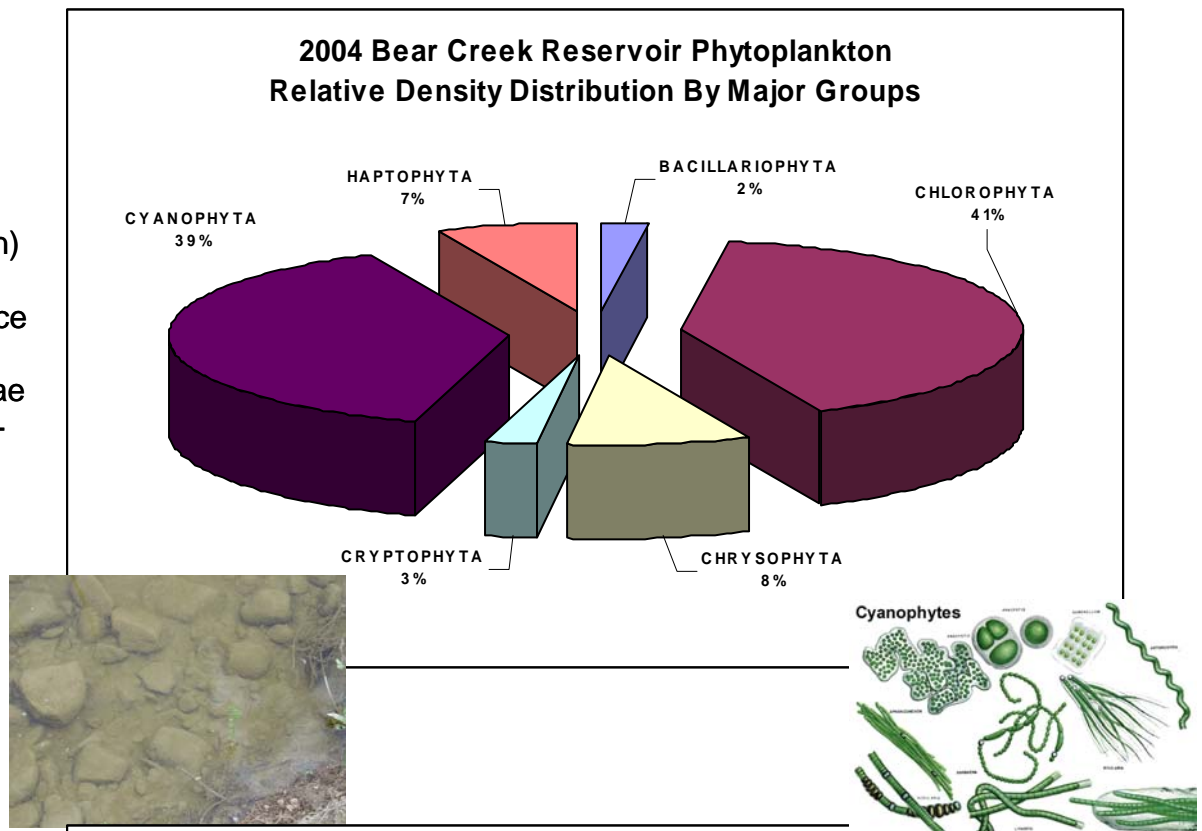
## Fact Sheet 19. Bear Creek Reservoir Chlorophyll-a Trends

The reservoir-monitoring program provides necessary data to make statistical water quality trend assessments and verify the effectiveness of control and alternative management programs. The concentration of chlorophyll-a within the reservoir water column is a critical measure of how the reservoir responds to water quality management strategies. The control regulation is designed to reduce the loading total phosphorus reaching the reservoir and subsequently limiting algal production in the reservoir. Algal blooms are associated with declining water quality. The target reservoir concentration for the chlorophyll concentrations in the growing season should not exceed 20 ug/l as an average growing season value to be consistent with the intent of the narrative standard. The 2004 growing season chlorophyll-a (8.5 ug/l) was below the target and 15.2 ug/l as a peak value.



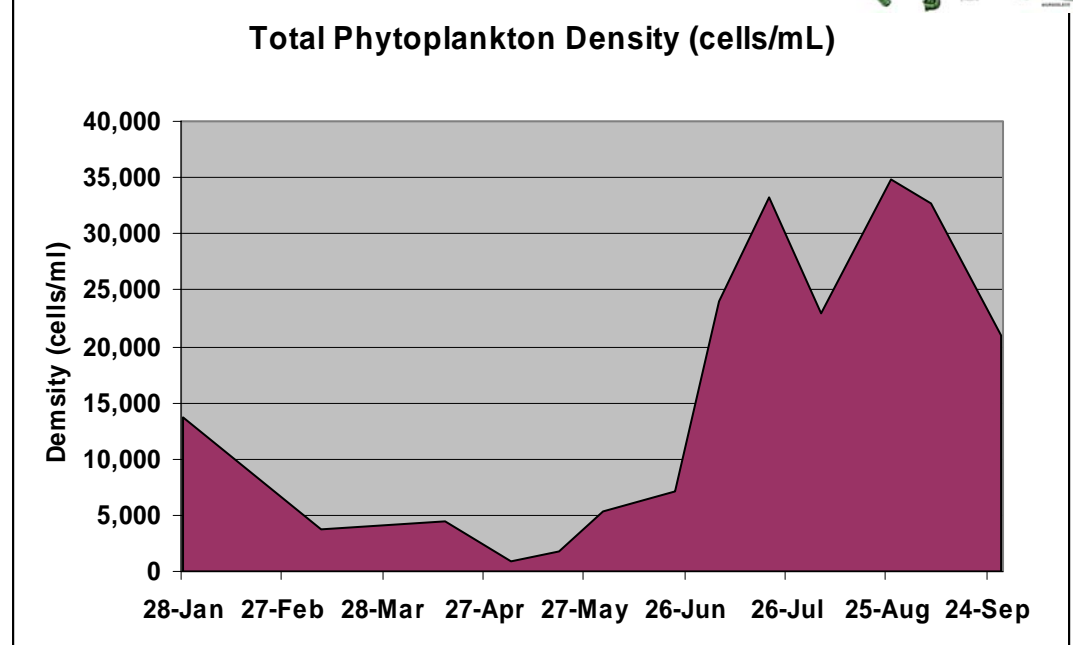
## Fact Sheet 20. Bear Creek Reservoir Phytoplankton Distribution

The biological integrity of Bear Creek Reservoir is assessed by monitoring changes in growing season plant (phytoplankton) communities. The increased abundance within a reservoir of certain types of algae or plants (e.g., blue-green algae or Cyanophyta) can indicate declining water quality. In 2004, the blue-green species made up on the average 35% of plants present in the reservoir.



Twenty species of blue-green algae were found in the reservoir with a maximum total density at 100,000 cells/ml, which was classified as a minor visual algal bloom. The green algae comprised 41% of the biomass (18 species) with a density of 30,000 cells/ml, which was also classified as a visual algal bloom. The diatoms

(Bacillariophyta, Haptophyta and Chrysophyta) made up most of the 10% remaining species. Certain species of diatom are problematic from a water supply perspective. No fish kills or algal related problems were reported for the reservoir.

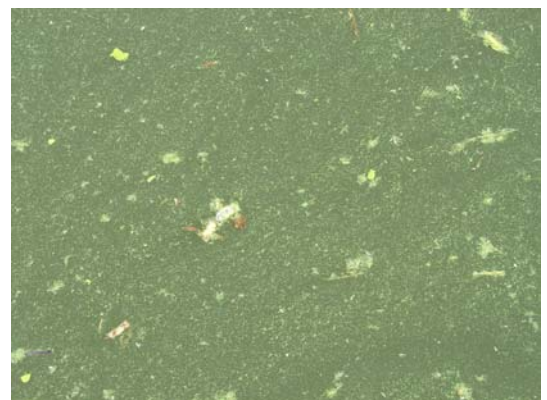


## Bear Creek Reservoir Zooplankton Distribution

Bear Creek Reservoir Zooplankton			
	6/23/04	7/21/04	8/26/04
COPEPODA			
Acanthocyclops vernalis			rare
Diacyclops thomasi	rare		rare
Eucyclops agilis			rare
Eucyclops speratus			rare
Leptodiaptomus siciloides			rare
Mesocyclops edax			intermediate
Skistodiaptomus pallidus			rare
calanoid nauplius	rare	rare	intermediate
calanoid juvenile		rare	intermediate
cyclopoid nauplius	intermediate	intermediate	very common
cyclopoid juvenile	rare	rare	intermediate
CLADOCERA			
Bosmina longirostris	rare		very common
Chydorus sphaericus	rare		
Daphnia mendotae			rare
Daphnia pulex - group			very common
cladoceran juvenile			rare
ROTIFERA			
Ascomorpha ovalis			rare
Asplanchna girodi			rare
Cephalodella gibba			rare
Collotheca (?) sp.		rare	rare
Conochilus unicornis			very common
Gastropus hytopus			rare
Kellicottia bostoniensis			intermediate
Keratella cochlearis	common	rare	very common
Keratella quadrata			rare
Lecane (L.) hastata			rare
Lecane (M.) bulla			rare
Lecane (M.) closterocerca			rare
Lepadella rhomboides			rare
Lepadella sp.	rare		
Lophocharis salpina			rare
Polyarthra vulgaris	intermediate	intermediate	very common
Pompholyx sulcata		rare	very common
Proales (?) sp.			rare
Synchaeta pectinata	rare		rare
Trichocerca elongata			rare
Trichocerca rousseleti			common
Trichocerca similis			rare

A detailed evaluation of zooplankton species presence was assessed from June through August 2004. Species were counted as present without density determinations. The zooplankton species found in the reservoir are divided among three major groups of copepods, cladocerans and rotifers, which are typical of front-range reservoirs. Zooplankton are common in the upper regions of the reservoir where assemblages include 16 species of rotifers, five species of cladocerans and eleven species from the class Copepoda. Copepods are usually a dominant group in the reservoir. The microcrustacean class Ostracoda is missing from the reservoir, but has been found in other front-range waterbodies. Most species of three functional groups make their living grazing algae either from the water column or off surfaces. Zooplankton is a vital link for passing energy up the food chain to fish.

Rotifers have incredible reproductive rates. Population densities often exceed 1000 individuals per liter. They play important roles in energy flow and nutrient cycling, accounting for more than 50% of the zooplankton production in the reservoir.



## Fact Sheet 21. Temperature Inflow Trends For Bear Creek

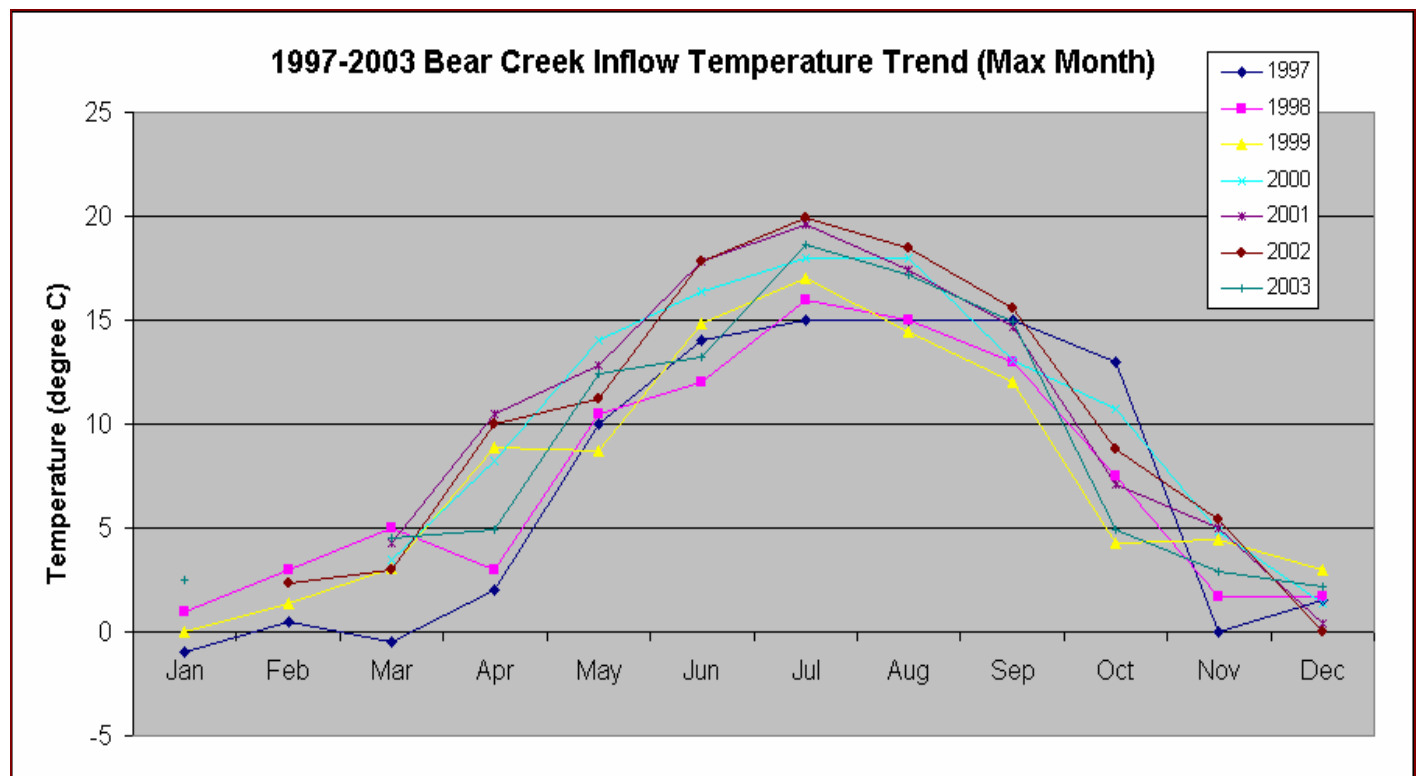
Aquatic life species are sensitive to excessive temperature fluctuations. Large changes in water temperature are due to a combination of factors including, geography, season, source inputs (e.g., wastewater) and anthropogenic activities. While the optimum temperature range for trout is below 18 degrees Celsius (C) (64.5 F), trout can survive in waters up to 25 C (77 F). Water temperatures over 25 C can stress trout. Based on temperature measurements in summer months, the reservoir is a marginal cold-water fishery (classified as cold warm fishery), while Bear Creek and Turkey Creek meet temperature requirements for a cold-water fishery.



## Optimum Temperature Ranges For Trout



Trout Species	Rearing		(i) Spawning	
	F	C	F	C
Brown	43-64	6.0-18	45-55	7-13
Cutthroat	45-61	7.0-16	48-54	9-12
Rainbow	61-65	16-18	50-60	10-16
Brook	54-65	12-18	45-55	7-13

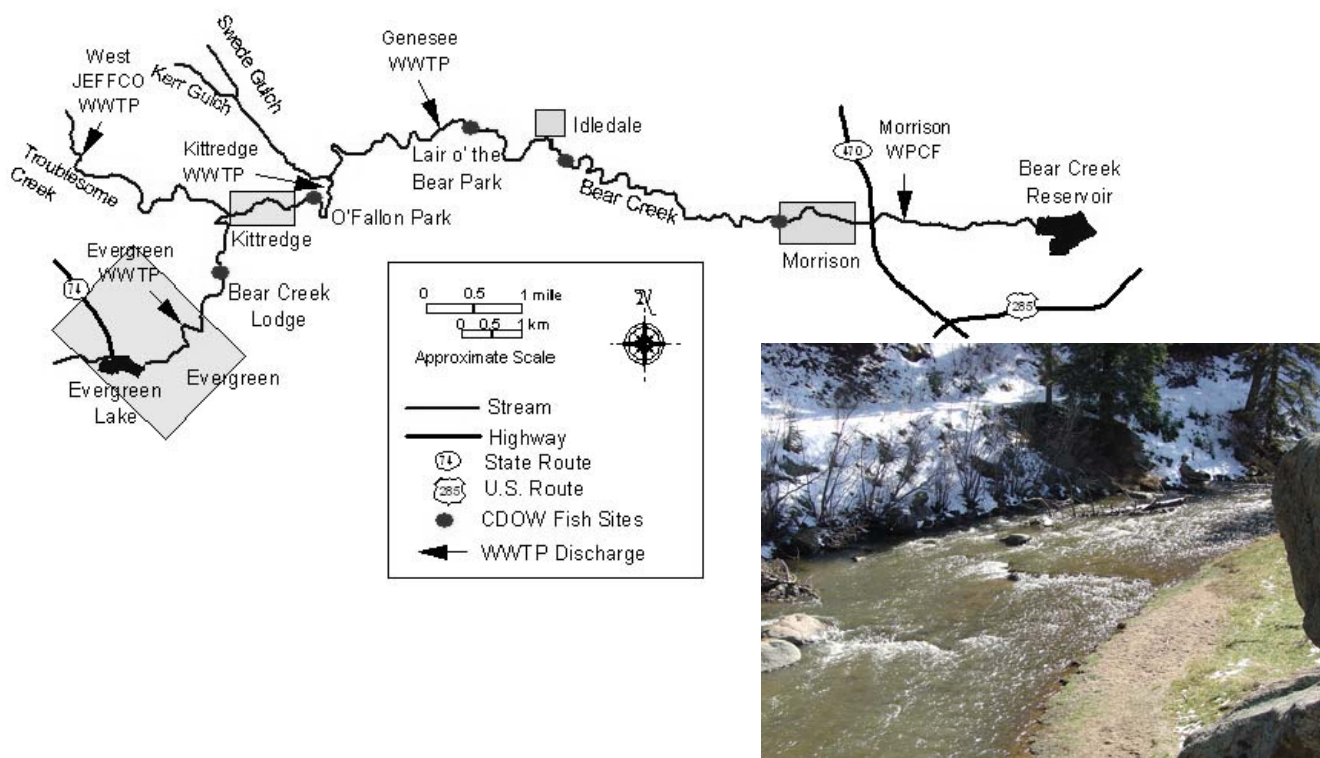




## Fact Sheet 22. Bear Creek Special Trout Population Trend Study

**Evaluation Of The Effects Of Wastewater Treatment Plants On Trout Populations In Bear Creek, Jefferson County, Colorado, 1994-2001 [Chadwick Ecological Consultants, Inc., 2002]**

The municipalities along Bear Creek divert water from Evergreen Lake and Bear Creek, and discharge wastewater treatment plant effluent back to the stream. The report presents historical fish population data available for Bear Creek, identifies spatial trends in trout populations and shows temporal trends from year to year. The data evaluation assessed status of trout populations to determine changes associated with reported fish kills and temperature effects of wastewater discharges. Brown and rainbow trout populations for Bear Creek decline in density and biomass from upstream near Evergreen downstream to near Morrison. This general trend occurs in all sampling years. The trend relates to the transition of the stream from a coldwater mountain stream to a warm-water plains stream below Morrison. Trout density in 1999 was relatively low at all sites. In 2000 and 2001, trout density and biomass were higher than previous years. A substantial increase in trout density and biomass at all sites occurred between 1999 and 2000. Trout biomass in Bear Creek is consistently above average for Rocky Mountain streams at almost all sites and in most years, and exceeds the biomass criterion for Gold Medal Trout Waters in Colorado. The presence of healthy trout populations at sites downstream of treatment plant discharges indicates no adverse effect on trout populations. Modeling of water temperature indicates discharge of wastewater effluent has a slight cooling effect on Bear Creek. The important factor determining trout population density and abundance is related to the magnitude of spring runoff. In years with high runoff, there are fewer trout, and in years of low runoff, trout populations increase. The presence of very strong year classes of both brown and rainbow trout in 2000 indicates conditions during the summer of 2000 were suitable to sustain resident trout populations, including sensitive young trout. The severe drought of 2003 resulted in low flow conditions in which temperatures probably had a detrimental effect on the trout populations of Bear Creek.



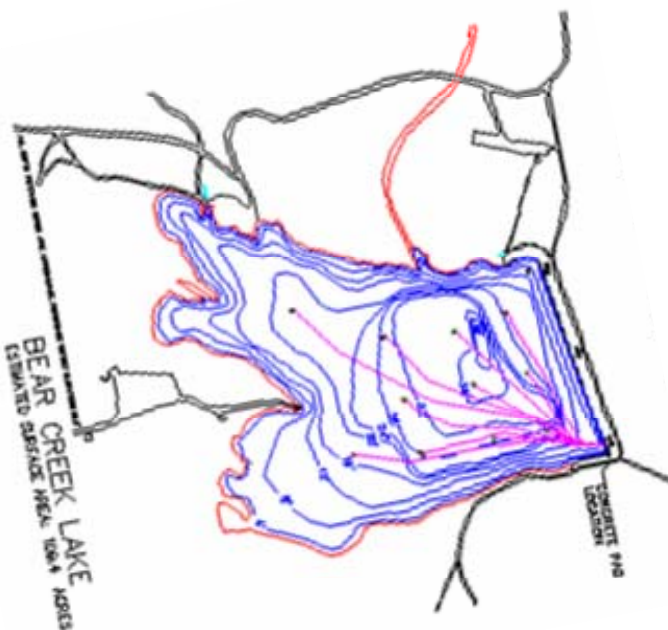
## Fact Sheet 23. City of Lakewood Bear Creek Reservoir Aeration System



The City of Lakewood maintains an aeration system in Bear Creek Reservoir as a water quality enhancement best management practice consistent with the Bear Creek Reservoir Control Regulation. This aeration system increases the amount of dissolved oxygen in the water column to protect the existing fishery. The original aeration system was designed to oxygenate the water column through a series of anchored towers. This Hypolimnetic aeration system didn't de-stratify the water column. Beginning in 2002, the aeration system began to structural fail from continued freezing in the winter,

which resulted in minimal oxygen transfer efficiency. Consequently, the City of Lakewood bid and installed a new complete aeration system in early fall of 2002. This new system has greater coverage throughout the reservoir and much high oxygen transfer potential. Key features of the new aeration system include:

- Eleven Air Diffusion Systems LTC Stainless Steel Modules
- Six Dura-Venturi aerators (From previous installation)
- 22 Million Gallon per Day per Module pumping rate
- Approximately one complete reservoir turnover every 3 days



The aeration system is expected to Increased dissolved oxygen concentrations throughout the entire water column; increased availability of habitat for all fish species (warm and cold); result in pH values that are homogenous and stabilized and cause water column temperatures to be more homogenous throughout the entire water column.

**Lake Aeration Treatment Systems Operational History:** Hypolimnetic Aeration System (1993); Dura-Venturi Installation (1999); ASI Lakebed Aeration System (2002)



## Fact Sheet 24. City of Lakewood Stormwater Program



Lakewood provides stormwater education programs in elementary, middle and high schools within the City. Lakewood made presentations and stenciled inlets in 2003 with more than 450 students and teachers. Lakewood staff continues to work with the Colorado Department of Public Health and Environment (CDPHE) to meet the terms of our Phase I National Pollutant Discharge Elimination System (NPDES) permit. Water quality enforcement actions are required by our existing NPDES permit to stop illicit connections and prevent illegal discharges from entering

the stormwater conveyance system. In some cases, grease traps from commercial properties such as restaurants or dumpsters may be poorly maintained allowing them to overflow and reach stormwater facilities. Approximately eight contacts have been made in recent months with commercial property owners or tenants regarding pollution prevention.

The dumpster shown above in the upper portion of the picture has not been properly maintained and is allowing unwanted fluids to leak and eventually be washed into the stormwater conveyance system. Lakewood responded to this and other sites requiring expeditious compliance from property owners.

*Lakewood supports the Rooney Road Recycling Center (RRRC) as part of our Phase I NPDES permit*

### **Significant Accomplishments:**

**The following are considered significant accomplishments of the program in 2004:**

- 2,629 residents have had access to proper disposal of their hazardous household waste (HHW)
- 8.9% increase in overall participation over 2001
- 368,431 pounds collected "Door-to-Door" or dropped off at the Center during 2003
- Slash program was introduced and approximately 2,750 households utilized the program
- Electronic waste recycling program introduced with 21,891 pounds collected and recycled
- Significant increases in number of pounds of waste collected
- Survey results excellent
- Program is tracking within budget for the period
- The Center and Authority were presented with an award by the State of Colorado for offering the most innovative environmental programs to the residents



## Fact Sheet 25. Jefferson County Stormwater Program

## Jefferson County stormwater permit activities



- Jefferson County is mandated to improve the quality of stormwater
- General Permit for Stormwater Discharges Associated with Municipal Separate Storm Sewer Systems
- Storm drain marking with Jeffco R1 school
- Storm sewer outfall map to trace sources of potential illicit discharges and illegal dumping
- Added stormwater information to the County's web page
- Revised County's standard for storm sewer inlets, requires "*No Dumping*" insignia on inlets
- Stormwater infiltration techniques encouraged
- Jefferson County provides opportunities for residents and visitors to learn and be involved in environmental stewardship.





Fact Sheet 26. Recreational Uses in Watershed

Jefferson County Open Space

Lair 'o the Bear Park

**Acreage: 319 acres**

**Annual Visitation: 52,000**

**Activities:** Hiking, biking, horseback riding, wildlife viewing, fishing, picnicking



Mount Falcon Park

**Acreage: 1,705 acres**

**Annual Visitation: 118,000**

**Historical Point of Interest**

**Activities:** Hiking, biking, horseback riding, wildlife viewing, fishing, picnicking

Alderfer/ Three Sisters Park

**Acreage: 770 acres**

**Annual Visitation: 62,500**

**Activities:** Hiking, biking, horseback riding, wildlife viewing, picnicking



Elk Meadow Park

**Acreage: 1,650 acres**

**Annual Visitation: 72,500**

**Activities:** Hiking, running, biking, horseback riding, wildlife viewing, picnicking

Mainstem Bear Creek

**Annual Visitation: >275,000**

**Activities:** Trout fishing (cutthroat, brook trout, browns, rainbows), hiking, biking, horseback riding, wildlife viewing, photography, picnicking, historical points of interest



Bear Creek Reservoir



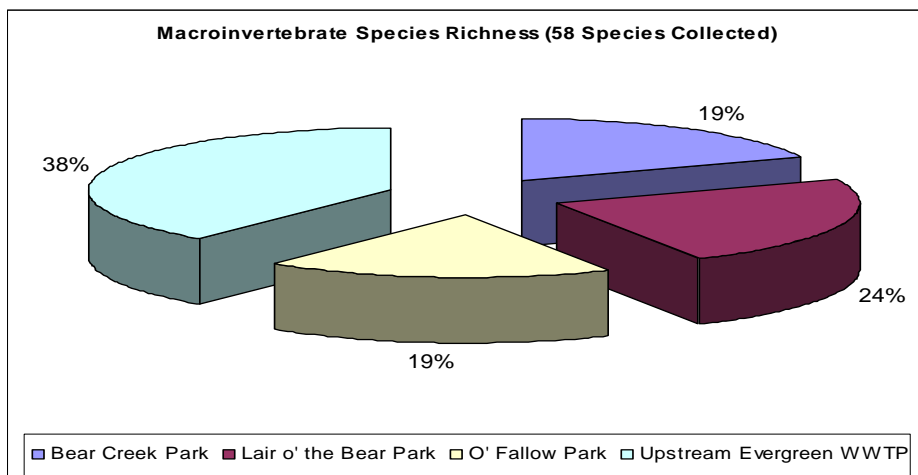
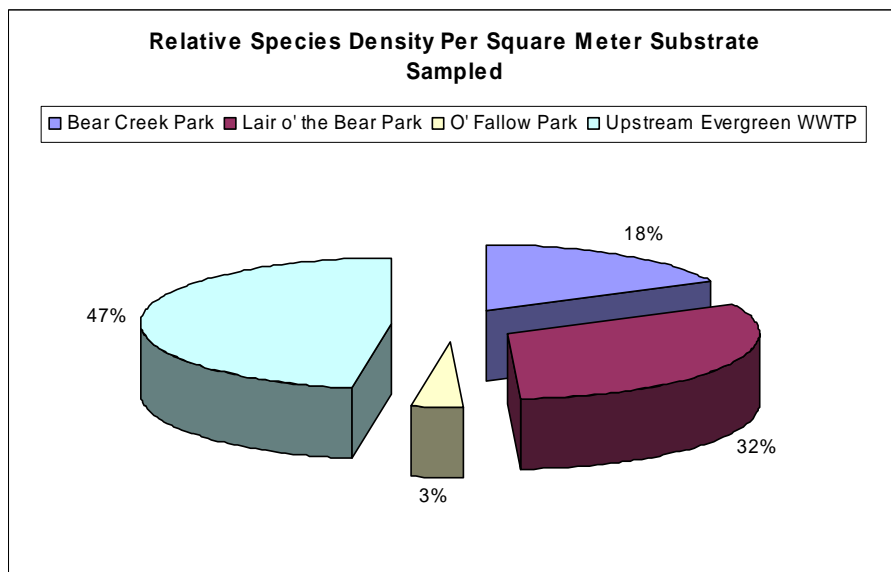
**Lakewood Bear Creek Lake Park Acreage: 2,600**

**Annual Visitation: 350,000**

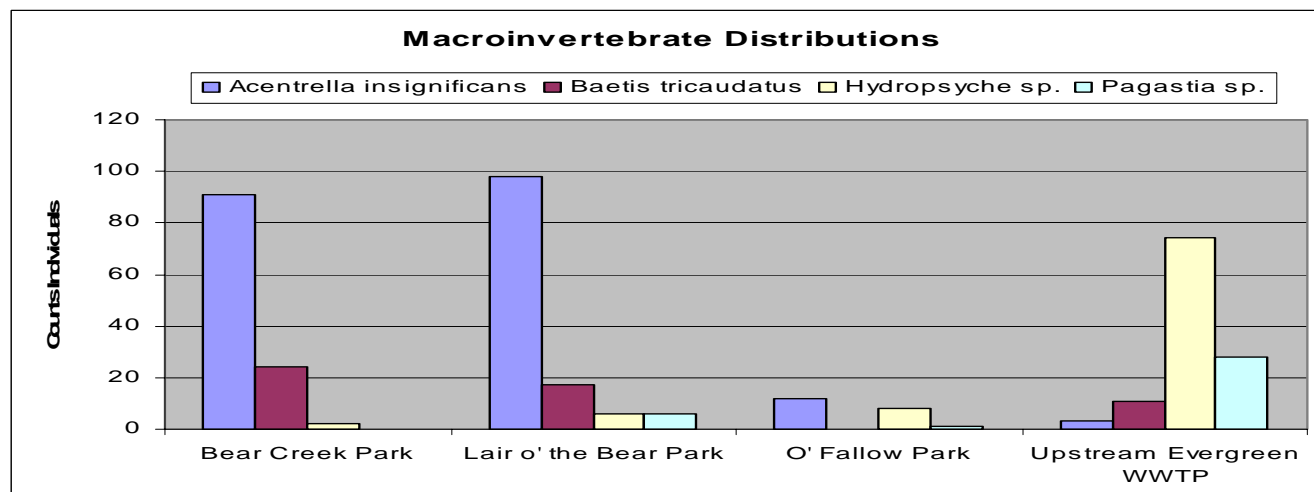
**Activities:** Fishing (Saugeye, rainbow trout, smallmouth bass, channel catfish, yellow perch, tiger musky), boating, sail boarding, swim beach, hiking, biking, horseback riding, wildlife viewing, picnicking, camping, nature center, educational activities, archery, glider plane flying, special event facilities, historical point of interest

## Fact Sheet 27. Bear Creek Segment 1a 2004 Macroinvertebrate Assessment

The macroinvertebrate integrity of Bear Creek segment 1a was assessed by collecting macroinvertebrate at four sites along Bear Creek on June 11, 2005: Bear Creek Park, Lair o' the Bear Park, O' Fallow Park, and Upstream Evergreen wastewater treatment plant effluent outfall. Association members used a Surber Stream-bottom sampler (After Brewer and McCann, 1982) and standard sampling protocol. A discrete section of randomly selected stream substrate was stirred in fixed quarter-meter framed area with a trowel for 2 minutes and 4 – 6 inches deep. Floating organisms captured in the net. Large rocks removed and hand picked on shore. **58 different species were collected at these sites.**



The species richness, density and dominant species distribution depicted in graphics. Macroinvertebrate density was distinctly lower at O'Fallon Park. Species were distributed by site along the stream gradient as depicted in lower graphic.





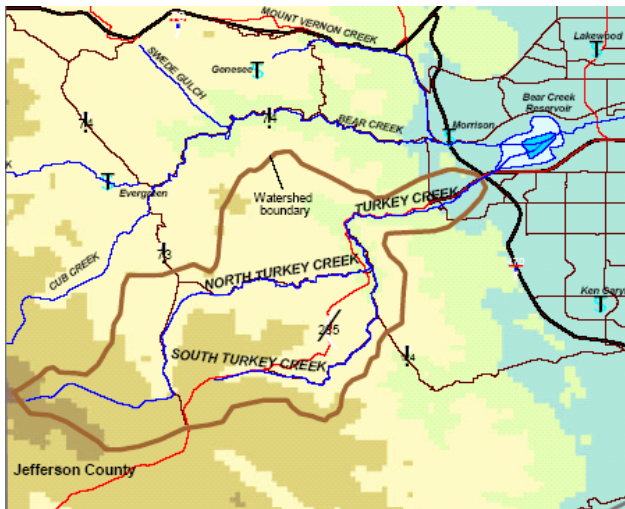
## Fact Sheet 28. CDOT Monitoring Program And Best Practice Effectiveness



The Turkey Creek Surface-Water Quality Monitoring Program 2003 Annual Report (TDS Consulting Inc. 2003) provides results of a final year's monitoring program for the Turkey Creek watershed and Kennedy Gulch area. It is a fifth (and final) report in an annual series provided since 1999 on behalf of the Colorado Department of Transportation (CDOT) for assessing the overall effectiveness of best management practices (BMPs) along the U.S. 285 highway corridor just west of the Denver metropolitan area. The 2003 basic-data results for 12 monitoring sites are within or border the Turkey Creek watershed, along with supplemental hydrologic and water-quality information. 2003 monitoring results when coupled with data for previous years (1995-2002) have addressed the continuing concerns relative to the U.S. 285 highway-related construction impacts. Post-construction monitoring has demonstrated, in large part, that any during-construction adverse impacts have been

substantially controlled by effective use of BMPs. On the other hand, late-season 2003 flows in the watershed continued to be characterized by below-normal precipitation. Thus, the potential for storm-generated sediments were relative low during the summer and early-fall months of 2003.

*Sedimentation basin above Site AP-1, 5/15/03*



**Appendix A:**  
**Summary of the Bear Creek Segment 1a Supplemental Monitoring Program**  
**For June 1-September 30, 2004**

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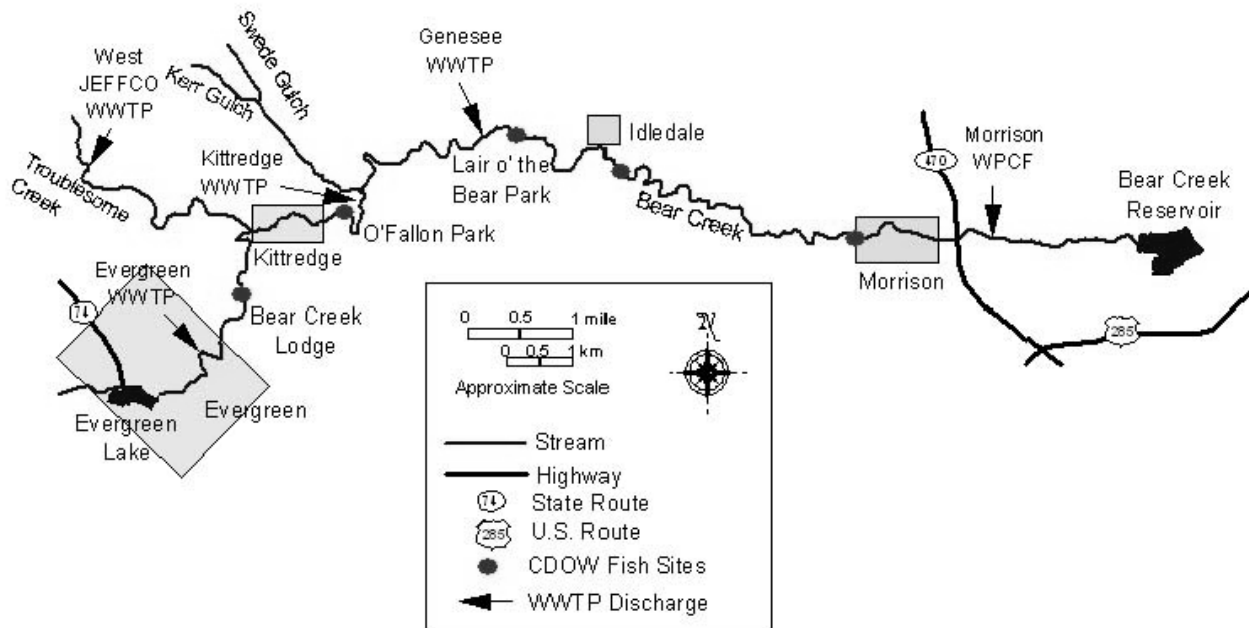
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## PURPOSE

The Bear Creek Watershed Association (Association) conducted a special stream monitoring program for Bear Creek Segment 1a during the summer of 2004. The segment listed on the State of Colorado's Monitoring and Evaluation List Regulation #94 is Bear Creek Segment COSPBE01a from below Evergreen Lake to the Harriman Diversion. Temperature data obtained from five in-stream locations, monitoring data from nine in-stream locations and data from four wastewater treatment plant (WWTP) effluents will be presented in this report.



The Program included data gathering locations outside of the identified Segment. Those locations include above Evergreen Lake, in Evergreen Lake (at the dam), and below the Harriman Diversion. The Morrison wastewater treatment plant (WWTP) discharge is also below the Harriman Diversion. The complete 2004 water quality data set is an electronic attachment to this data summary report.

The Program was a cooperative effort between the Association and the five larger wastewater treatment plant dischargers into Bear Creek Segment 1a. The entities include Evergreen Metropolitan District (EMD), West Jefferson County Metropolitan District (WJCMD), Kittredge Sanitation and Water District (KSWD), Genesee Water and Sanitation District (GWSD) and the town of Morrison. This supplemental monitoring program began June 1, 2004 and completed on September 30, 2004. (A limited sampling and monitoring program continues through the spring of 2005.) The in-stream monitoring program provides more detailed water quality information specifically for temperature, pH, dissolved oxygen, specific conductance and ammonia in Bear Creek Segment 1a. The monitoring program design specially addresses the listing parameters of aquatic life, temperature and ammonia as included in the 2004 Colorado Monitoring and Evaluation List.

## **BACKGROUND**

- The 2004 Colorado Monitoring and Evaluation List identified Bear Creek Segment 1a as potentially impaired due to temperature and ammonia, and conditions affecting aquatic life. The Association needed to obtain detailed water quality data throughout Segment 1a to determine if temperature and ammonia were a water quality problem.
- The routine water quality monitoring program maintained by the Bear Creek Watershed Association (for Bear Creek Reservoir) had not demonstrated a temperature or ammonia toxicity problem; consequently the supplemental monitoring effort was designed to assess gaps in the routine monitoring program by expanding the temporal and spatial data gathering efforts on the stream. Once the more detailed stream data was analyzed, the Association would determine the best location and sampling protocol to characterize Segment 1a.
- The Association wanted to obtain water quality data that could be used in future stream modeling and prediction. Additional evaluation and modeling of the temperature information was necessary to determine a management strategy for the stream.
- The listing for aquatic life required a more detailed stream characterization to assess how the trout populations are responding to both natural and human induced alterations. The supplemental data set allowed the Association to determine if chemical effects were part of the problem.
- The Association wanted to evaluate the cause and effect response to stream chemistry and recommend a management strategy to the Water Quality Control Commission.

## **SPECIAL STREAM MONITORING PROGRAM COMPONENTS**

The Program consisted of several components in an effort to assemble as much pertinent scientific data and information about Bear Creek Segment 1a as possible. Components included:

### **Temperature dataloggers**

Programmable temperature dataloggers measured and recorded hourly stream and WWTP effluent temperatures. The loggers used in the Program were Onset Computer Corporation brand, HOBO model H8 programmable dataloggers. The dataloggers were placed into watertight cases and secured to weights before placed underwater. The Program also used Onset computer software specifically designed for these dataloggers, which enables launch and readout (start and stop) and viewing of downloaded data. The software automatically presents the downloaded data in graph and table formats and allows data export into a spreadsheet format.

Dataloggers placed at 5 locations in Segment 1a and in all five WWTP effluents. Additionally, two dataloggers recorded measurements in Evergreen Lake (at the dam), one datalogger in Bear Creek above Evergreen Lake and one in Bear Creek below the Harriman

Diversion. As mentioned above, these four dataloggers (along with the Morrison WWTP effluent datalogger) were not within the scope of this report, but utilized for supplementary data collection and historical record. Their data will be included as an electronic attachment to this report. The datalogger identification codes and locations are shown in Table 1.

**Table 1 Datalogger Identification and Location**

<b>Datalogger ID</b>	<b>Datalogger Location</b>
EMD1	Above Evergreen Lake, at the USGS gaging station
EMD2	In Evergreen Lake, at the dam face, on the surface
EMD3	In Evergreen Lake, at the dam face, 10 feet below the surface
EMD4	Bear Creek Segment 1a, above EMD WWTP effluent
EMD5	EMD WWTP effluent
WJ6	WJCMD WWTP effluent
KSWD7	Bear Creek Segment 1a, above KSWD WWTP effluent
KSWD8	KSWD WWTP effluent
GWSD9	Bear Creek Segment 1a, above GWSD WWTP effluent
GWSD9A	GWSD WWTP effluent
EMD5A	Bear Creek Segment 1a, below Idledale (east end of town)
MORR10	Bear Creek Segment 1a, above Morrison (west end of town)
MORR11	Bear Creek Segment 1a, above Morrison WWTP effluent
MORR12	Morrison WWTP effluent

The dataloggers were programmed for hourly measurements at an office computer equipped with the Onset software. At this frequency, the memory capacity is approximately 75 days. However, because of the Onset program design, the units begin recording temperatures immediately, once launched. (Newer models have delayed-start capabilities.) Logsheets were utilized to record the exact time of deployment and retrieval of all units, so that erroneous measurements (measurements recorded out of water) could be omitted during the data evaluation process.

A typical retrieval/deployment procedure is as follows: The loggers are removed from their locations, beginning in Evergreen and proceeding downstream toward Morrison. The date and time of each retrieval are noted on a log sheet. After retrieving the last logger in Morrison, the loggers are transported to the computer with the Onset software at the EMD Administration office. The loggers are then removed from their watertight cases. The loggers are connected to the computer via a download cable, data collection is stopped and data on the loggers is individually downloaded into separate program files. A desiccant packet in the watertight case is removed and dried. The cases are prepared for the re-immersion by coating the o-ring with silicone sealant. The loggers are then individually connected to the computer and launched (started). The logger with a desiccant packet is placed into the case and closed, hand tight. Beginning in Evergreen, the dataloggers are returned to their respective locations, moving downstream to Morrison, noting the date and time of deployment on the log sheet.

Precautions were taken during the Program to avoid lost temperature data. In previous years, dataloggers have been stolen from their location and all data for that recording period lost. In an effort to minimize lost data, dataloggers located in Segment 1a were retrieved and downloaded on a monthly schedule. The dataloggers located in the WWTP effluents were retrieved and downloaded every two months, because of the secure environment. Summary results from the temperature dataloggers presented in the table format.

## Weekly Measurements

Monitoring for pH, dissolved oxygen, temperature and specific conductance was performed weekly at ten locations in Segment 1a. Some of the locations were coincident with temperature dataloggers. (Monitoring was performed in Evergreen Lake at two locations near the dam face and one location in the “middle” of the Lake. In addition, measurements were taken at Kerr Gulch, a spring-fed drainage into Bear Creek, just below the KSWD WWTP discharge. Measurements were obtained at a location above Morrison’s WWTP discharge. These data presented as an electronic attachment to this report. The monitoring ID’s and locations shown in Table 2 and parameters sampled shown in Table 3.

**Table 2 Monitoring Identification and Location**

Monitoring ID	Location
EMD4	Bear Creek Segment 1a, above EMD WWTP effluent
BCC	Bear Creek Segment 1a, vehicle bridge below Bear Creek Cabins
WELCHBR	Bear Creek Segment 1a, vehicle bridge at Welch Avenue in Kittredge
OPFWEST	Bear Creek Segment 1a, west end of O’Fallon Park in Kittredge
KSWD7	Bear Creek Segment 1a, above KSWD WWTP effluent
KERR	Kerr Gulch, above the confluence of Bear Creek Segment 1a
GWSD9	Bear Creek Segment 1a, above GWSD WWTP effluent
IDLEWEST	Bear Creek Segment 1a, west end of Idledale, west of Little Park
EMD5A	Bear Creek Segment 1a, below Idledale (east end of town)
MORR10	Bear Creek Segment 1a, above Morrison (west end of town)
MORR11	Bear Creek Segment 1a, above Morrison WWTP effluent

**Table 3 The weekly sampling and monitoring events**

Sampling/ Monitoring ID	Parameters
EMD4	pH, Temperature (Temp.), Dissolved Oxygen (DO), Specific Conductance (SpCd); Total Ammonia; Temp. Datalogger
BCC	pH, Temp., DO, SpCd; Total Ammonia
WELCHBR	pH, Temp., DO, SpCd; Total Ammonia
OPFWEST	pH, Temp., DO, SpCd; Total Ammonia
KSWD7	pH, Temp., DO, SpCd; Total Ammonia; Temp Datalogger
KERR	pH, Temp., DO, SpCd; Total Ammonia
GWSD9	pH, Temp., DO, SpCd; Total Ammonia; Temp Datalogger
IDLEWEST	pH, Temp., DO, SpCd; Total Ammonia
EMD5A	pH, Temp., DO, SpCd; Total Ammonia; Temp Datalogger
MORR10	pH, Temp., DO, SpCd; Total Ammonia; Temp Datalogger
MORR11	pH, Temp., DO, SpCd; Total Ammonia; Temp Datalogger

Weekly measurements performed alternately in scheduled morning and afternoon events. Morning events began at approximately 8:00 in Evergreen Lake, while afternoon events began about noon. The purpose for alternating morning and afternoon events was to determine if any significant changes observed are temporally related. Morning and afternoon datasets presented separately in report tables.

Measurements recorded with a Yellow Springs Instruments, Inc. (YSI) Model 556 MPS hand-held meter. The meter utilizes a multi-probe sensor, capable of measuring pH, temperature, dissolved oxygen and specific conductance simultaneously. The measurements are logged and retained in the on-board computer until manually or electronically downloaded. (Typically, the logged data was manually downloaded by viewing each file and transcribing data onto weekly Logsheets. At the completion of the Program, the memory was downloaded to a computer for use as a quality control check.) Prior to the Program, the meter was calibrated by certified technicians at Geotech Environmental Equipment in Denver. Prior to each monitoring event, the meter calibrated for each parameter, using a purchased calibration solution for specific conductance and technician-mixed pH buffers (two-point calibration, 7.00 and 10.01). All calibrations were documented on a Logsheets.

Fresh batteries were installed in the meter at the start of the Program and batteries were replaced when the observed battery charge reached 50%. The YSI multimeter utilizes a YSI software program to download and present collected data. Ecowatch software presents the data in graphic and tabular formats and data can be exported into a spreadsheet program.

### **Total Ammonia Weekly Sampling**

Weekly sampling for total ammonia performed at ten locations in Segment 1a. In addition, the locations above Evergreen Lake, Kerr Gulch and above Morrison's WWTP discharge were sampled. As stated above, this data will be included as an electronic attachment to this report.

Sampling performed concurrently with weekly monitoring. The temperature and pH values measured at the time of sampling used in the unionized ammonia calculation. The weekly sampling and monitoring was also coordinated with permit sampling performed by the WWTP's discharging into Bear Creek. The reason for this coordinated effort was to attempt to provide a water quality "snapshot" of Bear Creek at that point in time.

WWTP effluents analyzed by onsite laboratories: EMD, WJCMD and KSWD plant effluents were analyzed by EMD personnel, as typically done for CPDES permit reporting. EMD personnel utilize the EPA-approved Method 4500-NH3 D., *Standard Methods for the Analysis of Water and Wastewater, 20<sup>th</sup> Edition*. Similarly, GWSD WWTP personnel analyzed plant effluent per approved methods: Method 4500-NH3 D., *Standard Methods for the Analysis of Water and Wastewater, 20<sup>th</sup> Edition*.

Samples taken in the field were documented on Logsheets and EMD Chain of Custody forms. Samples were taken in polyethylene bottles, unpreserved, and immediately iced. Morning sampling events resulted in same-day transport to the University of Colorado Limnology Laboratory. Afternoon sampling events resulted in next morning transport to the University of Colorado Limnology Laboratory. Samples were iced overnight. The CU Lab uses a low level, spectrophotometric method: Method 4500-NH3 F., *Standard Methods for the Analysis of Water and Wastewater, 20<sup>th</sup> Edition*. Summary results of the ammonia sampling are presented in this summary report.

### **24-hour Profiling At Two Locations**

In addition to weekly sampling and monitoring, the Association decided to purchase a programmable, sonde-type, recording, multi-sensor probe to profile selected sites for pH, temperature, dissolved oxygen and specific conductance over a 24-hour period. Two locations were selected: Bear Creek Segment 1a, above KSWD WWTP effluent and Lair o' the Bear Park, near Idledale.

The location above KSWD WWTP effluent is at the east end of O'Fallon Park. This Denver Mountain Park is a high-use park popular with day users from the Denver area. The Park has been identified as a problem area for water quality in past years. The Lair o' the Bear Open Space Park site was chosen for its proximity to the midpoint of the Segment. Both sites were chosen for their accessibility and cover from the public. The reason for 24-hour profiling was to document naturally occurring, diurnal parameter fluctuations. In prior years, high parameter fluctuations (pH) were documented but attributed to low flows. This is an effort to begin historical data collection to compare normal and low flow years.

The probe selected for the Program was a YSI 600XLM. Calibrations were performed and documented prior to each use. A two-point calibration was used for pH (7.00 and 10.01) and the specific conductance calibration was performed with a purchased solution. The probe was programmed for a delayed start and programmed to measure parameters hourly. The probe was weighted, disguised and deployed at each location six times during the Program. The YSI Ecowatch software downloads data and presents it in graphic and tabular formats. Data can be exported into a spreadsheet program.

## **Data Management**

Large quantities of varied data were collected during the Program. As mentioned above, weekly stream monitoring and sampling (separated into morning and afternoon events), laboratory results, hourly temperature measurements from dataloggers, wastewater treatment plant effluent process control and permit monitoring data (from four treatment plants), weather statistics and stream flows comprise raw data. All data was stored on an office computer, using Microsoft Office 2000 software. The majority of the data resides in and analyses occurred in Excel spreadsheet format. The PC is connected to a LAN, which provides nightly backup to a server. Other software programs that contain raw data include Onset Computer Corporation Boxcar software and YSI Ecowatch software. Both of these programs reside on the same PC mentioned above. Laboratory results consisted of low-level total ammonia results from the Limnology Laboratory at CU Boulder. These results, coupled with pH and temperature values taken simultaneously were used to calculate the unionized ammonia fraction.

## **Weekly stream monitoring and sampling data**

Weekly stream monitoring and sampling data was tabulated and separated into morning and afternoon datasets. Data was retrieved from the YSI memory shortly after each monitoring event. Data was transcribed onto the weekly Logsheets and subsequently entered onto Excel spreadsheets. Each monitoring site has an individual folder, with files of data. Additionally, individual parameter files created to evaluate separately. Minimum, maximum, average and standard deviation analyses were performed on this (and mostly all) data.

## Temperature datalogger data

Hourly datalogger temperature measurements were exported from the Onset Computer software into Excel spreadsheets. Each download of temperature data is treated as a file in the Onset software. Once the Onset file formats had been saved as separate Excel files, the Excel files for each location were combined into one Excel file with multiple worksheets. Therefore, each Excel file contains multiple worksheets, one for each separate download of data, and a summary worksheet. The summary worksheet contains the combined individual data files and statistical analysis.

The date and time recorded on the Launch/Retrieval logsheet were used to eliminate erroneous temperature measurements prior to data analysis. Once in a spreadsheet format, the data was analyzed for Daily Maximum Temperature, Seven-day Average Maximum Temperature and  $\Delta^{\circ}\text{C}/4$  hours. Temperature data was analyzed against the  $20^{\circ}\text{C}$  maximum stream standard and the  $\Delta 3^{\circ}\text{C}/4$  hours limits. Additionally, any values found to exceed the  $\Delta 3^{\circ}\text{C}/4$  hours were analyzed to determine whether the exceedence occurred above or below  $20^{\circ}\text{C}$ . Percentages of compliance were calculated.

## Wastewater Treatment Plant Data

Since there are five “major” wastewater treatment facilities that discharge into Bear Creek Segment 1a, an effort was undertaken to analyze effluent parameters that would be consequential to the receiving waters (Table 4). (The Morrison WWTP is not included in this report, because its discharge enters Bear Creek below the identified Segment 1a.) Effluent flow, temperature, dissolved oxygen, pH and total ammonia data has been collected and reviewed. Only data that typically comprises daily Process Control and permit-mandated monitoring was reviewed. In prior years, the same data was collected and combined with monitoring and measurements taken in Bear Creek. This combined data was introduced to separate temperature, dissolved oxygen models to document existing effects, and predict possible outcomes of specific scenarios.

**Table 4      Wastewater Treatment Plants And Parameters**

WWTP	Parameters
EMD	Flow, pH, Temperature, Dissolved Oxygen, Total Ammonia; Temp Datalogger
WJCMD	Flow, pH, Temperature, Dissolved Oxygen, Total Ammonia; Temp Datalogger
KSWD	Flow, pH, Temperature, Dissolved Oxygen, Total Ammonia; Temp Datalogger
GWSD	Flow, pH, Temperature, Dissolved Oxygen, Total Ammonia; Temp Datalogger
Morrison	Flow, pH, Temperature, Dissolved Oxygen, Total Ammonia; Temp Datalogger

The sampling and monitoring portion of the Program was coordinated with the permit required effluent sampling. This occurred on Thursdays during the Program.

## Weather (local)

A National Weather Service reporting station is maintained at the EMD WWTP. Daily high and low air temperatures and precipitation are recorded and transmitted monthly to the



National Weather Service. Weather data is tabulated and correlated with Bear Creek stream flows for the Program.

### **Stream flows**

A USGS stream gage (USGS 06710385) is maintained at the temperature datalogger location ID EMD1, which is located above Evergreen Lake. The gage location is adjacent to the Denver Mountain Parks golf course and restaurant (Keys on the Green) parking lot. A second gaging station is located at the temperature datalogger location ID MORR10, above the town of Morrison, just west of the Highway 8 bridge over Bear Creek. This station (BCMORCO) is maintained by the US Army Corps of Engineers and the Colorado Division of Water Resources. Weekly stream flow graphs were printed from both stations and filed for record. Monthly average daily flows from the USGS station have been exported to a spreadsheet for comparison with historical data.

### **Problems**

Relatively few problems encountered during the Program. The datalogger located just above the EMD WWTP effluent outfall (EMD4) malfunctioned shortly after its return to service on 8/2/04. The malfunction occurred on 8/6/04 at 04:05; however, it was not realized until the datalogger was retrieved on 9/11/04. The unit experienced a thermistor problem and no data collected for essentially the month of August. A replacement datalogger put into service with the subsequent launching. There were no other equipment problems during the Program. An attempt made to use temporary staff gages placed in the creek at four different locations for relative measurements. The heavy rains in July toppled the gages and sometimes swept them away, resulting in repositioning and inconsistent readings. Readings halted approximately midway through the Program.

## **OTHER SUPPORTING STREAM STUDY EFFORTS**

### **Macroinvertebrate Assessment**

The macroinvertebrate integrity of Bear Creek segment 1a was assessed by collecting macroinvertebrate at four sites along Bear Creek on June 11, 2005: Bear Creek Park, Lair o' the Bear Park, O'Fallon Park, and Upstream Evergreen wastewater treatment plant effluent outfall. Association members used a Surber Stream-bottom sampler (After Brewer and McCann, 1982) and standard sampling protocol. A discrete section of randomly selected stream substrate was stirred in fixed quarter-meter framed area with a trowel for 2 minutes and 4 – 6 inches deep. Floating organisms captured in the net. Large rocks removed and hand picked on shore. 58 different species were collected at these sites.

### **CDOW Fish Count**

The Colorado Division of Wildlife (CDOW) performed an electro-fishing fish count in Segment 1a on September 14-15, 2004. Five locations were surveyed (moving upstream to downstream): Bear Creek Cabins, O'Fallon Park, Lair o' the Bear Park, below Idledale and at the west end of Morrison. Chadwick Ecological Consultants (CEC) requested the raw data for analysis. BCWA did not retain CEC to perform a detailed analysis of the data, but received a verbal summary of the data. CDOW contacted for the same: a verbal analysis of

the data, with a comparison to prior years. BCWA took this approach (verbal summaries) to maximize the return on monitoring dollars. The BCWA includes the fish count data summaries as an indicator of the overall water quality in Segment 1a.

## **Fishing Survey**

A fishing survey was created by EMD personnel and handed to anglers along Bear Creek during the Program. The purpose was to collect additional non-scientific data regarding water quality through the personal input of recreational users. Five return-addressed, stamped surveys were distributed and one was returned.

## **DATA SHEETS AND STUDY FORMS**

Several forms were generated by EMD personnel to document measurements and actions during the Program. Logsheets used in the Program include:

- Datalogger Launch/Retrieve
- Bear Creek Study Staff Gage Readings
- Calibration Record-YSI 556
- Calibration Record-YSI Sonde
- Bear Creek Weekly Checks Log
- EMD Chain of Custody form

### **Data Sheets-Launch/Retrieve Record**

This form was used during the Program to document the precise time and date when the dataloggers were removed from and immersed in Bear Creek. This was an important to document because no delayed start was used with the dataloggers. Temperature measurement began as soon as the logger was launched at the computer, so documenting exactly when the logger was immersed allows for the exclusion of erroneous readings. Date, time and initials recorded.

### **Data Sheets-Staff Gage Readings**

This form used during the Program to document relative stream height on non-permanent staff gages. Date, time, height in feet and initials recorded. Readings were taken whenever personnel were performing Program tasks. Because the staff gages were non-permanent, high flows from rain events caused toppling. Staff gages were up righted and readings taken, usually from a new location. Because of this frequent occurrence, the readings became more meaningless and the procedure abandoned midway through the Program.

### **Data Sheets-Calibrations**

The two-calibration log sheets used during Program documented the instrument calibrations performed before each measuring activity. Date, time, equipment warm-up time, pH (7.00 and 10.01), dissolved oxygen, temperature, specific conductance and initials were recorded. Both the YSI 556 and the YSI 600 XLM Sonde instruments were calibrated prior to each use. Any unusual conditions (unit will not calibrate) or service activities (changing batteries) were also noted.

### **Data Sheets-Weekly Log**

The weekly log sheets used during the Program summarized sampling and monitoring event results. Date, pH, temperature, dissolved oxygen, specific conductance, sampling time and initials were documented. Parameter results and monitoring time were transcribed from the YSI 556 meter memory. A note was also made regarding the presence (or absence) of the datalogger. Weather observations were noted.

### **Data Sheets-EMD Chain of Custody**

The Chain of Custody form was used during the Program to document the secure handling of stream samples obtained. Date, time, sample location, sample type (composite/grab), number of containers, analysis, sampler signature, remarks, relinquished by and received by signature was recorded. The form is a carbonless copy, and the copy remained with the samples in the Limnology Laboratory at CU Boulder and the original was retained on file by EMD. Datasets that are much more detailed include all locations from individual events, graphed representation of such data and all recorded temperature data (exported to spreadsheet format) from the dataloggers. This data is available as an attachment to the report. Total ammonia results were combined with pH and temperature measurements recorded at the time of sampling to calculate the unionized fraction.

## BEAR CREEK IN-STREAM DATA TABLES

**Table 5      Above EMD WWTP effluent**

[Monitoring station/Datalogger ID: EMD4   GPS Coordinates: 39.6376°N, 105.3150°W; The location of the sampling/monitoring site is in Bear Creek, behind the EMD WWTP UV building, upstream of the plant effluent outfall.]

9 weekly morning sampling/monitoring events   June 1-Sept 30, 2004						
Weekly Parameter results	pH, SU	Temp, °C	Dissolved Oxygen, mg/L	Sp. Cond., mS/cm	Total NH3-N, ug/L	Unionized NH3-N, ug/L
Min	6.95	10.50	7.97	0.053	8.2	0
Max	7.84	17.89	11.34	0.078	34.4	0
Avg	7.39	13.53	8.85	0.063	18.8	0
Std. Dev.	0.23	1.92	0.95	0.007	9.6	0
9 weekly afternoon sampling/monitoring events   June 1-Sept 30, 2004						
Weekly Parameter results	pH, SU	Temp, °C	Dissolved Oxygen, mg/L	Sp. Cond., mS/cm	Total NH3-N, ug/L	Unionized NH3-N, ug/L
Min	6.82	9.94	8.37	0.057	8.9	0
Max	7.87	16.93	9.19	0.078	39.6	1
Avg	7.44	13.95	8.65	0.066	18.5	0
Std. Dev.	0.26	1.81	0.27	0.007	9.2	0
Datalogger Temperature Data						
All Temperatures in °C		Hourly Temp.	Daily Max Temp.	7-Day Avg. Max Temp.	Δ°C/4 hr Moving Averages	
Min		9	10.2	10.6	0.0	
Max		19	19.0	18.1	2.7	
Avg		13.6	14.7	14.9	0.6	
Std. Dev.		1.9	1.9	1.6	0.4	
# of measurements		2113	89	77	2101	
# of 20°C exceed		0	0	0		
% Compliance		100	100	100		
Δ3°C/ 4 hr exceedances					0	
% Compliance					100	
Δ3°C/ 4 hr exceedances > 20°C					0	
% Compliance					100	

Existing stream standards: 0.02 mg/L (20.0 ug/L) Unionized Ammonia (NH3-N), chronic;  
20°C Maximum, 3°C increase per 4 hours; pH 6.5-9.0; DO 6.0 mg/L

**Table 6 Bear Creek Cabins**

[Monitoring station/Datalogger ID: BCC GPS Coordinates: 39.6437°N, 105.3074°W The location of the sampling/monitoring site is in Bear Creek, below the Bear Creek Cabins WWTP, on the upstream side of the vehicle bridge at Old Gulch Road. There was no temperature datalogger at this location.]

9 weekly morning sampling/monitoring events June 1-Sept 30, 2004						
Weekly Parameter results	pH, SU	Temp, °C	Dissolved Oxygen, mg/L	Sp. Cond., mS/cm	Total NH3-N, ug/L	Unionized NH3-N, ug/L
Min	7.29	10.53	8.31	0.056	7.4	0
Max	8.50	18.23	11.38	0.086	137.2	1
Avg	7.73	13.88	9.03	0.069	28.3	0
Std. Dev.	0.38	1.96	0.88	0.009	39.1	0
9 weekly afternoon sampling/monitoring events June 1-Sept 30, 2004						
Weekly Parameter results	pH, SU	Temp, °C	Dissolved Oxygen, mg/L	Sp. Cond., mS/cm	Total NH3-N, ug/L	Unionized NH3-N, ug/L
Min	7.01	10.40	8.33	0.056	9.0	0
Max	8.18	17.30	9.27	0.093	35.5	0
Avg	7.66	14.67	8.72	0.075	15.6	0
Std. Dev.	0.35	2.03	0.30	0.011	8.2	0

Existing stream standards: 0.02 mg/L (20.0 ug/L) Unionized Ammonia (NH3-N), chronic; 20°C Maximum, 3°C increase per 4 hours; pH 6.5-9.0; DO 6.0 mg/L

**Table 7 Welch Avenue Bridge**

[Monitoring station/Datalogger ID: WELCHBR GPS Coordinates: 39.6548°N, 105.3028°W The location of the sampling/monitoring site is in Bear Creek, on the upstream side of the bridge at Welch Avenue in Kittredge, near the Kittredge Community Park. There was no temperature datalogger at this location.]

9 weekly morning sampling/monitoring events June 1-Sept 30, 2004						
Weekly Parameter results	pH, SU	Temp, °C	Dissolved Oxygen, mg/L	Sp. Cond., mS/cm	Total NH3-N, ug/L	Unionized NH3-N, ug/L
Min	7.22	9.97	8.30	0.063	7.3	0
Max	8.41	18.10	11.61	0.102	191.1	1
Avg	7.68	13.71	9.02	0.081	32.8	0
Std. Dev.	0.39	2.01	0.96	0.013	56.3	0
9 weekly afternoon sampling/monitoring events June 1-Sept 30, 2004						
Weekly Parameter results	pH, SU	Temp, °C	Dissolved Oxygen, mg/L	Sp. Cond., mS/cm	Total NH3-N, ug/L	Unionized NH3-N, ug/L
Min	7.22	10.94	7.96	0.071	8.1	0
Max	8.36	18.40	9.00	0.120	19.2	1
Avg	7.77	15.41	8.52	0.086	13.2	0
Std. Dev.	0.38	2.29	0.28	0.014	3.4	0

Existing stream standards: 0.02 mg/L (20.0 ug/L) Unionized Ammonia (NH3-N), chronic; 20°C Maximum, 3°C increase per 4 hours; pH 6.5-9.0; DO 6.0 mg/L

**Table 8 O'Fallon Park West**

[Monitoring station/Datalogger ID: OFPWEST GPS Coordinates: 39.6560°N, 105.2920°W The location of the sampling/monitoring site is in Bear Creek, at the west end of O'Fallon Park in Kittredge, just downstream of the Bear Creek Tavern restaurant.]

9 weekly morning sampling/monitoring events June 1-Sept 30, 2004						
Weekly Parameter results	pH, SU	Temp, °C	Dissolved Oxygen, mg/L	Sp. Cond., mS/cm	Total NH3-N, ug/L	Unionized NH3-N, ug/L
Min	7.34	9.99	8.61	0.064	5.8	0
Max	8.64	18.47	11.51	0.105	249.7	1
Avg	7.98	13.88	9.25	0.083	37.7	0
Std. Dev.	0.43	2.09	0.89	0.013	75.1	0
9 weekly afternoon sampling/monitoring events June 1-Sept 30, 2004						
Weekly Parameter results	pH, SU	Temp, °C	Dissolved Oxygen, mg/L	Sp. Cond., mS/cm	Total NH3-N, ug/L	Unionized NH3-N, ug/L
Min	7.53	11.28	7.94	0.071	7.2	0
Max	8.54	19.13	9.19	0.123	18.2	1
Avg	7.98	15.75	8.58	0.089	13.0	0
Std. Dev.	0.40	2.35	0.36	0.015	3.3	0

Existing stream standards: 0.02 mg/L (20.0 ug/L) Unionized Ammonia (NH3-N), chronic;  
20°C Maximum, 3°C increase per 4 hours; pH 6.5-9.0; DO 6.0 mg/L

**Table 9 Above KSWD WWTP effluent**

[Monitoring station/Datalogger ID: KSWD7 GPS Coordinates: 39.6585°N, 105.2863°W The location of the sampling/monitoring site is in Bear Creek, at the east end of O'Fallon Park in Kittredge, just upstream of the Kittredge WWTP effluent outfall.]

9 weekly morning sampling/monitoring events June 1-Sept 30, 2004						
Weekly Parameter results	pH, SU	Temp, °C	Dissolved Oxygen, mg/L	Sp. Cond., mS/cm	Total NH3-N, ug/L	Unionized NH3-N, ug/L
Min	7.48	9.86	8.12	0.066	7.3	0
Max	8.60	19.00	11.59	0.108	184.2	1
Avg	8.05	14.22	8.92	0.082	31.1	0
Std. Dev.	0.38	2.26	0.99	0.012	54.4	0
9 weekly afternoon sampling/monitoring events June 1-Sept 30, 2004						
Weekly Parameter results	pH, SU	Temp, °C	Dissolved Oxygen, mg/L	Sp. Cond., mS/cm	Total NH3-N, ug/L	Unionized NH3-N, ug/L
Min	7.50	11.49	7.58	0.073	8.7	0
Max	8.42	19.58	8.91	0.125	19.0	1
Avg	7.99	16.06	8.29	0.091	13.1	0
Std. Dev.	0.35	2.41	0.34	0.015	3.2	0
Datalogger Temperature Data						
All Temperatures in °C			Hourly Temp.	Daily Max Temp.	7-Day Avg. Max Temp.	Δ°C/4 hr Moving Averages
Min			8.6	11.3	12.7	0.0
Max			22.1	22.1	20.3	4.6
Avg			14	16.4	16.5	1.0
Std. Dev.			2.2	2.2	1.6	0.9
# of measurements			2912	122.0	116.0	2900
# of 20°C exceed			28	9.0	3.0	
% Compliance			99	93	97	
Δ3°C/ 4 hr exceedances						108
% Compliance						96
Δ3°C/ 4 hr exceedances > 20°C						14
% Compliance						87

Existing stream standards: 0.02 mg/L (20.0 ug/L) Unionized Ammonia (NH3-N), chronic;  
20°C Maximum, 3°C increase per 4 hours; pH 6.5-9.0; DO 6.0 mg/L

**Table 10 Above GWSD WWTP effluent**

[Monitoring station/Datalogger ID: GWSD9 GPS Coordinates: 39.6668°N, 105.2657°W The location of the sampling/monitoring site is in Bear Creek, at the west end of Lair o' the Bear Park near Idledale, just upstream of the Genesee WWTP effluent outfall.]

9 weekly morning sampling/monitoring events June 1-Sept 30, 2004						
Weekly Parameter results	pH, SU	Temp, °C	Dissolved Oxygen, mg/L	Sp. Cond., mS/cm	Total NH3-N, ug/L	Unionized NH3-N, ug/L
Min	7.71	9.19	7.98	0.069	8.3	0
Max	8.64	18.88	11.87	0.102	67.8	2
Avg	8.03	14.09	8.87	0.084	20.1	0
Std. Dev.	0.28	2.40	1.09	0.011	18.3	1
9 weekly afternoon sampling/monitoring events June 1-Sept 30, 2004						
Weekly Parameter results	pH, SU	Temp, °C	Dissolved Oxygen, mg/L	Sp. Cond., mS/cm	Total NH3-N, ug/L	Unionized NH3-N, ug/L
Min	7.56	11.47	7.54	0.075	1.1	0
Max	8.19	19.38	8.82	0.134	28.8	1
Avg	7.91	16.11	8.23	0.098	13.0	0
Std. Dev.	0.25	2.31	0.34	0.018	7.5	0
Datalogger Temperature Data						
All Temperatures in °C		Hourly Temp.	Daily Max Temp.	7-Day Avg. Max Temp.	Δ°C/4 hr Moving Averages	
Min		7.8	11.3	12.4	0.0	
Max		22.4	22.4	20.4	5.3	
Avg		13.9	16.5	16.4	1.1	
Std. Dev.		2.4	2.2	1.8	0.9	
# of measurements		2913	122.0	116.0	2901	
# of 20°C exceed		31	6.0	4.0		
% Compliance		99	95	97		
Δ3°C/ 4 hr exceedances					111	
% Compliance					96	
Δ3°C/ 4 hr exceedances > 20°C					13	
% Compliance					88	

Existing stream standards: 0.02 mg/L (20.0 ug/L) Unionized Ammonia (NH3-N), chronic; 20°C Maximum, 3°C increase per 4 hours; pH 6.5-9.0; DO 6.0 mg/L



**Table 11 Idledale West**

[Monitoring station/Datalogger ID: IDLEWEST GPS Coordinates: 39.6624°N, 105.2546°W The location of the sampling/monitoring site is in Bear Creek, at the west end Idledale, west of Little Park. There was no temperature datalogger at this location.]

9 weekly morning sampling/monitoring events June 1-Sept 30, 2004						
Weekly Parameter results	pH, SU	Temp, °C	Dissolved Oxygen, mg/L	Sp. Cond., mS/cm	Total NH3-N, ug/L	Unionized NH3-N, ug/L
Min	7.68	9.91	7.35	0.070	8.1	0
Max	8.31	19.72	11.92	0.107	56.7	1
Avg	7.91	14.74	8.76	0.089	18.7	0
Std. Dev.	0.21	2.47	1.19	0.013	15.5	0
9 weekly afternoon sampling/monitoring events June 1-Sept 30, 2004						
Weekly Parameter results	pH, SU	Temp, °C	Dissolved Oxygen, mg/L	Sp. Cond., mS/cm	Total NH3-N, ug/L	Unionized NH3-N, ug/L
Min	7.55	11.65	7.53	0.075	7.8	0
Max	8.47	19.81	8.75	0.139	33.3	1
Avg	7.97	16.37	8.17	0.101	14.2	0
Std. Dev.	0.28	2.27	0.33	0.019	8.0	0

Existing stream standards: 0.02 mg/L (20.0 ug/L) Unionized Ammonia (NH3-N), chronic;  
20°C Maximum, 3°C increase per 4 hours; pH 6.5-9.0; DO 6.0 mg/L

**Table 12 Below Idledale**

[Monitoring station/Datalogger ID: EMD5A GPS Coordinates: 39.6614°N, 105.2354°W The location of the sampling/monitoring site is in Bear Creek, at the east end of Idledale, at the upstream side of the residential bridge at 21020 Highway 74.]

9 weekly morning sampling/monitoring events June 1-Sept 30, 2004						
Weekly Parameter results	pH, SU	Temp, °C	Dissolved Oxygen, mg/L	Sp. Cond., mS/cm	Total NH3-N, ug/L	Unionized NH3-N, ug/L
Min	7.62	9.74	7.53	0.069	7.7	0
Max	8.01	19.72	12.05	0.108	48.1	1
Avg	7.77	14.76	8.78	0.089	18.0	0
Std. Dev.	0.13	2.52	1.21	0.013	13.4	0
9 weekly afternoon sampling/monitoring events June 1-Sept 30, 2004						
Weekly Parameter results	pH, SU	Temp, °C	Dissolved Oxygen, mg/L	Sp. Cond., mS/cm	Total NH3-N, ug/L	Unionized NH3-N, ug/L
Min	7.54	11.61	7.44	0.077	6.9	0
Max	8.16	19.87	8.83	0.137	35.0	1
Avg	7.85	16.34	8.19	0.100	12.5	0
Std. Dev.	0.19	2.27	0.37	0.018	8.4	0
Datalogger Temperature Data						
All Temperatures in °C			Hourly Temp.	Daily Max Temp.	7-Day Avg. Max Temp.	Δ°C/4 hr Moving Averages
Min			7.0	11.3	2.3	0.0
Max			22.8	22.8	20.8	4.7
Avg			14.0	16.6	15.4	1.2
Std. Dev.			2.5	2.2	3.8	0.9
# of measurements			2913	122.0	116.0	2901
# of 20°C exceed			49	9.0	6.0	
% Compliance			98	93	95	
Δ3°C/ 4 hr exceedances						114
% Compliance						96
Δ3°C/ 4 hr exceedances > 20°C						9
% Compliance						92

Existing stream standards: 0.02 mg/L (20.0 ug/L) Unionized Ammonia (NH3-N), chronic;  
20°C Maximum, 3°C increase per 4 hours; pH 6.5-9.0; DO 6.0 mg/L

**Table 13 West end of Morrison**

[Monitoring station/Datalogger ID: MORR10 GPS Coordinates: 39.6528°N, 105.1878°W The location of the sampling/monitoring site is in Bear Creek, at the west end of Morrison, just upstream of the gaging station west of Highway 8.]

9 weekly morning sampling/monitoring events June 1-Sept 30, 2004						
Weekly Parameter results	pH, SU	Temp, °C	Dissolved Oxygen, mg/L	Sp. Cond., mS/cm	Total NH3-N, ug/L	Unionized NH3-N, ug/L
Min	7.56	9.43	7.62	0.077	6.9	0
Max	7.91	19.68	12.38	0.166	50.8	1
Avg	7.73	14.80	8.92	0.119	16.3	0
Std. Dev.	0.11	2.63	1.28	0.030	14.0	0
9 weekly afternoon sampling/monitoring events June 1-Sept 30, 2004						
Weekly Parameter results	pH, SU	Temp, °C	Dissolved Oxygen, mg/L	Sp. Cond., mS/cm	Total NH3-N, ug/L	Unionized NH3-N, ug/L
Min	7.61	11.53	7.55	0.077	4.8	0
Max	8.11	20.20	8.95	0.135	31.1	1
Avg	7.89	16.27	8.37	0.099	11.0	0
Std. Dev.	0.16	2.31	0.41	0.019	7.5	0
Datalogger Temperature Data						
All Temperatures in °C		Hourly Temp.	Daily Max Temp.	7-Day Avg. Max Temp.	Δ°C/4 hr Moving Averages	
Min		7.0	11.7	2.3	0.0	
Max		22.4	22.4	20.7	4.9	
Avg		14.5	16.7	15.6	1.1	
Std. Dev.		2.5	2.2	3.7	0.8	
# of measurements		2913	122.0	116.0	2901	
# of 20°C exceed		49	10.0	7.0		
% Compliance		98	92	94		
Δ3°C/ 4 hr exceedances					57	
% Compliance					98	
Δ3°C/ 4 hr exceedances > 20°C					5	
% Compliance					91	

Existing stream standards: 0.02 mg/L (20.0 ug/L) Unionized Ammonia (NH3-N), chronic; 20°C Maximum, 3°C increase per 4 hours; pH 6.5-9.0; DO 6.0 mg/L

## DATA SHEETS-WWTP EFFLUENT

The following data sheets summarize the wastewater plant effluent quality for dischargers into Bear Creek Segment 1a. Data obtained from plant daily process control sheets and laboratory results that are utilized to complete CDPS Discharge Monitoring Reports (DMR). Since daily plant operations and reporting requirements differ, only available data was used. There no additional requirements requested of plant operators for the Program. Datalogger temperature measurements of plant effluent were obtained at the identical frequency of the instream dataloggers. Datasets that are much more detailed include all locations from individual events, graphed representation of such data and all recorded temperature data (exported to spreadsheet format) from the dataloggers. This data is available as an attachment to this report. Total ammonia results were combined with effluent pH and temperature to calculate the unionized fraction. The datasheets will be listed in a downstream direction, as the effluents enter Bear Creek, from the EMD WWTP to the Morrison WWTP.

**Table 14 Wastewater Plant Effluent Data EMD5**

[Datalogger ID: EMD5 GPS Coordinates: 39.6376°N, 105.3150°W The location of the sampling/monitoring site is the EMD WWTP effluent. The datalogger was originally located in the end of the chlorine contact chamber. Plant improvements during the study changed the disinfection process from chlorine to ultraviolet radiation (UV). The datalogger relocated to the UV channel, just upstream of the outfall. Effluent flows directly from the UV building to Bear Creek.]

EMD WWTP Effluent June 1-Sept 30, 2004						
Process Control and Permit Sampling and Monitoring						
Parameter	pH, SU	Temp, °C	Dissolved Oxygen, mg/L	Flow, MGD	Total NH <sub>3</sub> -N, ug/L	Unionized NH <sub>3</sub> -N, ug/L
Min	6.56	15.00	3.27	0.3587	30.0	0
Max	6.97	18.90	6.58	0.8209	7,020.0	14
Avg	6.75	17.46	4.98	0.5738	502.7	1
Std. Dev.	0.07	0.85	0.69	0.0717	1,584.9	3
# of Measurements	85	80	83	122	18	18
Datalogger Temperature Data						
All Temperatures in °C		Hourly Temp.	Daily Max Temp.	7-Day Avg. Max Temp.	Δ°C/4 hr Moving Averages	
Min		14.1	16.3	16.6	0.0	
Max		20.2	20.2	19.3	3.3	
Avg		17.0	18.0	18.0	0.4	
Std. Dev.		0.9	1.0	0.8	0.4	
# of measurements		2922	122.0	116.0	2916	
# of 20°C exceed		2	2.0	0.0		
% Compliance		99	98	100		
Δ3°C/ 4 hr exceedances					2	
% Compliance					99	
Δ3°C/ 4 hr exceedances > 20°C					0	
% Compliance					100	

Notes: Discharge permit limits for Total Ammonia (NH<sub>3</sub>-N), in ug/L are as follows- June-8,200 July-8,000 August-6,400 September-5,200; pH 6.5-9.0

**Table 15 Wastewater Plant Effluent Data WJ6**

[Datalogger ID: WJ6 GPS Coordinates: 39.6621°N, 105.3351°W The location of the sampling/monitoring site is the WJCMD WWTP effluent. The datalogger was located in the end of the chlorine contact chamber. The effluent flows into a ditch and joins Troublesome Gulch just outside the plant boundary. Troublesome Gulch flows to Kittredge and combines with Bear Creek at the west end of Kittredge. ]

WJCMD WWTP Effluent June 1-Sept 30, 2004						
Process Control and Permit Sampling and Monitoring						
Parameter	pH, SU	Temp, °C	Dissolved Oxygen, mg/L	Flow, MGD	Total NH <sub>3</sub> -N, ug/L	Unionized NH <sub>3</sub> -N, ug/L
Min	6.63	14.40	3.01	0.2425	30.0	0
Max	7.05	19.80	5.51	0.6354	1,180.0	2
Avg	6.81	18.60	3.61	0.4312	138.2	0
Std. Dev.	0.10	1.06	0.33	0.0695	286.5	1
# of Measurements	85	78	79	122	18	18
Datalogger Temperature Data						
All Temperatures in °C			Hourly Temp.	Daily Max Temp.	7-Day Avg. Max Temp.	Δ°C/4 hr Moving Averages
Min			14.4	15.9	16.4	0.0
Max			21.3	21.3	20.5	3.8
Avg			17.0	18.3	18.3	0.4
Std. Dev.			0.9	1.3	1.0	0.6
# of measurements			2922	122.0	116.0	2916
# of 20°C exceed			17	12.0	7.0	
% Compliance			99	90	94	
Δ3°C/ 4 hr exceedances						31
% Compliance						98.9
Δ3°C/ 4 hr exceedances > 20°C						14
% Compliance						45.2

Notes: Discharge permit limits for Total Ammonia (NH<sub>3</sub>-N), in ug/L are as follows-  
June-12,600 July-13,000 August-10,700 September-8,400; pH 6.5-9.0

**Table 16 Wastewater Plant Effluent Data KSWD8**

[Datalogger ID: KSWD8 GPS Coordinates: 39.6585°N, 105.2868°W The location of the sampling/monitoring site is the KSWD WWTP effluent. The datalogger was located near the flow-measuring flume, just upstream of the outfall. Effluent flows from the datalogger location under Highway 74 to the outfall in Bear Creek.]

KSWD WWTP Effluent June 1-Sept 30, 2004						
Process Control and Permit Sampling and Monitoring						
Parameter	pH, SU	Temp, °C	Dissolved Oxygen, mg/L	Flow, MGD	Total NH <sub>3</sub> -N, ug/L	Unionized NH <sub>3</sub> -N, ug/L
Min	6.55	15.25	4.51	0.0000	87.9	0
Max	7.34	19.99	8.00	0.0704	1,920.0	5
Avg	6.88	18.74	5.61	0.0490	590.6	1
Std. Dev.	0.19	0.98	0.61	0.0142	545.4	1
# of Measurements	78	70	70	117	17	14
Datalogger Temperature Data						
All Temperatures in °C		Hourly Temp.	Daily Max Temp.	7-Day Avg. Max Temp.	Δ°C/4 hr Moving Averages	
Min		10.9	13.3	16.4	0.0	
Max		20.2	20.2	19.9	5.3	
Avg		18.3	18.6	18.7	0.2	
Std. Dev.		1.4	1.3	1.0	0.4	
# of measurements		2922	122.0	116.0	2916	
# of 20°C exceed		1	1.0	0.0		
% Compliance		99	99	100		
Δ3°C/ 4 hr exceedances					6	
% Compliance					99	
Δ3°C/ 4 hr exceedances > 20°C					0	
% Compliance					100	

Notes: Discharge permit limits for Total Ammonia (NH<sub>3</sub>-N), in ug/L are as follows-  
June-5,200 July-7,700 August-5,500 September-3,300; pH 6.5-9.0

**Table 17 Wastewater Plant Effluent Data GWSD9A**

[Datalogger ID: GWSD9A GPS Coordinates: 39.6732°N, 105.2712°W The location of the sampling/monitoring site is the GWSD WWTP effluent. The datalogger was located in a wet well, just upstream of the outfall at the plant. Effluent flows from the datalogger location into a drainage, down to and under Highway 74 at the west end of Lair o' the Bear Park, and into Bear Creek.]

GWSD WWTP Effluent June 1-Sept 30, 2004						
Process Control and Permit Sampling and Monitoring						
Parameter	pH, SU	Temp, °C	Dissolved Oxygen, mg/L	Flow, MGD	Total NH <sub>3</sub> -N, ug/L	Unionized NH <sub>3</sub> -N, ug/L
Min	6.78	15.00	6.70	0.0560	20.0	0
Max	7.50	18.50	7.80	0.3150	256.0	1
Avg	7.09	17.22	7.23	0.2450	114.4	0
Std. Dev.	0.13	0.81	0.24	0.0314	64.3	0
# of Measurements	117	117	115	118	18	18
Datalogger Temperature Data						
All Temperatures in °C		Hourly Temp.	Daily Max Temp.	7-Day Avg. Max Temp.	Δ°C/4 hr Moving Averages	
Min		14.8	15.2	15.5	0.0	
Max		18.6	18.6	18.5	0.4	
Avg		17.4	17.5	17.6	0.1	
Std. Dev.		0.9	0.9	0.9	0.2	
# of measurements		2922	122.0	116.0	2916	
# of 20°C exceed		0	0.0	0.0		
% Compliance		100	100	100		
Δ3°C/ 4 hr exceedances					0	
% Compliance					100	
Δ3°C/ 4 hr exceedances > 20°C					0	
% Compliance					100	

Notes: Discharge permit limits for Total Ammonia (NH<sub>3</sub>-N), in ug/L are as follows-  
June-12,600 July-13,000 August-10,700 September-8,400; pH 6.5-9.0

## 24-HOUR PROFILE DATASHEETS

A recording, multi-sensor probe collected 24-hour data from two specific sites in Bear Creek during the Program. Parameters measured were pH, temperature, dissolved oxygen and specific conductance. Sensors calibrated prior to each deployment and data downloaded following each retrieval. The purpose was to evaluate multiple parameters over a 24-hour period. Two locations selected for their accessibility and ability to conceal the probe. The O'Fallon Park East (BCOFPEA) location was just upstream of the KSWD WWTP effluent discharge. The Lair o' the Bear (BCLAIR) location was within Lair o' the Bear Open Space Park, almost a half-mile downstream of the GWSD WWTP effluent discharge.

Six profiles collected for each of the two sites. Data collection began 6/24/2004 and completed on 9/23/2004. Frequency of data collection originally scheduled to be weekly, but the schedule was modified as necessary, because of weather and stream conditions.



**Table 18 O'Fallon Park East June 24, 2004**

GPS Coordinates: 39.6585°N, 105.2863°W

Date	Time	Temp °C	Specific Conductance, mS/cm	Dissolved Oxygen, mg/L	pH, S. U.
6/24/2004	11:00	15.69	0.109	8.27	8.15
	12:00	17.03	0.115	8.09	8.26
	13:00	18.36	0.116	7.89	8.34
	14:00	19.56	0.120	7.69	8.42
	15:00	18.67	0.118	7.59	8.30
	16:00	17.85	0.117	7.72	8.15
	17:00	17.06	0.116	7.84	8.09
	18:00	16.06	0.116	8.04	8.04
	19:00	15.54	0.115	8.08	7.98
	20:00	15.23	0.115	7.99	7.87
	21:00	14.91	0.114	7.96	7.78
	22:00	14.64	0.112	7.99	7.73
	23:00	14.38	0.114	8.04	7.71
	0:00	14.09	0.114	8.10	7.69
	1:00	13.87	0.114	8.13	7.69
	2:00	13.75	0.115	8.15	7.68
	3:00	13.68	0.113	8.16	7.67
	4:00	13.55	0.109	8.19	7.66
	5:00	13.40	0.105	8.22	7.65
	6:00	13.29	0.104	8.27	7.65
	7:00	13.25	0.103	8.33	7.68
	8:00	13.45	0.102	8.37	7.72
	9:00	14.02	0.100	8.39	7.82
	10:00	14.42	0.100	8.40	7.89
	<b>MIN</b>	13.25	0.100	7.59	7.65
	<b>MAX</b>	19.56	0.120	8.40	8.42
	<b>AVG</b>	15.24	0.112	8.08	7.90
	<b>StdDev</b>	1.86	0.006	0.22	0.25
	<b># &gt;20° C</b>	0			
	<b># &gt; 3° C/ 4 hrs</b>	1			

Existing stream standards: 20°C Maximum, 3°C increase per 4 hours; pH 6.5-9.0; DO 6.0 mg/L

**Table 19 O'Fallon Park East July 8, 2004**

GPS Coordinates: 39.6585°N, 105.2863°W

Date	Time	Temp °C	Specific Conductance, mS/cm	Dissolved Oxygen, mg/L	pH, S. U.
7/8/2004	15:00	19.60	0.087	7.74	8.60
	16:00	18.58	0.086	7.79	8.51
	17:00	17.97	0.087	7.86	8.43
	18:00	17.07	0.086	7.89	8.16
	19:00	16.78	0.085	7.92	8.05
	20:00	16.83	0.082	7.80	7.90
	21:00	16.50	0.081	7.75	7.73
	22:00	16.24	0.081	7.79	7.68
	23:00	16.03	0.080	7.84	7.66
	0:00	15.80	0.082	7.87	7.65
	1:00	15.60	0.082	7.91	7.64
	2:00	15.38	0.082	7.95	7.63
	3:00	15.15	0.082	8.01	7.62
	4:00	14.96	0.082	8.03	7.62
	5:00	14.77	0.081	8.09	7.62
	6:00	14.59	0.082	8.12	7.62
	7:00	14.43	0.082	8.22	7.65
	8:00	14.51	0.082	8.29	7.72
	9:00	15.10	0.082	8.33	7.85
	10:00	15.94	0.083	8.28	8.05
	11:00	16.97	0.085	8.19	8.27
	12:00	18.15	0.086	8.07	8.46
	13:00	18.81	0.085	7.84	8.58
	14:00	17.95	0.087	7.55	8.04
	<b>MIN</b>	14.43	0.080	7.55	7.62
	<b>MAX</b>	19.60	0.087	8.33	8.60
	<b>AVG</b>	16.40	0.083	7.96	7.95
	<b>StdDev</b>	1.46	0.002	0.20	0.35
	<b># &gt;20° C</b>	0			
	<b># &gt; 3° C/ 4 hrs</b>	1			

Existing stream standards: 20°C Maximum, 3°C increase per 4 hours; pH 6.5-9.0; DO 6.0 mg/L

**Table 20 O'Fallon Park East August 4, 2004**

GPS Coordinates: 39.6585°N, 105.2863°W

Date	Time	Temp °C	Specific Conductance, mS/cm	Dissolved Oxygen, mg/L	pH, S. U.
8/4/2004	15:00	16.59	0.077	8.06	8.19
	16:00	15.86	0.076	8.19	8.17
	17:00	15.11	0.074	8.26	8.08
	18:00	14.78	0.074	8.29	7.98
	19:00	14.85	0.074	8.20	7.90
	20:00	15.31	0.074	8.05	7.79
	21:00	15.65	0.074	7.92	7.72
	22:00	15.74	0.075	7.89	7.70
	23:00	15.38	0.075	7.99	7.69
	0:00	15.21	0.075	8.01	7.68
	1:00	15.00	0.075	8.06	7.68
	2:00	14.97	0.075	8.07	7.68
	3:00	14.97	0.074	8.06	7.69
	4:00	14.82	0.073	8.09	7.69
	5:00	14.67	0.072	8.12	7.67
	6:00	14.55	0.071	8.14	7.69
	7:00	14.43	0.070	8.21	7.69
	8:00	14.53	0.070	8.30	7.79
	9:00	14.70	0.069	8.35	7.87
	10:00	15.02	0.071	8.36	8.06
	11:00	15.64	0.072	8.31	8.20
	12:00	15.90	0.075	8.26	8.31
	13:00	16.38	0.075	8.14	8.38
	14:00	16.42	0.075	8.00	8.29
	<b>MIN</b>	14.43	0.069	7.89	7.67
	<b>MAX</b>	16.59	0.077	8.36	8.38
	<b>AVG</b>	15.27	0.074	8.14	7.90
	<b>StdDev</b>	0.61	0.002	0.13	0.24
	<b># &gt;20° C</b>	0			
	<b># &gt; 3° C/ 4 hrs</b>	0			

Existing stream standards: 20°C Maximum, 3°C increase per 4 hours; pH 6.5-9.0; DO 6.0 mg/L

**Table 21 O'Fallon Park East August 17, 2004**

GPS Coordinates: 39.6585°N, 105.2863°W

Date	Time	Temp °C	Specific Conductance, mS/cm	Dissolved Oxygen, mg/L	pH, S. U.
8/17/2004	12:00	17.08	0.083	9.00	9.04
	13:00	17.15	0.084	8.69	9.10
	14:00	17.94	0.082	8.61	9.23
	15:00	17.32	0.082	8.41	9.11
	16:00	16.85	0.080	8.59	9.04
	17:00	16.99	0.079	8.38	8.94
	18:00	16.98	0.080	8.05	8.47
	19:00	16.65	0.083	8.01	8.01
	20:00	16.04	0.082	8.09	7.87
	21:00	15.73	0.081	8.13	7.81
	22:00	15.60	0.081	8.19	7.78
	23:00	15.45	0.082	8.16	7.77
	0:00	15.28	0.083	8.24	7.76
	1:00	15.11	0.084	8.24	7.76
	2:00	14.87	0.082	8.29	7.75
	3:00	14.65	0.080	8.36	7.74
	4:00	14.49	0.077	8.39	7.73
	5:00	14.30	0.075	8.41	7.73
	6:00	14.06	0.073	8.48	7.72
	7:00	13.91	0.072	8.56	7.74
	8:00	13.95	0.072	8.71	7.87
	9:00	14.17	0.072	8.87	8.10
	10:00	14.58	0.073	9.06	8.48
	11:00	15.05	0.077	8.98	8.83
	<b>MIN</b>	13.91	0.072	8.01	7.72
	<b>MAX</b>	17.94	0.084	9.06	9.23
	<b>AVG</b>	15.59	0.079	8.45	8.22
	<b>StdDev</b>	1.22	0.004	0.30	0.56
	<b># &gt;20° C</b>	0			
	<b># &gt; 3° C/ 4 hrs</b>	0			

Existing stream standards: 20°C Maximum, 3°C increase per 4 hours; pH 6.5-9.0; DO 6.0 mg/L

**Table 22 O'Fallon Park East September 1, 2004**

GPS Coordinates: 39.6585°N, 105.2863°W

Date	Time	Temp °C	Specific Conductance, mS/cm	Dissolved Oxygen, mg/L	pH, S. U.
9/1/2004	15:00	17.17	0.097	8.43	9.03
	16:00	17.09	0.096	8.21	8.94
	17:00	16.46	0.097	8.23	8.88
	18:00	15.56	0.097	8.32	8.71
	19:00	14.58	0.099	8.38	8.25
	20:00	13.68	0.100	8.49	7.98
	21:00	13.23	0.099	8.56	7.88
	22:00	13.07	0.100	8.57	7.83
	23:00	12.88	0.100	8.62	7.80
	0:00	12.82	0.101	8.62	7.79
	1:00	12.80	0.101	8.61	7.80
	2:00	12.64	0.102	8.64	7.79
	3:00	12.42	0.101	8.68	7.78
	4:00	12.30	0.099	8.71	7.80
	5:00	12.14	0.097	8.74	7.78
	6:00	11.96	0.096	8.77	7.75
	7:00	11.82	0.096	8.84	7.77
	8:00	11.84	0.095	8.98	7.83
	9:00	12.19	0.095	8.95	7.90
	10:00	13.10	0.096	8.96	8.14
	11:00	13.71	0.100	8.86	8.32
	12:00	14.30	0.105	8.66	8.38
	13:00	14.78	0.106	8.56	8.38
	14:00	15.24	0.105	8.62	8.33
	<b>MIN</b>	11.82	0.095	8.21	7.75
	<b>MAX</b>	17.17	0.106	8.98	9.03
	<b>AVG</b>	13.66	0.099	8.63	8.12
	<b>StdDev</b>	1.61	0.003	0.21	0.41
	<b># &gt;20° C</b>	0			
	<b># &gt; 3° C/ 4 hrs</b>	0			

Existing stream standards: 20°C Maximum, 3°C increase per 4 hours; pH 6.5-9.0; DO 6.0 mg/L

**Table 23 O'Fallon Park East September 15, 2004**

GPS Coordinates: 39.6585°N, 105.2863°W

Date	Time	Temp °C	Specific Conductance, mS/cm	Dissolved Oxygen, mg/L	pH, S. U.
9/15/2004	15:00	15.73	0.099	8.70	8.85
	16:00	16.14	0.096	8.45	8.94
	17:00	16.00	0.096	8.23	8.88
	18:00	15.42	0.095	8.21	8.67
	19:00	14.50	0.097	8.32	8.22
	20:00	13.39	0.099	8.48	7.95
	21:00	12.52	0.098	8.66	7.87
	22:00	11.97	0.098	8.79	7.84
	23:00	11.58	0.098	8.88	7.82
	0:00	11.31	0.098	8.96	7.81
	1:00	11.10	0.098	9.00	7.80
	2:00	10.90	0.099	9.01	7.80
	3:00	10.69	0.100	9.07	7.80
	4:00	10.49	0.097	9.10	7.80
	5:00	10.27	0.093	9.16	7.79
	6:00	10.05	0.090	9.21	7.78
	7:00	9.89	0.089	9.25	7.77
	8:00	9.77	0.089	9.35	7.79
	9:00	9.84	0.090	9.41	7.83
	10:00	10.45	0.089	9.48	7.93
	11:00	11.73	0.091	9.34	8.09
	12:00	13.13	0.097	9.22	8.36
	13:00	14.32	0.109	8.92	8.55
	14:00	15.04	0.106	8.72	8.59
	<b>MIN</b>	9.77	0.089	8.21	7.77
	<b>MAX</b>	16.14	0.109	9.48	8.94
	<b>AVG</b>	12.34	0.096	8.91	8.11
	<b>StdDev</b>	2.14	0.005	0.37	0.40
# >20° C		0			
# > 3° C/ 4 hrs		3			

Existing stream standards: 20°C Maximum, 3°C increase per 4 hours; pH 6.5-9.0; DO 6.0 mg/L

**Table 24      Lair o' the Bear Park July 7, 2004**

GPS Coordinates: 39.6672°N, 105.2587°W

Date	Time	Temp °C	Specific Conductance, mS/cm	Dissolved Oxygen, mg/L	pH, S. U.
7/7/2004	11:00	15.41	0.090	9.70	8.01
	12:00	16.66	0.090	9.46	8.07
	13:00	17.80	0.090	9.20	8.10
	14:00	18.66	0.092	8.92	8.10
	15:00	18.90	0.093	8.89	8.11
	16:00	19.09	0.091	8.74	8.05
	17:00	19.34	0.090	8.65	8.01
	18:00	19.05	0.088	8.64	7.88
	19:00	18.65	0.090	8.74	7.88
	20:00	18.07	0.090	8.79	7.80
	21:00	17.50	0.090	8.88	7.75
	22:00	16.86	0.090	9.03	7.77
	23:00	16.11	0.090	9.20	7.74
	0:00	15.61	0.090	9.30	7.73
	1:00	15.32	0.091	9.37	7.74
	2:00	15.09	0.091	9.42	7.74
	3:00	14.83	0.090	9.47	7.73
	4:00	14.53	0.090	9.54	7.74
	5:00	14.20	0.090	9.62	7.74
	6:00	13.87	0.089	9.71	7.74
	7:00	13.62	0.087	9.84	7.77
	8:00	13.63	0.086	9.92	7.83
	9:00	14.04	0.088	9.91	7.91
	10:00	14.83	0.089	9.79	7.99
	<b>MIN</b>	13.62	0.09	8.64	7.73
	<b>MAX</b>	19.34	0.09	9.92	8.11
	<b>AVG</b>	16.32	0.09	9.28	7.87
	<b>StdDev</b>	1.94	0.00	0.42	0.14
	<b># &gt;20° C</b>	0			
	<b># &gt; 3° C/ 4 hrs</b>	1			

Existing stream standards: 20°C Maximum, 3°C increase per 4 hours; pH 6.5-9.0; DO 6.0 mg/L



**Table 25      Lair o' the Bear Park July 14, 2004**

GPS Coordinates: 39.6672°N, 105.2587°W

<b>Date</b>	<b>Time</b>	<b>Temp °C</b>	<b>Specific Conductance, mS/cm</b>	<b>Dissolved Oxygen, mg/L</b>	<b>pH, S. U.</b>
7/14/2004	14:00	21.32	0.091	7.81	8.40
	15:00	21.73	0.091	7.87	8.56
	16:00	21.62	0.089	7.62	8.39
	17:00	21.18	0.090	7.60	8.02
	18:00	20.83	0.089	7.65	7.89
	19:00	19.89	0.092	7.91	7.91
	20:00	18.95	0.091	8.04	7.87
	21:00	18.26	0.090	8.13	7.84
	22:00	17.81	0.090	8.22	7.83
	23:00	17.65	0.091	8.26	7.82
	0:00	17.65	0.091	8.25	7.81
	1:00	17.50	0.092	8.27	7.80
	2:00	17.27	0.091	8.32	7.80
	3:00	16.98	0.089	8.38	7.80
	4:00	16.72	0.090	8.44	7.80
	5:00	16.46	0.088	8.50	7.79
	6:00	16.22	0.086	8.57	7.79
	7:00	16.02	0.086	8.67	7.82
	8:00	15.92	0.084	8.79	7.88
	9:00	16.24	0.083	8.83	7.96
	10:00	16.98	0.086	8.75	8.07
	11:00	18.03	0.086	8.59	8.17
	12:00	19.27	0.085	8.40	8.28
	13:00	20.29	0.089	8.08	8.39
	<b>MIN</b>	15.92	0.08	7.60	7.79
	<b>MAX</b>	21.73	0.09	8.83	8.56
	<b>AVG</b>	18.37	0.09	8.25	7.99
	<b>StdDev</b>	1.89	0.00	0.36	0.24
	<b># &gt;20° C</b>	6			
	<b># &gt; 3° C/ 4 hrs</b>	2			

Existing stream standards: 20°C Maximum, 3°C increase per 4 hours; pH 6.5-9.0; DO 6.0 mg/L

**Table 26      Lair o' the Bear Park August 12, 2004**

GPS Coordinates: 39.6672°N, 105.2587°W

<b>Date</b>	<b>Time</b>	<b>Temp °C</b>	<b>Specific Conductance, mS/cm</b>	<b>Dissolved Oxygen, mg/L</b>	<b>pH, S. U.</b>
8/12/2004	13:00	16.82	0.082	8.78	8.44
	14:00	17.62	0.084	8.55	8.56
	15:00	18.20	0.085	8.38	8.64
	16:00	18.58	0.085	8.24	8.67
	17:00	18.47	0.084	8.19	8.63
	18:00	17.91	0.083	8.25	8.49
	19:00	17.11	0.083	8.26	8.18
	20:00	16.28	0.079	8.37	7.97
	21:00	15.48	0.084	8.54	7.87
	22:00	14.91	0.083	8.67	7.85
	23:00	14.60	0.083	8.74	7.83
	0:00	14.35	0.083	8.79	7.81
	1:00	14.11	0.083	8.84	7.81
	2:00	13.95	0.083	8.86	7.80
	3:00	13.79	0.082	8.89	7.79
	4:00	13.56	0.081	8.93	7.79
	5:00	13.32	0.080	8.98	7.78
	6:00	13.09	0.080	9.04	7.77
	7:00	12.89	0.078	9.13	7.79
	8:00	12.85	0.077	9.22	7.83
	9:00	13.11	0.077	9.27	7.91
	10:00	13.69	0.080	9.23	8.01
	11:00	14.61	0.082	9.09	8.10
	12:00	15.70	0.084	8.21	8.21
	<b>MIN</b>	12.85	0.077	8.19	7.77
	<b>MAX</b>	18.58	0.085	9.27	8.67
	<b>AVG</b>	15.21	0.082	8.73	8.06
	<b>StdDev</b>	1.90	0.002	0.35	0.32
	<b># &gt;20° C</b>	0			
	<b># &gt; 3° C/ 4 hrs</b>	0			

Existing stream standards: 20°C Maximum, 3°C increase per 4 hours; pH 6.5-9.0; DO 6.0 mg/L

**Table 27      Lair o' the Bear Park August 26, 2004**

GPS Coordinates: 39.6672°N, 105.2587°W

<b>Date</b>	<b>Time</b>	<b>Temp °C</b>	<b>Specific Conductance, mS/cm</b>	<b>Dissolved Oxygen, mg/L</b>	<b>pH, S. U.</b>
8/26/2004	13:00	14.69	0.115	9.05	8.18
	14:00	15.83	0.117	8.51	7.84
	15:00	16.60	0.117	8.43	8.09
	16:00	16.87	0.114	8.29	8.04
	17:00	16.55	0.114	8.30	7.97
	18:00	15.97	0.113	8.39	7.93
	19:00	15.20	0.114	8.52	7.87
	20:00	14.39	0.113	8.68	7.86
	21:00	13.82	0.114	8.82	7.85
	22:00	13.43	0.114	8.91	7.83
	23:00	13.36	0.115	8.94	7.83
	0:00	13.33	0.116	8.93	7.83
	1:00	13.18	0.118	8.97	7.81
	2:00	13.02	0.117	9.00	7.82
	3:00	12.98	0.121	9.01	7.82
	4:00	12.94	0.120	9.02	7.83
	5:00	12.87	0.116	9.03	7.81
	6:00	12.77	0.113	9.06	7.81
	7:00	12.67	0.112	9.10	7.78
	8:00	12.61	0.110	9.14	7.80
	9:00	12.57	0.111	9.17	7.81
	10:00	12.60	0.113	9.25	7.82
	11:00	12.69	0.115	9.17	7.86
	12:00	12.58	0.120	9.17	7.82
	<b>MIN</b>	12.57	0.110	8.29	7.78
	<b>MAX</b>	16.87	0.121	9.25	8.18
	<b>AVG</b>	13.90	0.115	8.87	7.87
	<b>StdDev</b>	1.44	0.003	0.30	0.10
<b># &gt;20° C</b>		0			
<b># &gt; 3° C/ 4 hrs</b>		0			

Existing stream standards: 20°C Maximum, 3°C increase per 4 hours; pH 6.5-9.0; DO 6.0 mg/L

**Table 28      Lair o' the Bear Park September 9, 2004**

GPS Coordinates: 39.6672°N, 105.2587°W

<b>Date</b>	<b>Time</b>	<b>Temp °C</b>	<b>Specific Conductance, mS/cm</b>	<b>Dissolved Oxygen, mg/L</b>	<b>pH, S. U.</b>
9/9/2004	13:00	14.21	0.097	9.58	8.49
	14:00	14.89	0.100	9.28	8.57
	15:00	15.44	0.110	9.27	8.64
	16:00	15.68	0.110	8.98	8.57
	17:00	16.15	0.105	8.86	8.62
	18:00	16.20	0.102	8.56	8.35
	19:00	15.88	0.102	8.59	8.10
	20:00	15.56	0.101	8.58	7.95
	21:00	15.17	0.103	8.66	7.89
	22:00	14.63	0.105	8.80	7.90
	23:00	14.18	0.106	8.88	7.90
	0:00	13.75	0.105	8.97	7.89
	1:00	13.25	0.103	9.09	7.89
	2:00	12.85	0.103	9.17	7.89
	3:00	12.48	0.102	9.26	7.89
	4:00	12.16	0.103	9.33	7.89
	5:00	11.85	0.104	9.41	7.89
	6:00	11.64	0.102	9.46	7.89
	7:00	11.52	0.102	9.51	7.89
	8:00	11.50	0.098	9.62	7.93
	9:00	11.55	0.097	9.61	7.96
	10:00	11.77	0.101	9.69	8.02
	11:00	12.00	0.102	9.54	7.99
	12:00	12.43	0.101	9.79	8.20
	<b>MIN</b>	11.50	0.097	8.56	7.89
	<b>MAX</b>	16.20	0.110	9.79	8.64
	<b>AVG</b>	13.61	0.103	9.19	8.09
	<b>StdDev</b>	1.67	0.003	0.38	0.27
<b># &gt;20° C</b>		0			
<b># &gt; 3° C/ 4 hrs</b>		0			

Existing stream standards: 20°C Maximum, 3°C increase per 4 hours; pH 6.5-9.0; DO 6.0 mg/L

**Table 29      Lair o' the Bear Park September 22, 2004**

GPS Coordinates: 39.6672°N, 105.2587°W

Date	Time	Temp °C	Specific Conductance, mS/cm	Dissolved Oxygen, mg/L	pH, S. U.
9/22/2004	12:00	11.62	0.103	9.66	8.22
	13:00	12.05	0.105	9.40	8.17
	14:00	12.40	0.104	9.31	8.18
	15:00	12.34	0.110	9.03	8.07
	16:00	11.88	0.110	9.22	8.04
	17:00	12.15	0.111	9.14	8.08
	18:00	12.05	0.107	9.17	8.06
	19:00	11.66	0.110	9.15	8.00
	20:00	11.24	0.109	9.20	7.93
	21:00	10.67	0.111	9.33	7.90
	22:00	10.21	0.108	9.43	7.88
	23:00	9.78	0.110	9.54	7.87
	0:00	9.38	0.109	9.63	7.86
	1:00	9.05	0.107	9.71	7.85
	2:00	8.78	0.107	9.78	7.85
	3:00	8.50	0.105	9.85	7.85
	4:00	8.32	0.105	9.90	7.85
	5:00	8.17	0.103	9.94	7.84
	6:00	8.01	0.100	9.97	7.84
	7:00	7.88	0.097	10.05	7.83
	8:00	7.83	0.094	10.11	7.84
	9:00	8.03	0.093	10.12	7.85
	10:00	8.58	0.098	10.11	7.90
	11:00	9.36	0.098	9.99	7.95
	<b>MIN</b>	7.83	0.093	9.03	7.83
	<b>MAX</b>	12.40	0.111	10.12	8.22
	<b>AVG</b>	10.00	0.105	9.61	7.95
	<b>StdDev</b>	1.66	0.005	0.36	0.12
	<b># &gt;20° C</b>	0			
	<b># &gt; 3° C/ 4 hrs</b>	0			

Existing stream standards: 20°C Maximum, 3°C increase per 4 hours; pH 6.5-9.0; DO 6.0 mg/L

**STREAM FLOW AND WEATHER DATA**

During the Program, stream flows for Bear Creek were tracked using two gaging stations. The stations are the USGS station above Evergreen Lake and the DWR/U.S. Army COE station above Morrison. Weekly downloads and printing of flow graphs was performed to document flows. Downloads were obtained at [http://www.dwr.state.co.us/Hydrology/flow\\_search.asp](http://www.dwr.state.co.us/Hydrology/flow_search.asp).

The Program utilizes the USGS station flows and presents monthly summary tables comparing 2004 flow data with 20 years of historical data. Local weather statistics summarized, comparing 2004 air temperatures and precipitation to 30- year historical data.

**Table 30 2004 June Bear Creek Flow vs. Historic Bear Creek Flow**

USGS 06710385 GPS Coordinates: 39.6330°N, 105.3371°W

<b>Date</b>	<b>Daily Mean Flow (cfs) June 2004</b>	<b>Historic Daily Mean Flow (cfs) 20 Years for June</b>	<b>Deviation from Historic Flow (cfs)</b>
<b>1</b>	34	111	-77
<b>2</b>	34	106	-72
<b>3</b>	37	105	-68
<b>4</b>	36	104	-68
<b>5</b>	35	105	-70
<b>6</b>	34	105	-71
<b>7</b>	34	111	-77
<b>8</b>	36	107	-71
<b>9</b>	59	115	-56
<b>10</b>	46	113	-67
<b>11</b>	36	106	-70
<b>12</b>	32	104	-72
<b>13</b>	30	105	-75
<b>14</b>	29	104	-75
<b>15</b>	29	104	-75
<b>16</b>	30	105	-75
<b>17</b>	41	105	-64
<b>18</b>	48	108	-60
<b>19</b>	46	99.2	-53.2
<b>20</b>	37	97.3	-60.3
<b>21</b>	40	94.7	-54.7
<b>22</b>	46	93.9	-47.9
<b>23</b>	36	90	-54
<b>34</b>	32	85.9	-53.9
<b>25</b>	38	82.9	-44.9
<b>26</b>	48	83.1	-35.1
<b>27</b>	56	79.6	-23.6
<b>28</b>	78	78.6	-0.6
<b>29</b>	64	79.3	-15.3
<b>30</b>	71	75.3	-4.3
<b>MAX</b>	78	115	-0.6
<b>MIN</b>	29	75.3	-77
<b>AVG</b>	41.7	98.8	-57.0

Historic flows calculated on 20 years of data obtained at the USGS gaging station above Evergreen Lake.

**Table 31      2004 July Bear Creek Flow vs. Historic Bear Creek Flow**

USGS 06710385      GPS Coordinates: 39.6330°N, 105.3371°W

<b>Date</b>	<b>Daily Mean Flow (cfs) July 2004</b>	<b>Historic Daily Mean Flow (cfs) 20 Years for July</b>	<b>Deviation from Historic Flow (cfs)</b>
<b>1</b>	93	69.8	23.2
<b>2</b>	73	65.9	7.1
<b>3</b>	67	63.8	3.2
<b>4</b>	64	62.7	1.3
<b>5</b>	62	62.2	-0.2
<b>6</b>	60	61.1	-1.1
<b>7</b>	58	62.3	-4.3
<b>8</b>	55	63.2	-8.2
<b>9</b>	54	67.3	-13.3
<b>10</b>	58	64.8	-6.8
<b>11</b>	54	62.7	-8.7
<b>12</b>	50	60.7	-10.7
<b>13</b>	48	61.5	-13.5
<b>14</b>	46	58.5	-12.5
<b>15</b>	53	54.7	-1.7
<b>16</b>	86	52.8	33.2
<b>17</b>	124	57.2	66.8
<b>18</b>	105	53.5	51.5
<b>19</b>	92	54.3	37.7
<b>20</b>	99	53.2	45.8
<b>21</b>	98	51.9	46.1
<b>22</b>	99	49.2	49.8
<b>23</b>	121	53.3	67.7
<b>34</b>	149	51.4	97.6
<b>25</b>	127	50.1	76.9
<b>26</b>	119	51	68
<b>27</b>	116	47.7	68.3
<b>28</b>	---	48.2	
<b>29</b>	122	51	71
<b>30</b>	108	52.2	55.8
<b>31</b>	104	52.4	51.6
<b>MAX</b>	149	69.8	97.6
<b>MIN</b>	46	47.7	-13.5
<b>AVG</b>	85.5	57.1	28.1

Historic flows calculated on 20 years of data obtained at the USGS gaging station above Evergreen Lake.



**Table 32 2004 August Bear Creek Flow vs. Historic Bear Creek Flow**

USGS 06710385 GPS Coordinates: 39.6330°N, 105.3371°W

<b>Date</b>	<b>Daily Mean Flow (cfs) August 2004</b>	<b>Historic Daily Mean Flow (cfs) 20 Years for August</b>	<b>Deviation from Historic Flow (cfs)</b>
1	100	58.8	41.2
2	99	59	40
3	98	58.1	39.9
4	91	61.4	29.6
5	98	65.3	32.7
6	91	65.7	25.3
7	85	61.9	23.1
8	82	59.5	22.5
9	77	58	19
10	72	59.4	12.6
11	69	57.9	11.1
12	68	55.5	12.5
13	64	56.4	7.6
14	60	53.2	6.8
15	57	52	5
16	55	50.7	4.3
17	54	50.8	3.2
18	61	55.1	5.9
19	104	55.3	48.7
20	82	53.4	28.6
21	71	57.3	13.7
22	65	58.3	6.7
23	64	59.3	4.7
34	56	61.7	-5.7
25	54	58.5	-4.5
26	51	59.4	-8.4
27	56	54.6	1.4
28	58	53	5
29	50	51.5	-1.5
30	46	50.1	-4.1
31	45	47.4	-2.4
<b>MAX</b>	104	65.7	48.7
<b>MIN</b>	45	47.4	-8.4
<b>AVG</b>	70.4	56.7	13.7

Historic flows calculated on 20 years of data obtained at the USGS gaging station above Evergreen Lake.

**Table 33 2004 September Bear Creek Flow vs. Historic Bear Creek Flow**

USGS 06710385 GPS Coordinates: 39.6330°N, 105.3371°W

<b>Date</b>	<b>Daily Mean Flow (cfs) September 2004</b>	<b>Historic Daily Mean Flow (cfs) 20 Years for September</b>	<b>Deviation from Historic Flow (cfs)</b>
<b>1</b>	43	48.3	-5.3
<b>2</b>	41	46.6	-5.6
<b>3</b>	39	44.7	-5.7
<b>4</b>	37	43.4	-6.4
<b>5</b>	41	41.5	-0.5
<b>6</b>	37	40.4	-3.4
<b>7</b>	36	40.2	-4.2
<b>8</b>	34	40.7	-6.7
<b>9</b>	33	39.5	-6.5
<b>10</b>	32	41	-9
<b>11</b>	33	41.1	-8.1
<b>12</b>	31	40.6	-9.6
<b>13</b>	30	38.5	-8.5
<b>14</b>	28	37	-9
<b>15</b>	27	36.3	-9.3
<b>16</b>	27	34.2	-7.2
<b>17</b>	26	33.9	-7.9
<b>18</b>	25	32.5	-7.5
<b>19</b>	25	32.8	-7.8
<b>20</b>	26	33	-7
<b>21</b>	32	33	-1
<b>22</b>	36	32.5	3.5
<b>23</b>	33	31.5	1.5
<b>34</b>	35	31.3	3.7
<b>25</b>	34	30.7	3.3
<b>26</b>	35	30.8	4.2
<b>27</b>	32	29.8	2.2
<b>28</b>	34	30	4
<b>29</b>	37	29.6	7.4
<b>30</b>	41	29.6	11.4
<b>MAX</b>	43	48.3	11.4
<b>MIN</b>	25	29.6	-9.6
<b>AVG</b>	33.3	36.5	-3.2

Historic flows calculated on 20 years of data obtained at the USGS gaging station above Evergreen Lake.

## Weather Data

Local weather data documented at the Evergreen Metropolitan District's WWTP. The plant has been operating the National Weather Service reporting station since EMD assumed operations of the plant in 1974. Recording maximum and minimum thermometers along with a rain gauge are present and read each morning. Daily readings logged on a monthly datasheet and entered into a NWS software program. Monthly maximum temperature and precipitation data compared to 30 years (1971-2000) of historical weather data.

**Table 34 Stream Flow and Weather Data June-September Summary**

<b>Average Daily Flow (cfs)</b>	<b>June 2004</b>	<b>July 2004</b>	<b>August 2004</b>	<b>September 2004</b>
Average Daily Min	29	46	45	30
Average Daily Max	78	149	104	43
Average Daily Mean	42	85	70	25
<b>Weather</b>				
Air Temp Low Max (°C)	11.1	12.2	15	4.44
Air Temp High Max (°C)	32.8	32.8	31.1	28.3
Air Temp Avg Max (°C)	22.2	25.5	24.4	22.8
Total Precip (in.)	2.99	2.79	2.64	1.07

The average daily flow data was downloaded from the website:

[www.dwr.state.co.us/Hydrology/flow\\_search.asp](http://www.dwr.state.co.us/Hydrology/flow_search.asp)

Local weather data was collected at the National Weather Service reporting station located at the Evergreen Metropolitan District WWTP. Historical weather data was obtained from the NWS.

**Table 35 2004 Weather Data vs. Historical Weather Data (30 years 1971-2000)**

	<b>June 2004</b>	<b>June Hist</b>	<b>% Dev.</b>	<b>July 2004</b>	<b>July Hist</b>	<b>% Dev.</b>	<b>Aug 2004</b>	<b>Aug Hist</b>	<b>% Dev.</b>	<b>Sept 2004</b>	<b>Sept Hist</b>	<b>% Dev.</b>
Avg Daily Min (°C)	5	5.17	-3.3	8.33	8.05	+3.5	6.66	7.44	-10.5	3.33	2.94	+13.3
Avg Daily Max (°C)	22.2	24.4	-9.0	25.6	27.4	-6.6	24.4	26.6	-8.3	22.8	22.4	+1.8
Avg Monthly Mean (°C)	13.6	14.8	-8.1	16.8	17.8	-5.6	15.5	17	-8.8	12.8	12.7	+0.8
Precip (in.)	2.99	2.05	+45.8	2.79	2.29	+17.2	2.64	2.38	+10.9	1.07	1.45	-26.2

## DATA SUMMARIES

### Summary Of In-Stream Temperature Datalogger Results

A total of 13,764 temperature data points were obtained for the five-datalogger locations within Segment 1a. The in-stream temperature limit is 20°C maximum, with an increase of 3°C/ 4 hr. 151 data points were greater than 20°C. This results in 99% of the values in compliance. In evaluating the  $\Delta^{\circ}\text{C}/ 4 \text{ hr}$ , 13,704 4-hour blocks were used. Including any 4-hour block of time that resulted in a greater than a 3°C change (increase and decrease), 390 exceedances were recorded. [This results in 97% compliance regarding the  \$\Delta 3^{\circ}\text{C}/ 4 \text{ hr}\$  requirement during the monitoring period at the same five Segment 1a locations.](#)

### Summary Of In-Stream Weekly Monitoring Parameter Results

Weekly spot measurements obtained from nine locations in Segment 1a over 18 weeks. 162 total measurements of temperature were obtained at a total of nine locations within Segment 1a. The in-stream temperature limit is 20°C maximum. One temperature value exceeded 20°C. This results in 94.4% of the values in compliance at that particular site (west end of Morrison, at the DWR gage station) and 100% of the values in compliance for each of the remaining sites. The complete dataset for temperature in the Segment 1a study results in 99% of the values in compliance. 162 total measurements of pH were obtained at a total of nine locations within Segment 1a. The in-stream pH range is 6.5 – 9.0. 100% of values were in compliance. 162 total measurements of dissolved oxygen were obtained at a total of nine locations within Segment 1a. The in-stream dissolved oxygen limit is 6.0 mg/L. [100% of the weekly monitored parameter measurements were in compliance.](#)

### Summary Of In-Stream Ammonia Results

Weekly grab samples taken at nine locations in Segment 1a over 18 weeks. The in-stream unionized ammonia limit is 0.02 mg/L. [100% of the ammonia results were in compliance.](#)

### Summary Of WWTP Effluent Temperature Datalogger Results

A total of 11,688 temperature data points were obtained from the four dataloggers located in the WWTP effluents that discharge into Segment 1a. The in-stream temperature limit is 20°C maximum, with an increase of 3°C/ 4 hr. This in-stream limit was utilized to evaluate the WWTP effluents. 20 data points were greater than 20°C. This results in 99% of the values in compliance. In evaluating the  $\Delta^{\circ}\text{C}/ 4 \text{ hr}$ , 11,664 4-hour blocks were used. Including any 4-hour block of time that resulted in a greater than a 3°C change (increase and decrease), 39 exceedances were recorded. [These results in 99% compliance regarding the  \$\Delta 3^{\circ}\text{C}/ 4 \text{ hr}\$  requirement during the Program at the four WWTP effluents that discharges into Segment 1a.](#)

## Summary Of WWTP Effluent Sampling And Monitoring Parameter Results

WWTP effluent measurements and samples were taken as necessary according to discharge permit requirements. Process control measurements were taken during the normal course of plant operations. 345 total measurements of temperature were obtained at the four WWTP effluents during the Program. The in-stream temperature limit is 20°C maximum. This in-stream limit was utilized to evaluate the WWTP effluents. All temperature values recorded were less than 20°C, resulting in 100% compliance. 365 total measurements of pH were obtained at the four WWTP effluents that discharge into Segment 1a. The discharge permit pH range is 6.5 – 9.0. 100% of values were in compliance. 347 total measurements of dissolved oxygen were obtained at the four WWTP effluents that discharge into Segment 1a. None of the four WWTP discharge permits has limits for dissolved oxygen. 68 unionized ammonia sample results were calculated from total ammonia results. Although there were three additional total ammonia results, corresponding pH and temperature values were not available for the unionized calculation. The in-stream unionized ammonia limit is 0.02 mg/L. [100% of the effluent analysis results were in compliance.](#)

## Summary Of 24-Hour Profiling Results (2 Sites)

At the O'Fallon Park East location, 144 measurements were obtained for each of the four parameters: pH, Temperature, Dissolved Oxygen and Specific Conductance.

- There were 5 exceedances of the 9.0 pH limit. There results in 96.5% compliance.
- There was 100% compliance with the Dissolved Oxygen standard.
- There was 100% compliance with the 20°C-temperature standard.
- There were five exceedances of the  $\Delta 3^{\circ}\text{C}/4$  hours temperature standard. This results in 96.5% compliance.

At the Lair o' the Bear Park location, 144 measurements were obtained for each of the four parameters: pH, Temperature, Dissolved Oxygen and Specific Conductance.

- There was 100% compliance with the pH standard.
- There was 100% compliance with the Dissolved Oxygen standard.
- There were 6 measurements exceeding the 20°C temperature standard. This results in 95.8% compliance.
- There were 3 exceedances of the  $\Delta 3^{\circ}\text{C}/4$  hours temperature standard. This results in 97.9% compliance.

## Summary of Macroinvertebrate Data

The Association analyzed relative macroinvertebrate information from four sites along segment 1a. The Water Quality Control Division also sampled for macroinvertebrate speciation in Bear Creek. The Association added a copy of the state data to the Association database. The Association results listed in Table 36.

**Table 36 Summary of Bear Creek Segment 1a Macroinvertebrate Data**

	Site BC01	Site BC02	Site BC03	Site BC04
	Bear Creek Park	Lair o' the Bear Park	O' Fallow Park	Upstream Evergreen WWTP
Organism	Individuals	Individuals	Individuals	Individuals
<i>Acentrella insignificans</i>	91	98	12	3
<i>Antocha</i> sp.		3		
<i>Atherix pachypus</i>			1	
<i>Baetis flavistriga</i>	4	1		
<i>Baetis tricaudatus</i>	24	17		11
<i>Brachycentrus americanus</i>	1			
<i>Caecidotea</i> sp.	4			28
<i>Ceratopogonidae</i>	1			1
<i>Ceratopogonidae pupae</i>	1			
<i>Cheumatopsyche</i> sp.	1	2		21
<i>Cheumatopsyche</i> sp. pupae				2
<i>Corynoneura</i> sp.			1	
<i>Cricotopus/Orthocladius</i> sp.			14	25
<i>Crangonyx</i> sp.	5	1		
<i>Cryptochironomus</i> sp.			4	1
<i>Cryptochironomus</i> sp. pupae			1	
<i>Diamesa</i> sp.		8		
<i>Dugesia</i> sp.	4			
<i>Empididae pupae</i>				1
<i>Ephemerella</i> sp.		4	2	4
<i>Erpobdellidae</i>		1	1	
<i>Eukiefferiella</i> sp.	4	7		6
<i>Eukiefferiella</i> sp. pupae	1			
<i>Hemerodromia</i> sp.				1
<i>Hydrobaenus</i> sp.				1
<i>Hydropsyche</i> sp.	2	6	8	74
<i>Hydropsyche</i> sp. pupae	2	16	2	39
<i>Hydroptila</i> sp.				1
<i>Isoperla</i> sp.	3			
<i>Lepidostoma</i> sp.		2		1
<i>Limnophyes</i> sp.			1	
<i>Lumbricidae</i>	1	1		3
<i>Nais</i> spp.				3
<i>Nanocladius</i> sp.				3
<i>Oecetis</i> sp.		1		
<i>Oecetis</i> sp. pupae			1	1
<i>Odontomesa</i> sp.			2	1
<i>Ophidonais serpentina</i>				11
<i>Optioservus</i> sp. adults		13		4
<i>Optioservus</i> sp. larvae		7		17
<i>Pagastia</i> sp.		6	1	28
<i>Paraleptophlebia</i> sp.			2	1
<i>Parametriochnemus</i> sp.				2
<i>Physidae</i>				2
<i>Petrophila</i> sp.		6		

	Site BC01	Site BC02	Site BC03	Site BC04
	Bear Creek Park	Lair o' the Bear Park	O' Fallon Park	Upstream Evergreen WWTP
Organism	Individuals	Individuals	Individuals	Individuals
<i>Polypedilum sp.</i>		2	1	7
<i>Potthastia longimana group</i>				1
<i>Rheocricotopus sp.</i>				1
<i>Rheocricotopus sp. pupae</i>				1
<i>Simulium sp.</i>		15		1
<i>Stenochironomus sp.</i>			1	
<i>Synorthocladius sp.</i>				2
<i>Thienemannimyia group</i>				15
<i>Thienemannimyia group pupae</i>				1
<i>Tipula sp.</i>		1		
<i>Tricorythodes minutus</i>	13	1		
<i>Tubificidae with hair chaetae</i>	20			
<i>Tubificidae w/o hair chaetae</i>			2	3
<b>Species Richness</b>	<b>18</b>	<b>23</b>	<b>18</b>	<b>38</b>
Geometric Mean	4	4	2	3
Total CTS	182	219	57	328
Area Sampled (sq meter)	0.75	0.5	1.25	0.5
Species density/m2	243	438	46	656

## Summary of CDOW fish count

The 2004 Fish Count in Segment 1a was completed on September 15<sup>th</sup>. Raw data was from CDOW transmitted to Chadwick Ecological Consultants (CEC) for evaluation. The BCWA did not formally contract with CEC to analyze the data, but CEC provided an overall assessment, which was summarized and included here. Additionally, CDOW was contacted to provide another opinion of the same data. The Fish Count will be evaluated site-by-site beginning upstream. The first evaluation is a summary of comments from CEC.

The Bear Creek Cabins site produced good year classes in browns and rainbows, indicating some reproduction. The numbers were up slightly from 2003, and close to pre-2002 numbers. The O'Fallon Park site was down in numbers all around. There were some larger fish present, but recent stream improvement restoration work most likely drove the smaller fish away. The Lair o' the Bear site data must be qualified because muddy water from in-stream activities upstream interfered with a second pass. Despite this, good young of the year numbers were present. The Idledale site produced numbers up slightly from 2003. All size classes were present in good numbers. The Morrison site produced good young of the year classes, indicating a good reproduction year. There were good numbers of medium sized fish. The Segment continues to improve with stronger numbers than 2003.

It is important to note that CDOW focused primarily on brown trout, because it is the naturally reproducing population. CDOW provided the following comments: The Bear Creek Cabins site yielded good biomass for the size of stream and raw data showed 12-15" sizes. The length frequency showed good multiple size classes. The O'Fallon Park site was not representative because of the habitat restoration work being done in the Park. The lower numbers were to be expected. The Lair o' the Bear site biomass numbers was good, considering the count did not successfully complete one pass. The numbers are probably



higher, but the pounds/acre of fish was still good. The Idledale site biomass numbers and length frequency were good. Raw data shows a 17" brown trout and a wide range of sizes. The Morrison site yielded an abundance of 'young of the year', but not as many adult fish. Size classes were in a wide range, from 8-14". The Segment 1a continues to improve from 2002, in both biomass and numbers.

### **Summary of Stream Flow Data and Weather**

The stream flows recorded during the Program, on average, were lower than the historic average in June and September, and higher than the historic average in July and August. This data is correlated to the measured precipitation. Measurable precipitation was recorded 11 of the last 14 days in June, and continued with 13 days of measurable precipitation in July. August followed with 10 days, but September had only 6 days of measurable precipitation. Precipitation was above historical average, with the exception of September (-0.38").

The Average Daily Minimum temperatures were within a degree or so of the historical data for the Program period. The Average Daily Maximum temperatures were below historical averages, with the exception of September (within one degree). The Average Monthly temperatures were slightly below historical averages, with the exception of September (at average).

### **Summary of Fishing Surveys**

Five Fishing Surveys were handed out from August 26 through September 9, 2004. The Surveys were return-addressed and stamped. Only one survey was returned. The angler was inexperienced, but commented that he had caught brown and rainbow trout in the 6" to 11" range. The survey response was a disappointing, but the survey will be used in future studies.

## **COMPLIANCE RESULTS**

The hourly temperature datalogger measurements recorded in Bear Creek from just above the EMD WWTP discharge to the west end of Morrison do not indicate that a problem exists, either man-induced or natural, that results in the non-compliance of the 20°C stream standard, utilizing the 85th%-tile qualifier. [99% of the temperature values were in compliance.](#)

Analysis of the hourly temperature datalogger measurements recorded in Bear Creek from just above the EMD WWTP discharge to the west end of Morrison do not indicate that a problem exists, either man-induced or natural, that results in the non-compliance of the  $\Delta 3^{\circ}\text{C}/4$  hour stream standard, utilizing the 85th%-tile qualifier. This analysis included every four-hour block of time (in a rolling average format) that resulted in a greater than 3°C change of temperature. [97% of the temperature values were in compliance.](#)

Weekly in-stream monitoring measurements recorded in Bear Creek at nine locations from just above the EMD WWTP discharge to the west end of Morrison, do not indicate that a problem exists, either man-induced or natural, that results in the non-compliance of stream standards for pH, Temperature, and Dissolved Oxygen, utilizing the 85th%-tile qualifier.

Analysis of all (18 weeks, nine locations) in-stream measurements (162 per parameter) results in 100% compliance for pH, 99% compliance for Temperature and 100% compliance for Dissolved Oxygen. It is important to note that nine weekly monitoring events occurred in the morning and nine in the afternoon.

Weekly in-stream sampling results and calculations obtained in Bear Creek at nine locations from just above the EMD WWTP discharge to the west end of Morrison, do not indicate that a problem exists, either man-induced or natural, that results in the non-compliance of stream standards for Ammonia, utilizing the 85th%-tile qualifier. pH and Temperature values recorded at the time of sampling were combined with Total Ammonia results to produce calculated Unionized Ammonia results. 100% of the calculated values were in compliance. It is important to note that nine weekly sampling events occurred in the morning and nine in the afternoon.

The hourly temperature datalogger measurements recorded in the four WWTP effluents that discharge into Bear Creek in Segment 1a, do not indicate that a problem exists in the temperature of any WWTP effluent that results in the non-compliance of any temperature stream standard, utilizing the 85th%-tile qualifier. Since there are no temperature effluent limits for the four-wastewater plants, the existing stream standards of 20°C Max, with an increase of >3°C/ 4 hours were applied. 99% of the effluent temperature values were in compliance with the 20°C Max stream standard and 99% of the effluent temperature values were in compliance with the >3°C/ 4 hours.

The daily WWTP Process Control measurements recorded in the four WWTP effluents that discharge into Bear Creek in Segment 1a, do not indicate that a problem exists in any WWTP effluent that results in the non-compliance of any pH, Temperature, Dissolved Oxygen or Unionized Ammonia stream standard, utilizing the 85th%-tile qualifier. It is important to note that there were no permit violations for any WWTP with respect to pH or Ammonia.

The results of the 24-hour profiling at the two selected locations in Bear Creek Segment 1a do not indicate that a problem exists, either man-induced or natural, that results in the non-compliance of stream standards for pH, Temperature, and Dissolved Oxygen, utilizing the 85th%-tile qualifier. A total of 144 measurements per parameter were recorded at each location. 96.5% or higher compliance was achieved for the pH, Temperature and Dissolved Oxygen stream standards at the O'Fallon Park location. 95.8% or higher compliance was achieved for the pH, Temperature and Dissolved Oxygen stream standards at the Lair o' the Bear Park location.

The fish count data shows that Segment 1a continues to improve since 2002. The water quality of Bear Creek is a major factor contributing to its improvement. Without detailed data analyze by the Association, it appears that both Chadwick and CDOW agree that Segment 1a continues to improve. The numbers, biomass and size classes continue to improve since the 2002 summer season.

Weather records and stream gage readings indicate that the cooler, wetter season contributed to the more typical water quality conditions seen in Bear Creek. Stream gage measurements recorded at the USGS station above Evergreen Lake showed lower than historic averages for June and September, but the beginning of a return to regular summer

precipitation pattern produced higher than historical average flows in July and August. The precipitation in July and August was slightly above historical average. Average daily maximum air temperatures were slightly lower than historical average, with the exception of September (near normal).

### **No Water Quality Impairment In 2004**

The 2004 special stream monitoring program in Bear Creek segment 1a showed no evidence of impairment. Compliance with temperature and ammonia stream standards, the two main parameters of concern, was never in question during the Program period. A comprehensive temperature data collection effort, summarized in 13,764 hourly measurements in five in-stream locations throughout the Segment, showed no evidence of thermal impairment. Eighteen ammonia-sampling events at nine locations throughout the Segment, showed no evidence of ammonia toxicity or impairment.

A major contributing factor in the 2004 Program were the regular precipitation events that produced and sustained above average stream flows during the typically warmest period of the summer. The snow pack runoff proved non-existent for May and June. This is evident in the less than average flows for May and June, as compared to 20-year historical data. Monthly average stream flow for May 2004 was 51.6 cfs, as compared to the historical 93.9 cfs. Monthly average stream flow for June 2004 was 39.1 cfs, as compared to the historical 98.8 cfs. Once July and August precipitation events occurred, stream flows were increased and sustained. Monthly average stream flows were above historical averages.

A comprehensive temperature data collection effort, summarized in 11,688 hourly measurements in four wastewater treatment plant effluents that discharge into Bear Creek Segment 1a, showed no evidence of thermal pollution. Similarly, there was no evidence of ammonia, dissolved oxygen or pH exceedances during the typical operation of these plants. All four plants met discharge limits stated in their Colorado Discharge Pollutant Elimination System (CDPES) permit for parameters of concern regarding this report during the Program period.

There were no observed impairment issues in the Segment or any permit violations in wastewater plant effluents during the Program. There were no observed temperature or ammonia issues with the Segment. Wastewater treatment plant effluents had no detrimental effect on the water quality of Segment 1a. Increased flows from typical summer precipitation events produced above average stream flows for most of the Program period, which resulted in near normal water quality conditions. Bioassessment and fish count data indicate that the fishery continues to recover from the drastic conditions encountered in the most severe drought year of 2002.

## EXAMPLE DATA FORMS

### EVERGREEN METROPOLITAN DISTRICT

Water and Wastewater  
P.O. Box 3819  
Evergreen, Colorado 80437-3819  
303-674-4112  
Fax 303-674-7267

#### BEAR CREEK STUDY—SUMMER 2004 DATALOGGER LAUNCH/RETRIEVE

LOGGER #	LOGGERLOCATION	DATE OUT	TIME OUT	DATE IN	TIME IN	INITIALS
EMD1	Above Evergreen Lake, at gaging station					
EMD2	In Evergreen Lake, near dam, at surface					
EMD3	In Evergreen Lake, near dam, 10' down					
EMD4	Above EMD WWTP effluent					
EMD5	EMD WWTP effluent					
EMD5A	Below Idledale, at McGoldrick bridge					
WJ6	WJCMD WWTP effluent					
KSWD7	Above KSWD WWTP effluent, east end of O'Fallon					
KSWD8	KSWD WWTP effluent					
GWSD9	Above GWSD WWTP effluent, west end of Lair o' the Bear					
GWSD9A	GWSD WWTP effluent					
Morr10	Morrison gaging station, west end of town above Harriman Diversion					
Morr11	Above Morrison WWTP effluent, start of Bear Creek segment 1b					
Morr12	Morrison WWTP effluent					

COMMENTS: \_\_\_\_\_

### EVERGREEN METROPOLITAN DISTRICT

Water and Wastewater  
P.O. Box 3819  
Evergreen, Colorado 80437-3819  
303-674-4112  
Fax 303-674-7267

#### Bear Creek Study 2004 Staff Gage Readings

Date	Time	Location	Feet
		Keys on the Green gaging station	
		O'Fallon Park at pedestrian bridge	
		Corwina Park	
		Lair o' the Bear Park south of parking lot	
		Keys on the Green gaging station	
		O'Fallon Park at pedestrian bridge	
		Corwina Park	
		Lair o' the Bear Park south of parking lot	
		Keys on the Green gaging station	
		O'Fallon Park at pedestrian bridge	
		Corwina Park	
		Lair o' the Bear Park south of parking lot	
		Keys on the Green gaging station	
		O'Fallon Park at pedestrian bridge	
		Corwina Park	
		Lair o' the Bear Park south of parking lot	

Notes

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EVERGREEN METROPOLITAN DISTRICT  
Water and Wastewater  
P.O. Box 3819  
Evergreen, Colorado 80437-3819  
303-674-4112  
Fax 303-674-7267

BEAR CREEK STUDY—SUMMER 2004  
pH/Temp/DO/COND METER CALIBRATION RECORD

MAKE YSI MODEL 556 MPS S/N 02E1048AA

Comments: \_\_\_\_\_

DATE	20 Min Warm up	DO Calib. OK?	pH 7 Calib OK?	PH 10 Calib OK?	Temp °C	COND 1.413 mS/cm OK?	Probe Maint?	Init

EVERGREEN METROPOLITAN DISTRICT  
Water and Wastewater  
P.O. Box 3819  
Evergreen, Colorado 80437-3819  
303-674-4112  
Fax 303-674-7267

BEAR CREEK STUDY—SUMMER 2004  
pH/Temp/DO/COND SONDE CALIBRATION RECORD

MAKE YSI Sonde MODEL 600 XLM S/N 03C0209

Comments: \_\_\_\_\_

DATE	20 Min Warm up	DO Calib. OK?	pH 7 Calib OK?	PH 10 Calib OK?	Temp °C	COND 1.413mS @ 25°C OK?	Probe Maint?	Init

BEAR CREEK STUDY—SUMMER 2004  
WEEKLY CHECKS

DATE: \_\_\_\_\_

LOGGER or YSI ID	LOCATION	PH (SU)	TEMP °C	DO (mg/L)	COND (mS)	Monitoring Time	Logger Intact? Y/N	Location Sampled? Y/N	Sampling Time
KSWD7	Above KSWD WWTP effluent, east end of O'Fallon Park								
KERR	Kerr Gulch, at Hwy 74 bridge						N/A		
GWSD9	Above GWSD WWTP effluent, west end of Lair o' the Bear Park								
IDLEWES T	Above Idledale, west end of town						N/A		
EMD5A	Below Idledale, at McGoldrick bridge								
Morr10	At Morrison gaging station, above Harriman Diversion								
Morr11	Above Morrison WWTP effluent, at start of Bear Creek segment 1b								

WEATHER: \_\_\_\_\_  
 START TIME: \_\_\_\_\_ END  
 TIME: \_\_\_\_\_ INITIALS: \_\_\_\_\_

LOGGER or YSI ID	LOCATION	PH (SU)	TEMP °C	DO mg/L	COND (mS)	Monitorin g Time	Logger Intact? Y/N	Location Sampled? Y/N	Sampling Time
EMD1	Above Evergreen Lake, at gaging station								
EMD2	In Evergreen Lake, near dam, at surface							N	N/A
EMD3	In Evergreen Lake, near dam, 10' down							N	N/A
EVLKMID	In Evergreen Lake, middle						N/A	N	N/A
EMD4	Above EMD WWTP effluent								
BCC	Below Bear Creek cabins, at bridge						N/A		
WELCHBR	Below Troublesome Gulch, at Welch Ave. bridge						N/A		
OFPWEST	O'Fallon Park, west end						N/A		

COMMENTS: Data retrieved from YSI memory

BEAR CREEK STUDY—SUMMER 2004

COMMENTS: Data retrieved from YSI memory

\_\_\_\_\_  
 \_\_\_\_\_

Evergreen Metropolitan District					# of Containers	Matrix (Water, Soil, Sludge)	List analyses requested here					Remarks
Sample Number	Date	Time	Comp/Grab	Sample Location								

Relinquished by: (Signature)	Date	T i m e	Received by: (Signature)	Date	Ti me
Relinquished by: (Signature)	Date	T i m e	Received by: (Signature)	Date	Ti me
Relinquished by: (Signature)	Date	T i m e	Received by: (Signature)	Date	Ti me
Relinquished by: (Signature)	Date	T i m e	Received by: (Signature)	Date	Ti me
Relinquished by: (Signature)	Date	T i m e	Received by: (Signature)	Date	Ti me

Notes: 1.) Label all samples.

2.) Transport all samples in coolers with ice or freeze packs. Store at 4°C.