

Chatfield Watershed Report 2004:

Annual Summary and Water Quality Fact Sheets

May 2005



Established 1984

Working for Water Quality

Watershed Management Agency

Chatfield Watershed Authority

Chatfield Watershed Report 2004: Water Quality Summary

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Introduction

The Chatfield Watershed Authority (Table 1) is the designated water quality management agency for the Chatfield Watershed. The Authority implements the *Chatfield Reservoir Control Regulation* (Regulation #73). The control regulation assures watershed point and nonpoint source water quality compliance consistent with adopted stream standards and classifications. Water quality data began as part of an intense one-year *Chatfield Reservoir Clean Lake Study* (DRCOG 1984). A generally continuous collection of surface quality data in the watershed and reservoir began in 1990. Data collection includes specific chemical, physical and biological parameters.

Table 1. Authority Membership and Wastewater Treatment Plants

Towns & Communities	Counties	Special Districts	Industry & Agencies	Church Camps & Special Interest
City of Littleton	Jefferson	Plum Creek Wastewater Authority	Lockheed Martin Space Systems Company	Ponderosa Retreat & Recreation Center
Town of Castle Rock	Douglas	Castle Pines Metro District	Denver Water Department	Sacred Heart Retreat
Town of Larkspur		Centennial Water & Sanitation District	U.S. Army Corps of Engineers	Highlands Ranch Law Enforcement Center
		Louviers Mutual Service Company	Tri-County Health Department	
		Roxborough Park Metro District	Water Quality Control Division	
		Jackson Creek Ranch Metro District		
		Perry Park Water & Sanitation District		

The U.S. Army Corps of Engineers operates Chatfield Reservoir (below), including storage and releases of water. The Corps is an active and valuable member of the Authority.

The Colorado Division of Parks manages for recreational activities at the Chatfield Reservoir State Park. The Colorado Parks Division does not financially or actively support or participate in Authority programs.



The wastewater treatment facilities include Plum Creek Wastewater Authority, Roxborough Park Metropolitan District, Centennial Water & Sanitations District, Louviers Mutual Service Company, Perry Park Water and Sanitation District, Lockheed Martin Space Systems Company, Sacred Heart Retreat. The Ponderosa Retreat and Recreation Center is converting from a series of on-site disposal systems to a combination of a centralized treatment plant and a reduced number of on-site systems. The Jackson Creek Ranch Metropolitan District has an approved wastewater utility plan to construct a wastewater treatment plant after obtaining necessary Douglas County zoning approvals. Roxborough Park and Lockheed Martin have developed a joint pipeline project to transmit wastewater to the Littleton/Englewood treatment plant. The wastewater utility plan for the joint pipeline was approved by the Authority and accepted by the Denver Regional Council of Governments. The Plum Creek Wastewater Authority treatment plant expanded to 4.9 million gallons per day.

Adopted Total Maximum Annual Load (TMAL)

Based upon a Clean Lakes Study, The Water Quality Control Commission adopted a total phosphorus standard of 27 ug/l targeted to maintain a chlorophyll a goal of 17 ug/l. The phosphorus standard applies for the growing season, July through September. Chatfield reservoir has complied with the Chlorophyll a target every year, and the phosphorus standard for 18-22 years. The Chatfield Reservoir Control Regulation #73 (approved 1986) incorporates the total maximum annual load (TMAL) that maintains wasteload allocations for point sources and the allowable nonpoint source load of 59,000 pounds of total phosphorus per year (Table 2). This maximum phosphorus loading of 59,000 lbs/year presumes a Q10 flow condition of 261,000 ac-ft/year. The point sources of phosphorus to the reservoir are limited to 7,358 lbs/yr with 51,642 lbs/yr allocated to nonpoint and background sources. Ongoing water quality modeling predicts the total phosphorus loading to Chatfield Reservoir that can be assimilated without exceeding the water quality standard of 0.027 mg/l total phosphorus.

The total maximum annual load formula for total phosphorus by sources:

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

The reservoir base-load represents the five-year rolling average total phosphorus load reaching Chatfield Reservoir. The TMAL incorporates an error based or implied MOS.

Table 2. The TMAL total phosphorus allocations distributed among sources

Allocation Type	Total Phosphorus Pounds/Year
<i>Total Maximum Annual Load (TMAL) =</i>	<i>59,000 @ 261,000 ac-ft/year</i>
Chatfield Watershed	41,070
Reservoir Base-Load	13,400
Background Sources	20,312
Wasteload Allocation (Point Sources)	7,358
Upper South Platte River Watershed ¹	17,930
Reservoir Base-Load	6,000
Background Sources	11,930

¹Loadings from the Upper South Platte River watershed include all point sources upstream of the Strontia Springs Reservoir, including 88 pounds of total phosphorus per year from wastewater originating in Summit County and discharged directly into the Roberts Tunnel, and all nonpoint sources above the Strontia Springs Reservoir outfall.

TMAL Compliance

Total Maximum Annual Load = 59,000 at 261,000 ac-ft/year (total input into Chatfield reservoir based on Waterton and Plum Creek monitoring sites)(Table 2). The wasteload allocation, based upon flow, allocates the load by type and basin of origin. The annual inflow is estimated from monthly flow data at monitoring stations, averaged during a sampling event (once or twice per month), and then averaged over a monthly period based on number of days per month. While this method is subject to error, it provides a reasonable estimate of annual flow and compares reasonably well with U.S. Corps of Engineers data. Additional flow data is obtained from the Denver Water Department for the South Platte River at Waterton and used to back-adjust flow data for the TMAL analysis.

Chatfield Reservoir record exceeded the TMAL only once in 1998. However, this value is within the margin of safety and it was associated with a single large stormwater runoff event.. Annual measured TMAL compliance values are shown in Table 3. The relationship of flow data and total phosphorus data are shown in Figure 2. Data shows a good record of compliance with the adopted TMAL, including basin suballocations. The assumptions and nonpoint source load allocations assigned to the Chatfield and Upper South Platte River source watersheds are reasonable.

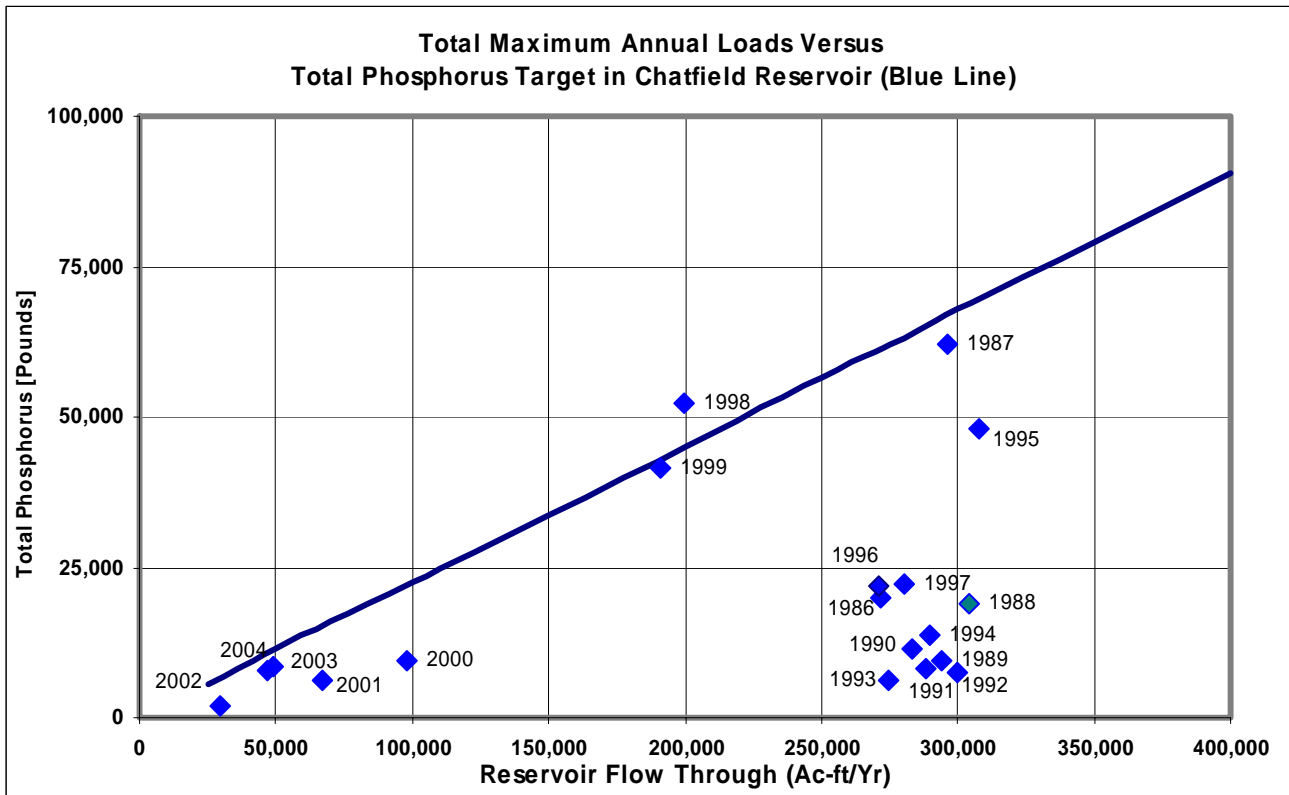


Figure 1 Annual measured TMAL values versus control regulation targets

Table 3 Total Phosphorus Loading 1986-2004

Data Year	Total Volume	T Phosphorus Loading		South Platte	Reservoir
	acre-ft	Total Load	South Platte	Average Conc.	Average Conc.
	(Estimate)	(Measured)	(Calc)	mg/l	mg/l
1986	272,000	19,998	13,332	0.018	0.027
1987	295,890	62,040	7,251	0.009	0.077
1988	303,850	19,030	7,446	0.009	0.023
1989	294,160	9,612	6,408	0.008	0.012
1990	283,350	11,573	1,543	0.002	0.015
1991	300,170	7,638	2,826	0.025	0.017
1992	288,460	8,043	6,284	0.008	0.031
1993	274,470	6,181	8,221	0.011	0.021
1994	289,850	13,763	5,505	0.017	0.014
1995	307,530	48,032	5,024	0.006	0.013
1996	270,659	21,799	8,066	0.047	0.026
1997	280,000	22,150	12,863	0.039	0.015
1998	199,463	52,167	13,785	0.026	0.024
1999	205,361	44,218	6,953	0.023	0.017
2000	98,268	9,380	2,865	0.021	0.014
2001	75,422	8,719	2,510	0.010	0.023
2002	28,885	2,089	1,656	0.020	0.025
2003	48,807	8,379	3,701	0.041	0.066
2004	46,768	7,809	4,442	0.052	0.035
Average	219,124	20,823	6,458	0.021	0.026

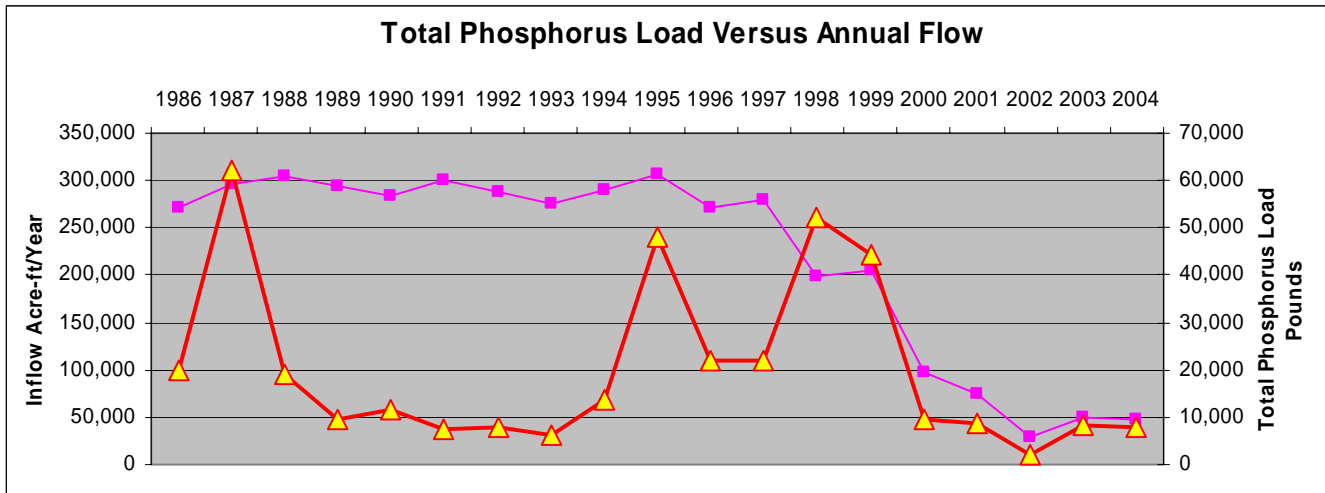


Figure 2 Total Phosphorus Annual Load (Triangle) Versus Reservoir Inflow (Squares)

Water Quality Monitoring

The Chatfield Watershed Authority maintains a water-quality monitoring program in the Chatfield Watershed (Figure 3). The Chatfield Watershed includes Chatfield Reservoir, Plum Creek, Deer Creek, the South Platte River from the Strontia Springs Reservoir to the Chatfield Reservoir, and areas tributary to these drainages. The watershed tributary to the South Platte River upstream of the Strontia Springs Reservoir outfall is part of the Upper South Platte River Watershed.

The Authority determines the monitoring program elements in cooperation with the Colorado Water Quality Control Division (WQCD). Three critical questions answered by the monitoring program are:

- 1) Does Chatfield Reservoir meet the growing season total phosphorus standard and chlorophyll goal, annually?
- 2) *Are total phosphorus load controls sufficient to assure compliance with the TMAL?*

Water-quality data characterize the trophic state of the reservoir (see fact sheet 32), evaluate trends in the watershed and assess compliance with the adopted control regulation. The in-reservoir total phosphorus data are used by the Division to determine compliance with the total phosphorus standard of 0.027 mg/L (27 ug/L) as a growing season average (July-September). The components of the monitoring program characterize inputs into the reservoir, the reservoir water column and outflow from the reservoir. The program provides time-trend monitoring of the South Platte River and Plum Creek; nonpoint source screening for major drainage systems, and a periodic measurement of alluvial groundwater quality.

Quality Assurance Plan

The sampling and analysis plan [*2004-2008 Chatfield Watershed Authority: Quality Assurance Project Plan (QAPP), Sampling and Analysis Plan (SAP) and Standard Operating Procedures (SOP) Version 3.0, August 1, 2004*] describes the basic monitoring program for the Chatfield Watershed. The basic program is applicable for calendar years (CY) 2004-2008. The field-sampling portion of the monitoring program for the Chatfield Watershed for CY 2004-2008 generally matches previous monitoring efforts with the exception that sampling of alluvial groundwater wells is discontinued. The Authority monitoring program maximizes the use of available financial resources, while providing the information necessary to meet water-quality program objectives. The sampling plan is flexible and adjusted to respond to water quality monitoring and management needs. The sampling plan was accepted by the Water Quality Control Division in 2004.

Massey Draw Special Monitoring

A stream restoration project was under construction in late 2004 on Massey Draw. A multi-organization project has stabilized streambanks and wetlands for a portion of Massey Draw that experienced severe erosion. The Chatfield Watershed Authority has incorporated a limited water quality monitoring in Massey Draw from 2003 through 2006 into the standard monitoring program. This monitoring effort compares pre-and post- construction trends within Massey

Draw during each spring and summer runoff seasons. The three water quality parameters to be measured are: total nitrogen, total phosphorous, and total suspended sediment (turbidity). The Authority takes a single grab sample upgradient of the C-470 crossing during each of three dry weather events. During each of three stormwater events, the Authority takes grab samples at three points on the hydrograph. Flow measurements estimated for each sample. This data will be used to calculate nitrogen, sediment and phosphorus loading from Massey Draw. All monitoring will adhere to the established quality assurance program of the Authority. Data results are incorporated into the Authority database. The Massey Draw data will determine the effectiveness of tributary restoration in reducing total phosphorus loading to Chatfield Reservoir. On June 27, 2004, Massey Draw experienced a 10-year flood event that caused significant bank erosion.

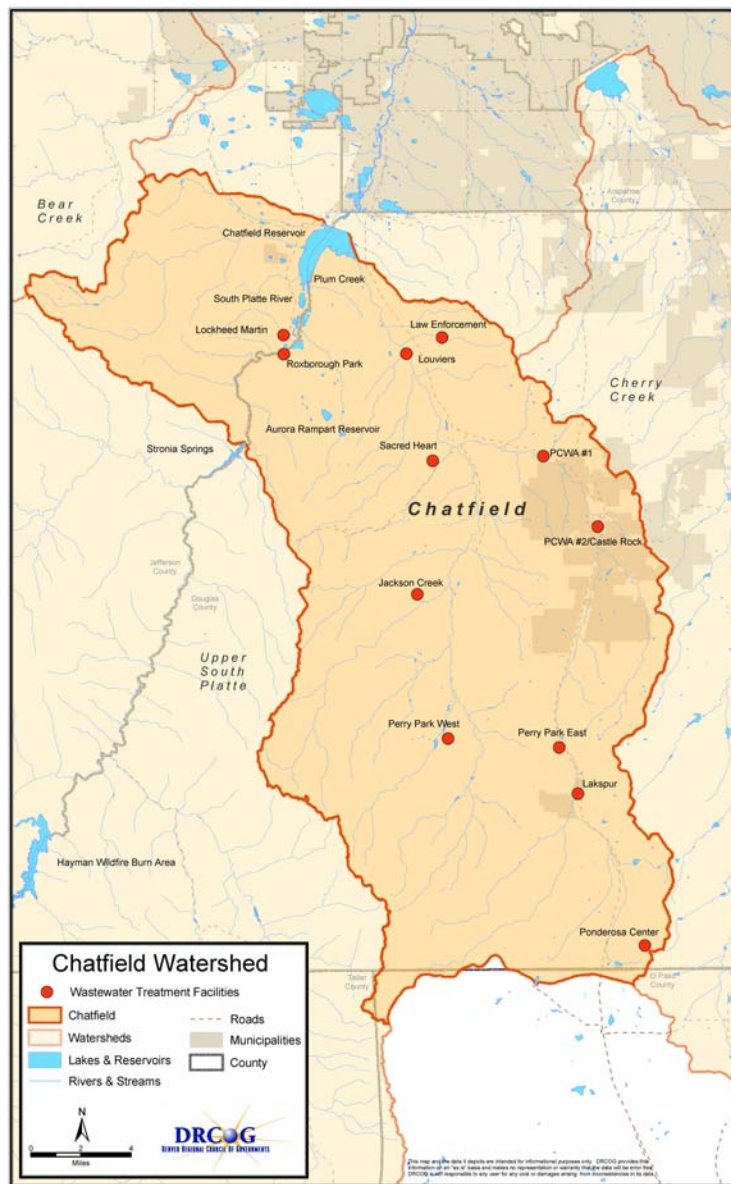


Figure 3 Chatfield Watershed

Supplemental Metal Monitoring

In 2004, the Authority reviewed the metal data collection frequency and modified sampling for metals beginning in the 2005. This supplemental metal sampling evaluates the expected increase in metal loading from the Hayman fire. Results and requirements for additional supplemental metal monitoring will be evaluated in the 2005-06 monitoring program. Limited metal loading associated with the Hayman Fire runoff was recorded in 2004 by the Authority (see fact sheet #31).

2004 Data Report and Data Record

The Authority produced and distributed the 2004 Water Quality Monitoring Annual Data Report, (Authority March 2005). Electronic copies of the data report were provided to the Authority membership, WQCD staff and interested parties. Copies of the data record are available on request to the Authority. Additionally, the Authority distributed a CD of all available data and reports to all interested parties.

Authority Web Site

The Authority maintains a web site www.chatfieldwatershed.org and places all monitoring data on the web site each month. The site contains reports and associated documents of the Authority. The web site is updated bi-monthly.

Beneficial Use and Water Quality Standard Indicators

The reservoir trophic parameters determine overall water quality trends and compliance with designed uses and standards. The Authority applies two trophic models (TSI) that evaluate chemical and biological parameters and produce a growing season and annual estimate of water quality. The models and reservoir indicator parameters show a distinct improvement in water quality through 2004. Presumably, 2004 water quality data shows a shift in water quality as a result of wildfire runoff. The pre-fire quality exceeds the water quality objective of the control regulation and meets the goal of the watershed management strategy. Over the period of data record, the trend in reservoir balances between a mesotrophic and a eutrophic state (see fact sheet 39). The reservoir program evaluates seasonal as well as long-term changes in seven categories:

- 1) Nutrient (nitrogen and phosphorus) concentrations and trends;
- 2) Standard physical and chemical parameters used by the Water Quality Control Division to determine compliance with basic standards and the Chatfield Reservoir Control Regulation;
- 3) Indicator metal concentrations (limited water chemistry and bottom sediments);
- 4) Indicator biological characteristics;
- 5) Indicator zoological characteristics;

- 6) Characterization of mass loading into Chatfield Reservoir from the South Platte River system and Plum Creek drainage; and
- 7) Changes to inflow water quality caused by uncontrolled external factors such as fire burn erosion and organic loading (Hayman and Buffalo Creek fires), drought and upstream development.

Base Management Activities

The Authority Board implemented a set of base program concepts within a five-year business plan format:

1. Collaboration and increased networking.
2. Establish and maintain a group image; increase outreach and education.
3. Maintain a funding strategy, a list of funding opportunities/ projects and Seek opportunities for watershed planning grants.
4. Continuous evaluation of the Authority role in nonpoint source and stormwater management.
5. The Authority assumes a leadership role in the watershed.
6. Tracks issues and players.

The Authority “Business” or “Master” plan elements are as follows:

1. Collaboration efforts, strategies and processes;
2. Image, Education and Outreach;
3. Monitoring & Quality Assurance Project Plan; Monitoring and Watershed Opportunities;
4. Funding opportunities and strategy; Project list (Capital improvement plan);
5. Program management/ administration;
6. Control Regulation Compliance [TMAL, Temporary Modifications, 303(d) list].

Stormwater Management

The Authority is concerned with the quality of dry-weather and stormwater runoff associated with significant development sites, which relate to urban development construction activities. The Authority reviews development projects for stormwater controls. The Authority has no direct responsibility for regulating development activities or implementing site-specific water quality or stormwater control facilities. The Authority works with its members through local review processes to ensure that development uses the best available management practices. The Authority reviews best management practices and makes recommendations as requested by local governments. Jefferson County and Douglas County have stormwater permitting programs.

Hayman Wildland Fire

In 2002, the Hayman fire burned over 137,000 acres of Ponderosa Pine and Douglas Fir forest. This extremely hot fire vitrified soils and produced large tracts of impermeable surface with greatly increased runoff. The fire severely damaged 11 sixth level watersheds and threatens a major water supply for the Denver region. Over 188 miles of perennial streams and 182 miles of intermittent streams were impaired. The erosion potential from the runoff area is extreme. Downstream water quality data for 2004 show that concentrations for five water quality parameters (nutrients and metals) exceed historic data trends. Water quality data suggests that wildfire runoff pollutants could exceed numeric water quality standards. Consequently, management programs currently in place to address other pollution problems are jeopardized.

The Authority continues monitoring both inflow and outflow water quality within Chatfield Reservoir. The Authority believes that an opportunity exists to have the standards in Segments 6a and 6b met if there is continued diligence in the upstream watershed to mitigate the wildland fire impacts. However, because the Authority has no legal basis for managing water quality in the Upper South Platte River Watershed, it cannot guarantee that mitigation will be sufficient to offset wildland fire impacts, and ensure that the underlying standards in Segments 6a and 6b will be met within a 20-year recovery period.

Duration of Recovery and Cooperative Efforts

The U.S. Forest Service estimated that the Hayman burn area could take 20-50 years for full recovery. A minimum of 10 years are needed to begin revegetation of grasses and the forest recovery could take decades. The *Coalition for the Upper South Platte River* is the management group assisting with the fire mitigation efforts necessary to restore damage from the Hayman burn. The coalition is extremely concerned about the water quality impact from fire area runoff and cooperates with the Authority. Additionally, the Denver Water Department is very concerned about the burn runoff dramatically affecting their key water supplies and cooperates with the Authority. Since the fire took place primarily on federal lands, federal land management agencies (e.g. Forest Service) are actively involved with mitigation. The U.S. Geological Survey has begun a limited water quality monitoring effort in the Upper South Platte Watershed near Cheeseman Reservoir.

Fire Recovery Uncertainty

Fire recovery literature in Colorado and for other western states shows considerable variability in duration of recovery, magnitude of the problem and predictability of impacts from burn areas. A burn area the size of the Hayman burn will generate considerable amounts of erosion products even with best mitigation efforts until revegetation has stabilized the area. This long-term erosional potential generates uncertainty about sediment, nutrient and metal loading to downstream waterbodies. Chatfield data and fire literature information shows a clear nutrient-loading problem associated with fire runoff. However, the data is variable and the magnitude of the loading is very difficult to predict. Already the downstream Chatfield Reservoir has exceeded the growing season total phosphorus standard in 2003 and 2004 with the drought influenced runoff remaining extremely low. Normal runoff in the South Platte River could a dramatic impact the reservoir quality; however, there is uncertainty on the magnitude of this impact. Preliminary water quality data predicts that there will be an impact.

Since many parts of the burn area experienced such high burn temperatures, the soil was sterilized and recovery of vegetation and supporting biota will take much longer than a typical fire. Some scientific experts estimate the recovery in the Hayman burn area to take many decades, while others have speculated that recovery of non-forest habitat is more variable. There is no good indication that the South Platte River runoff will return to the same quality as pre-fire conditions in a near-term. Literature information suggests the water quality could be altered for the long-term. Consequently, the fire runoff and increased loading from the South Platte River could affect the total maximum annual load distributions.

The wasteload allocation assigns 17,930 pounds of total phosphorus to the Upper South Platte Watershed with 6,000 pounds as the base-load reaching the reservoir after upstream water diversions. The South Platte River inflow into Chatfield Reservoir as estimated by the Chatfield Authority in 2004 was 47,000 acre-feet, which is about 17% of the “normal” condition identified in the control regulation. The measured load from the South Platte River in 2004 was 3,787 pounds total phosphorus, which is over the assigned allocation. The 2004 total phosphorus load to the reservoir was 7,800 pound of total phosphorus, which is slightly below the TMAL limit. Table 6 summarizes the growing season nutrient concentrations by watershed. The total phosphorus loading in the South Platte River has increased since the Hayman Wildfire. Although 2004 inflow into Chatfield Reservoir was substantial below normal, the flow-based loading was significantly increased as a direct result of runoff from the Upper South Platte Watershed.

Table 4 2004 Growing Season Nutrients and Fire Runoff Affect

2004 Growing Season				
	South Platte Inflow	South Platte Outflow	Plum Creek	Reservoir Average
Nitrate/Nitrite as N, dissolve (ug/l)				Total Nitrogen (mg/l)
July	181	156	278	1052
August	256	49	907	723
September	198	21	752	493
Phosphorus, ortho total (ug/l)				
July	8.8	6	50	7
August	16	6	53	10
September	15	5	101	6
Phosphorus, total (mg/l)				
July	47	34	144	37
August	160	37	36	47
September	30	23	234	28
2004 Season	79	31	138	37
2003 Season	63	442	51	38
2002 Season	25	23	38	23

Correlation Between Phosphorus and Chlorophyll

An underlying assumption of the TMAL is that phosphorus and chlorophyll are significantly correlated. Figure 4 shows the relationship between chlorophyll and total phosphorus (as a linear regression) using Authority data records. The data correlation shows a poor linear fit, no polynomial fit or a log relationship. The data suggests phosphorus and chlorophyll are not

significantly correlated. The target for chlorophyll in the reservoir during the growing season is 17 ug/l, which is the maximum allowable level that will still protect all of the reservoir’s assigned beneficial uses (e.g., aquatic life and water supply). The Chatfield Authority asserts that the chlorophyll- target of 17 ug/l is appropriate and reasonable for the reservoir. Consequently, total phosphorus loading needs to be managed in order to not exceed the chlorophyll target.

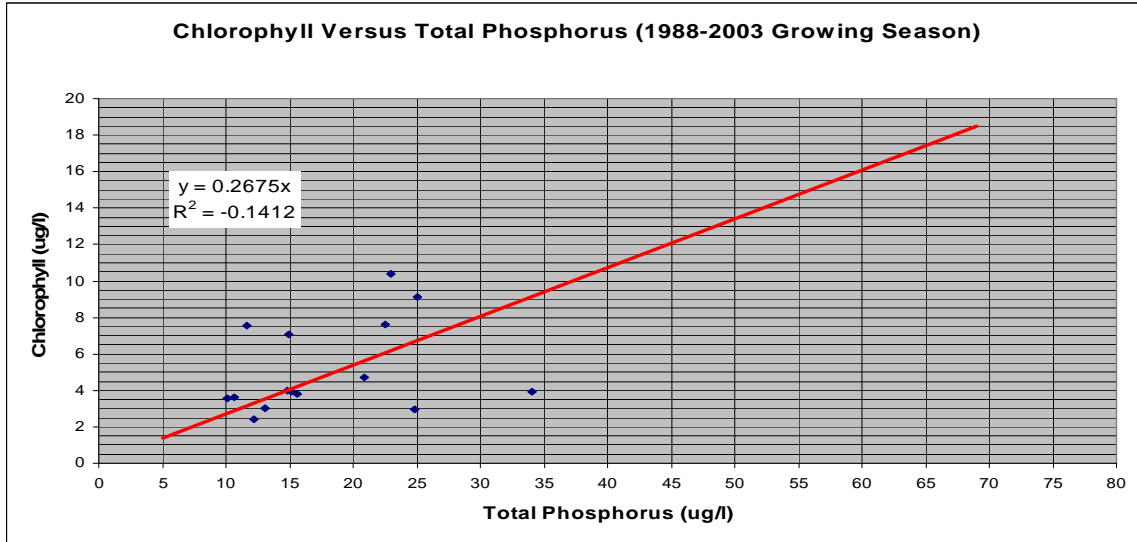


Figure 4 Growing Season Correlation Between Phosphorus and Chlorophyll Supplemental Monitoring Program

The Chatfield Authority continues to seek funding to support a special monitoring program and obtain supplemental water quality data:

- 1) Characterize burn area water quality runoff impacts on Chatfield Reservoir through the routine Authority monitoring program;
- 2) Document how changes to water quality relate to standards, beneficial uses and implementation of the total phosphorus TMAL;
- 3) Determine what adjustments are appropriate or recommended in management planning or as part of upstream mitigation plans by other agencies; and
- 4) Coordinate with upstream mitigation efforts by other agencies involved in fire mitigation with downstream management plans/ control efforts.

If funding becomes available, the Authority will document how standards, uses and implementation of total phosphorus TMDL are altered or affected by the Hayman Fire and associated impacts.

Chatfield Reservoir Storage Reallocation Project

Two proposals are pending before the Corps, which could modify storage and releases from Chatfield Reservoir. One proposal would allow water releases from the reservoir during

droughts, lowering the minimum pool. The second proposal would allow increased storage in Chatfield Reservoir, which could alter the detention time and releases. The Authority is coordinating with the Corps and proponents on water quality modeling to characterize resulting impacts, if any, to Chatfield water quality.

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Fact Sheet 2004 Series

This series of fact sheets describe compliance with the adopted control regulation, the watershed management activities, water quality-monitoring program and analytical results from the 2004 Chatfield Watershed Authority water quality-monitoring program. The fact sheets are grouped by categories:

- [Control Regulation \(Chatfield Reservoir Control Regulation #73\);](#)
- [Management;](#)
- [Nonpoint Source Management;](#)
- [Watershed Monitoring;](#)
- [Watershed Hydraulics;](#)
- [Watershed Trends; and](#)
- [Chatfield Reservoir.](#)

Fact sheets are individually available from the Authority manager. The Authority allows use of these fact sheets in other publications with notification to the Authority.

Authority Web Site: www.chatfieldwatershed.org

Fact Sheet # 1. Control Regulation: Total Maximum Annual Load (TMAL) & Total Phosphorus Distributions

Chatfield Reservoir Control Regulation #73 controls total phosphorus loading into and within Chatfield Reservoir from the Chatfield Watershed. Water quality modeling predicted the total phosphorus loading to Chatfield Reservoir. 59,000 pounds of total phosphorus assimilated with an inflow volume of 261,000 ac-ft per year would not exceed the water quality standard of 0.027 mg/l. The total phosphorus load from point sources is limited to 7,446 lbs/yr with 51,554 lbs/yr allocated to nonpoint and background sources.

The total maximum annual load (TMAL) distributions of total phosphorus by sources are based on the formula:

TMAL = Chatfield Watershed (reservoir base-load + background + wasteload allocation) + **Upper South Platte River Watershed** (reservoir base-load + background + wasteload allocation) + **Margin of Safety**

The reservoir base-load represents the average measured total phosphorus load reaching Chatfield Reservoir. An implied margin of safety incorporates error terms into the TMAL allocation of 59,000 pounds/year of phosphorus with an inflow volume of 261,000 acre-feet/year.

Continuous water quality monitoring is used by the Authority to confirm model predictions. The TMAL total phosphorus poundage is distributed among sources as follows:

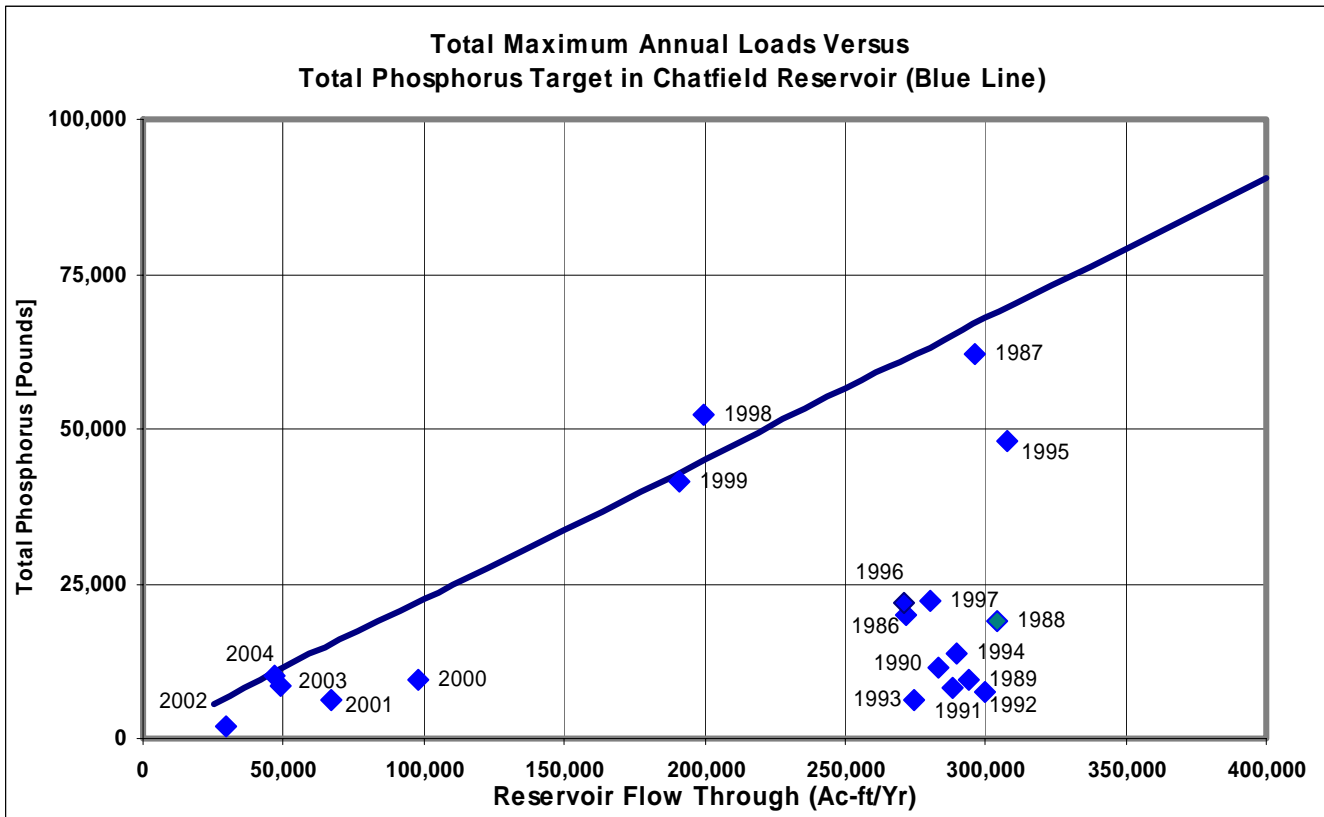
Allocation Distribution	Total Phosphorus Pounds/Year
Total Maximum Annual Load (TMAL)	59,000 @ 261,000 ac-ft/year
Chatfield Watershed	41,070
Reservoir Base-Load	13,400
Background	20,312
Wasteload Allocation (point sources)	7,358
Upper South Platte River Watershed	17,930
Reservoir Base-Load	6,000
Background	11,842
Summit County Wasteload Allocation	88

[Note - Loadings from the Upper South Platte River Watershed include all point sources upstream of the Strontia Springs Reservoir outfall, including 88 pounds of phosphorus per year from wastewater originating in Summit County and discharged directly into the Roberts Tunnel, and all nonpoint sources above the Strontia Springs Reservoir outfall.]

Fact Sheet # 2. Control Regulation: Total Maximum Annual Load Compliance

The total maximum phosphorus load to the reservoir is limited in the Chatfield Reservoir Control Regulation as a flow dependent function where 59,000 pounds of total input can occur at 261,000 acre-feet total inflow without causing a standard exceedence. On the graphic, the total maximum annual load (TMAL) target shows allowable total phosphorus load given different reservoir inflows. In low flow years, the total load assimilated in the reservoir decreases substantially. The predicted line on the graph reflects an implied margin of safety that protects the 17 ug/l chlorophyll growing-season goal based on error terms from the original model. This chlorophyll goal met in 19 years of continuous monitoring.

In 2004, the TMAL value of 7,800 total phosphorus pounds was below the compliance range based on an inflow of 46,800 acre-feet of water. There is not a good linear relationship between the Total Phosphorus TMAL and reservoir inflow as predicted from the original Clean Lakes Study. The Authority will continue monitoring the TMAL and investigating the relationships and assumptions as part of the annual monitoring program.



Reservoir Meets Standards and Goals

Chlorophyll a goal met 100% of monitored years

Annual Total Phosphorus load met 95% of monitored years

Fact Sheet # 3. Control Regulation: Total Phosphorus Effluent Limitations, Point Source Wasteload Allocations & 2004 Total Phosphorus Pounds Discharged From Treatment Plants in Chatfield Watershed

The allowed annual wasteload of point source phosphorus (among all permitted dischargers) in the Chatfield Watershed is limited to 7,358 lbs/year. In 2004, recorded total phosphorus discharges were 5,758.5 pounds/year or about 78% of the allowable total discharge poundage.

Facility	Wasteload Allocation Pounds Per Year	2004 Point- Source Total Pounds
Plum Creek Wastewater Authority	4,256	4559 ¹
Lockheed Martin Space Systems Company	1,005	200
Roxborough Park Metro District	1,168	833
Perry Park Water & San. District-Waucondah	365	155
Perry Park Water & San. District-Sageport	73	0 ²
Town of Larkspur	231	No Report
Louviers Mutual Service Company	122	11.5 ³
Sacred Heart Retreat	(15) ⁴	No Monitoring
Ponderosa Center	(75) ⁵	ND ⁶
Jackson Creek Metropolitan District	(50) ⁷	ND ⁶
Centennial Law Enforcement Foundation	(50) ⁸	ND ⁶
Reserve/Emergency Pool	73	
Total Point Source Phosphorus Wasteload	7,358	5,758.5

1. Trade agreement with Lockheed Martin for 450 pounds in 2004 (temporary allocation of 4,706 pounds; Lockheed Martin temporary allocation 555 pounds)
2. Dry Monitoring Lysimeters, assume land application at agronomic rates
3. May and December only discharge from wastewater lagoons
4. The Authority & Water Quality Control Division recommend a temporary five-year phosphorus allocation of 15 pounds for inclusion in discharge permit; obtained from the Reserve/Emergency Pool
5. The Authority recommends a 75-pound allocation for a new Ponderosa Center treatment plant; allocation established by trade agreement (Site Approval Complete)
6. ND - No Data, Monitoring Program Not Established by Permit
7. Authority recommends inclusion of plant in management plan and a wasteload allocation. Jackson Creek has a transfer of 50 pounds from Roxborough Park.
8. The Centennial Law Enforcement Training Foundation approved wastewater utility plan includes a 50-pound allocation; allocation established by trade agreement (Site Approval Complete).

Point Sources limited to wastewater treatment plants sited within the Chatfield Watershed. The Chatfield Control Regulation does not cover treatment plants in the upper portion (upstream of Strontia Reservoir) of the South Platte River.

Fact Sheet # 4. Control Regulation: Chatfield Authority Trading Program

TRANSFERS

The Chatfield Watershed Authority may approve transfers of all or part of one point source discharger's total phosphorus allocation to another point source wastewater discharger.

The *Chatfield Reservoir Control Regulation* authorizes trading for point-to-point source trades and point-to-nonpoint source trades. The trading program allows point source dischargers to receive phosphorus pounds for new or increased phosphorus wasteload allocations in exchange for phosphorus loading reductions from nonpoint sources. The trading program allows trades that have a net water quality benefit in the watershed. The trading program and adopted trade guidelines provide for Authority trade pools or in-kind trades. Point sources can use four mechanisms to obtain additional phosphorus wasteload allocations:

- Nonpoint source to point source trades (Proposed Jackson Creek Ranch; Permitted Ponderosa Retreat Center and Law Enforcement Foundation).
- Point source to point source transfers (Approved transfer from Roxborough Park for Jackson Creek Ranch).
- Alternative treatment arrangements for phosphorus reductions (Application of effluent at agronomic rates – Larkspur).
- Reserve/emergency pool allocations (Ponderosa Retreat Center and Sacred Heart Retreat).

All Authority approvals of trade credits and alternative arrangements are subject to review and confirmation by the Water Quality Control Division. Approval of trades by the Authority with acceptance by the Division allows trade ratios for nonpoint-point source trades that are less than 2:1, on a site-specific basis, if such a lower ratio is substantiated by greater nonpoint source phosphorus removals.

DISCHARGE PERMIT

Trade credits shall be incorporated into discharge permits by the Water Quality Control Division, as appropriate, and incorporated as proposed amendments to the phosphorus allocation at the next triennial review or rulemaking hearing for this regulation.

Trade Credit Regulations

TRADE RATIO

The amount of point source trade credit shall be based upon one pound of credit for two pounds of nonpoint source reduction, unless water quality data substantiates greater phosphorus removals, in which case one pound of trade credit may be established by fewer than two pounds of nonpoint source reduction, on a site-specific basis.

No municipal, domestic, or industrial wastewater discharge in the Chatfield Watershed can exceed 1.0 mg/l total phosphorus as a 30-day average concentration, except as provided under trading provisions. A wastewater treatment facility can adjust operations for periods sufficient to meet the annual phosphorus poundage allocation by producing effluent

total phosphorus concentrations below 1.0 mg/l. Point source dischargers may apply to the Chatfield Watershed Authority for phosphorus trade credits, which would allow corresponding increases to a discharger's total phosphorus wasteload allocation. Phosphorus trade credits for point sources are based upon reductions of phosphorus from nonpoint sources.

Fact Sheet # 5. Control Regulation: Special Review of Nonpoint Assumptions Adopted In The Chatfield Reservoir Control Regulation

The Chatfield Authority in cooperation with the Water Quality Control Division (Division) and the Coalition for the Upper South Platte (CUSP) reviewed nonpoint source load assumptions as summarized in the Control Regulation with an independent contractor, and interested parties. The review process did not alter the existing wasteload allocations, but rather evaluated the validity of nonpoint source load assumptions used to allocate total phosphorus between the Chatfield and Upper South Platte River Watersheds.

The TMAL developed nonpoint load allocation from a ten-year running average of water quality data that for Chatfield and Upper South Platte River Watersheds. The averaging period for the load assumptions used in the Control Regulation was from a wet period of record. Since 2000, the watersheds experienced continued drought conditions. This has resulted in the lowest recorded inflow record for Chatfield Reservoir. The Chatfield Authority, CUSP, and Division received 319 grant funding to evaluate the equities between the Upper South Platte and Plum Creek allocations.



The two goals of the special study are:

1. Review the nonpoint source and total maximum annual phosphorus load allocation assumptions incorporated into the Chatfield Reservoir Control Regulation # 73 as requested by the Water Quality Control Commission in the 1999 triennial review of the control regulation;
2. Independently certify assumptions and nonpoint source load allocations assigned to the Chatfield and Upper South Platte River source watersheds.

This review process requires evaluation of the original assumptions used to establish the TMAL using the Woodward Clyde Report (1992), water quality data of the Authority, the control regulation, original Clean Lakes Study and information provided by the Authority, WQCD and CUSP. The findings of the special study will be incorporated into the Chatfield Authority 2005 annual report.

Fact Sheet # 6. Control Regulation: Underlying Watershed Total Phosphorus Annual Allocation Assumptions

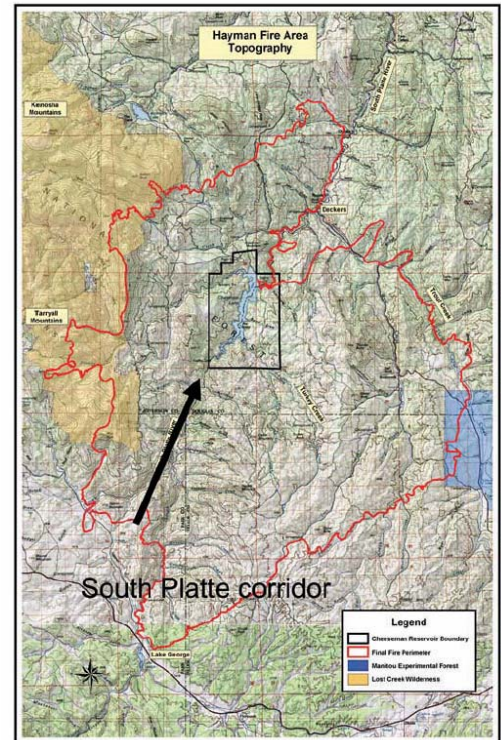
The Chatfield Watershed Authority assessed a variety of factors for the allocation of phosphorus between the Upper South Platte River Watershed and Chatfield Watersheds. This analysis split the total phosphorus wasteload allocation based on the 59,000 pounds allowable at 261,000 acre-feet per year resulting in 41,070 pounds assigned to the Chatfield Watershed and 17,930 assigned to the Upper South Platte River Watershed. As annual flow changes (either more or less flow), the ratio of allocated pounds shifts accordingly. The minimum annual flow assumed for this sub-allocation process was 50,000 acre-feet per year. In 2002-2004, the annual inflow into Chatfield Reservoir was below this threshold.

Factor	South Platte River Watershed	Chatfield Watershed	Importance of Factor
Watershed			
1. Total Area	70 %	30 %	Low
2. Average Flow Into Reservoir	63 %	37 %	Medium
3. Measured Total Phosphorus Base-load (14-year record)	30 %	70 %	Very High
Selected Factors			
Estimated Percentage Split For Base-Flow and Background	35 %	65 %	
Selected Background Reserve	37%	63%	
Growth			
Growth & Development (20-year Predictions)	15 %	85 %	High
Economic and Political Concerns	Low	High	Medium
Water Quality and Regulation			
Phosphorus Regulated Wastewater Treatment Plants	No (note -88 pounds assigned to Summit County for wastewater discharge into Roberts Tunnel)	Yes	High
State Regulated - Chatfield Control Regulation	No	Yes	Watershed Constraint
Water Quality Concerns	No (note - Prior to Hayman Wildfire)	Yes	High
Nonpoint Source Problems Listed	Minimal in NPS Assessment report	High priority watershed	Medium
Available Infrastructure			
Existing Management Agency	No (Information Group)	Yes	Medium

Fact Sheet # 7. Management Issues: Hayman Fire Runoff Continues To Affect 2004 Downstream Growing Season Water Quality

The Hayman fire burned over 137,000 acres of Ponderosa Pine and Douglas Fir forest. This extremely hot fire vitrified soils and produced large tracts of impermeable surface with greatly increased runoff. The fire severely damaged 11 sixth level watersheds and threatens a major water supply for the Denver region. Over 188 miles of perennial streams and 182 miles of intermittent streams were impaired. Forest Service estimates suggest 10-25 years before recovery of low lying vegetation and forest recovery is decades away. The erosional potential from the runoff area is extreme and 2004 downstream water quality data shows five water quality parameters (nutrients and metals) that exceed historic data trends. Water quality data predict fire quality runoff and erosion runoff from the 2002 Hayman Wildland Fire could exceed numeric water quality standards for decades. The 2003 and 2004 growing season total phosphorus was 37 ug/l with the standard set at 27 ug/l. This standard exceedence is of great concern to the Authority. Consequently, water quality management programs currently in place to address other pollution problems are now jeopardized. The Authority continues to monitor both inflow and outflow water quality within Chatfield Reservoir in the hope that the effects will be attenuated and not as long lasting.

2004 Growing Season				
	South Platte Inflow	South Platte Outflow	Plum Creek	Reservoir Average
Nitrate/Nitrite as N, dissolve (ug/l)				Total Nitrogen (ug/l)
July	181	156	278	1052
August	256	49	907	723
September	198	21	752	493
Phosphorus, ortho total (ug/l)				
July	8.8	6	50	7
August	16	6	53	10
September	15	5	101	6
Phosphorus, total (ug/l)				
July	47	34	144	37
August	160	37	36	47
September	30	23	234	28
2004 Season	79	31	138	37
2003 Season	63	442	51	37
2002 Season	25	23	38	23



2002 Cheeseman Reservoir



Fact Sheet # 8. Management Issues: Control Regulation #38 Statement of Basis and Purpose Related to Hayman Fire Runoff Impact To Chatfield Reservoir

The Chatfield Watershed Authority submitted two alternative proposals for a temporary modification of water quality standards for total phosphorus and selected metals in Segments 6a and 6b of the South Platte River basin. The temporary modifications were in response to concerns over the potential effects of the runoff from the Hayman Wildland Fire. The runoff may contain increased levels of total phosphorus and metals, which impede attainment of water quality standards in the South Platte River system and Chatfield Reservoir. The Authority and the Water Quality Control Division concluded that additional monitoring data is required to establish a basis for temporary modifications and, if appropriate numeric values to adopt. The Authority withdrew its proposal and the Commission included the following language in the Statement of Basis and Purpose.

Cheeseman Reservoir and Burn Area



The point source and stormwater discharge permit holders in the Chatfield Watershed, which contribute a small percentage of the total phosphorus load to the reservoir, discharge regulated constituents, including phosphorus. These dischargers will continue treatment and best management practices so as to minimize nutrient and metal loads in the Chatfield Watershed. The Authority and Division have agreed that point source discharge permit holders and regulated stormwater permittees who are in compliance with their permit limits and terms for a constituent will not have those limits or terms modified prior to any future adjustment of classifications or standards by the Commission to the extent any observed water quality standards exceedances are attributable to other factors such as the Hayman Fire. However, the Authority has agreed to cooperate with the Division in the identification and promotion of enhanced stormwater control BMPs, which could be implemented on a voluntary basis prior to any such adjustment if warranted by monitoring conditions in the watershed.

Additional monitoring data will help the Authority and Division determine what, if any, long-term modifications may be necessary to the uses and water quality standards for Chatfield Reservoir.

Hayman Burn Area and Erosion



Fact Sheet # 9. Management: Chatfield Reservoir and State Park Recreation

Chatfield Reservoir



Chatfield Dam is one unit in the comprehensive plan for flood control located in Douglas and Jefferson Counties, Colorado, on the South Platte River, South Platte Basin.

Chatfield State Park has a reservoir for boating, fishing and water sports, trails for hiking, horseback riding and cycling, and even launch sites for hot-air balloons and model airplanes.

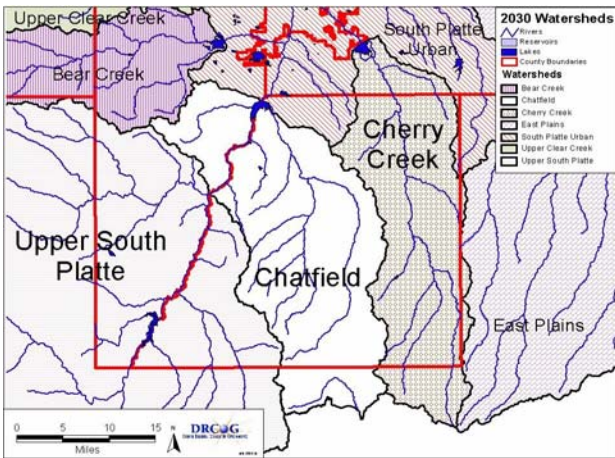
Top Walleye fishery. Spring and fall trout fishing is excellent. Bass, channel catfish, yellow perch and crappie caught in summer. Ice fishing occurs in the winter. Year-round fishing and seasonal boating are major recreational uses.



More than 300 species of birds observed in park. There is also a rookery to more than 80 pairs of great blue herons. The reservoir and park are important recreational and aquatic life amenities for the entire Denver Metropolitan region.

Fact Sheet # 10. Management: Active Participants in Watershed

Chatfield Reservoir receives drainage from the South Platte River Watershed in Jefferson and Park Counties. The Coalition for the Upper South Platte (CUSP) manages water quality in this Upper South Platte Watershed. Plum Creek drainage in Douglas County flows into Chatfield Reservoir. The northern portion of the Chatfield Watershed is in Jefferson County. The Town of Castle Rock is the largest community in the watershed and it overlaps between Chatfield and Cherry Creek Watersheds. The Cherry Creek Watershed bounds Chatfield on the east. Wastewater flows are pumped into the Chatfield Watershed from the Cherry Creek Watershed, which makes the two authorities co-management agencies for certain wastewater utility plans. The members and participants in the Authority are listed below.



Towns & Communities	Counties	Special Districts	Industry & Agencies	Church Camps & Special Interest
City of Littleton	Jefferson	Plum Creek Wastewater Authority	Lockheed Martin Space Systems Company	Ponderosa Retreat & Recreation Center
Town of Castle Rock	Douglas	Castle Pines Metro District	Denver Water Department	Sacred Heart Retreat
Town of Larkspur		Centennial Water & Sanitation District	U.S. Army Corp of Engineers	Highlands Law Enforcement Foundation
		Louviers Mutual Service Company	Tri-County Health Department	
		Roxborough Park Metro District	Water Quality Control Division	
		Jackson Creek Ranch Metro District		
		Perry Park Water & Sanitation District		

Fact Sheet # 11. Management: 2004 Wastewater Activities

Treatment Plants

- Highlands Ranch Law Enforcement Training Foundation
 - ✓ Trade Agreement
 - ✓ Site Application
 - ✓ Approved Wastewater Utility plan
- Ponderosa Retreat Center
 - ✓ Revised site application
 - ✓ Trade Agreement
- Plum Creek Metropolitan District utility plan
 - ✓ Lift Station amendments for Castle Rock
 - ✓ Plum Creek Treatment Plant expansion completed
- Louviers Mutual Service Company Treatment Plant Planning
- Perry Park – Sageport Plant Review



Lift Stations

- Eastern Water Treatment Plant (EWTP) Lift Station
- Meadow Filing Lift Station
- Updated Review Policy

Review Process and Policies

- Wastewater Service Planning for Titan Road
- Roxborough Park & Lockheed Martin wastewater management strategies (Fact Sheet #16)
- Wastewater Utility Plan Review Team and Submittal Requirements For Chatfield Technical Review Committee and Authority Board Actions
- Chatfield Reservoir Reallocation Environmental Impact Scoping
- River Canyon Development and Wastewater Service Options
- Updated Data Management Protocols
- Update Quality Assurance Plan & Sampling Protocols; Revised Monitoring Program
- New Legal Expense Policy
- New Cost of Utility Plan Review Policy
- Reviewed Nonpoint Source Practices And Stormwater Management Role With Counties
- The Chatfield Watershed Authority strongly supports the beneficial use of reclaimed water for irrigation applications within the Chatfield Watershed
- Initiated Special Study To Review Assumptions In Control Regulation (Wasteload Allocation Assumptions)



Fact Sheet # 12. Management: Plum Creek Wastewater Authority Plant Expansion Completed

Treatment Plant Expansion

Beginning late summer of 2002, the Plum Creek Wastewater Authority started construction on a \$30 million expansion of their advanced wastewater treatment facility with a phased wastewater discharge capacity of 4.9 million gallons per day (MGD) to 10.7 MGD.

New Treatment Plant Constructed



Plum Creek Wastewater Authority is currently finishing its Phase IA expansion, with a capacity of 4.9 million gallons per day (MGD). The new plant consists of two biological nutrient removal oxidation ditches, secondary clarification, cloth media filtration and ultraviolet disinfection, as well as additional sludge dewatering facilities and an ionization odor control system. Phase IB includes outfitting a third oxidation ditch and clarifier, resulting in a 7.3 MGD capacity. Phase II is projected for startup in 2011, and will include the addition of primary clarification and anaerobic digestion, with a capacity of 10.7 MGD.



Preliminary treatment expanded with the addition of two screw pumps for a total of four, a second grit chamber and a second bar screen. The oxidation ditches operate for biological phosphorous, nitrogen and biological oxygen demand removal. Biological nutrient removal facilitated by the use of anaerobic, anoxic, and aerated zones in order to manipulate the growth and activity of phosphorous accumulating bacteria and to nitrify and denitrify. Anaerobic selectors located at the head of each ditch insure volatile fatty acid uptake and phosphorous release by phosphorous accumulating organisms. Automated blower control used to maintain constant dissolved oxygen levels in the aerated zones of the ditches. This insures sufficient dissolved oxygen for phosphorous uptake, nitrification and biological oxygen demand oxidation, while preventing oxygen from bleeding into anoxic zones, thereby inhibiting denitrification. Each ditch dedicated to a clarifier. Return activated sludge rates are based on percentage of influent flow and clarifier performance; while pumps that run in preset on/off cycles obtain wasting. Cloth media filters remove any residual solids prior to ultraviolet disinfection and discharge to East Plum Creek.



PCWA supplies several golf courses with irrigation water. The addition of a course in the Cherry Creek Basin requires stringent effluent phosphorous limits. The plant's design parameter for phosphorous was 0.23 mg/L. A combination of

biological phosphorous removal, alum addition, and cloth media filtration has made achieving this effluent concentration possible.



Fact Sheet # 13. Management: Chatfield Watershed Authority 5-Year Funding Plan

The Authority maintains a management program through funding provided by annual dues from Authority members and contributing participants. The Authority faces severe resource constraints and must justify all expenditures to associated member governments and special district boards. Consequently, the Authority maintains a five-year funding schedule as a financial management tool. The program identifies those annual work elements necessary for a base program and then allocates some limited resources to other needed projects.

The 2004 annual dues collected from members and contributing participants with interest payments are about \$112,000. The decision by any member not to participate will create a revenue shortfall and limit activities. The Authority has attempted to keep funding levels constant, so annual spending does not to exceed \$118,500 by 2008. The Authority membership does recognize that this funding level is not sufficient to accomplish all of the monitoring and management work elements needed within the watershed.

Massey Draw



Beginning in 2004, the Authority devoted financial resources for development and construction of water quality improvement projects. Funding limits placed on the water quality monitoring and administrative programs in future years.

Program Work Element	Actual		Proposed			
	2003	2004	2005	2006	2007	2008
Base Program						
Water Quality Monitoring Program	52,000	52,000	52,000	53,000	54,000	55,000
Administration & Program Management	38,000	38,000	38,000	38,000	38,000	38,000
Audit and Legal (Minimum)	6,500	6,500	6,500	6,500	6,500	6,500
Water Quality Control Commission - Triennial Review & Rulemaking	0	5,000	5,000	0	0	5,000
Sub-Total	96,500	101,500	101,500	97,500	98,500	104,500
Special Projects, Programs and Contingency						
Special Projects & Education*	5,000	5,000	5,000	10,000	10,000	10,000
Contingency	5,500	5,500	5,500	6,000	6,000	6,000
Sub-Total	10,500	10,500	10,500	16,000	16,000	14,000
TOTAL ANNUAL FUNDING	107,000	112,000	112,000	113,500	114,500	118,500

* The Authority will apply for various grants and use cash for leveraging funding of these projects. The Authority will pursue nonpoint source 319 water quality projects designed to reduce total phosphorus loading in the watershed and provide necessary education and information exchange to citizens and agencies. Special projects will address water quality impacts from wildland fire burn runoff and other erosion problems within the watershed.

Fact Sheet # 14. Management: Costs of Chatfield Reservoir Program

Chatfield Authority Started = 1984

Continuous Monitoring Record = 1982-2004

Sampling Sites

- 28 total stream and reservoir monitoring sites
- 4 long-term permanent sites
 - ✓ South Platte River Above Reservoir at Waterton
 - ✓ Chatfield Reservoir
 - ✓ Plum Creek at Titan Road
 - ✓ South Platte River Below Reservoir
- 60 watershed field screening sample sites

Algal Growth in South Platte River



Sample Frequency

- Monthly Samples in January, February, March, April, May, November, December
- Bi-monthly Growing Season Samples in June, July, August, September, October

Quality Assurance Plan (QAPP/SAP/SOP) – Approved January 2003; annually reviewed

Plum Creek Above Reservoir

Other Associated Costs

- \$100,000 Clean Lake Study
- Special Studies >\$300,000
- Total water quality data record \$1.75 million
- Necessary Wastewater Treatment Plant Upgrades > \$55.5 million



Cost Assumptions:

- Member & Participants Dues
- Lake Users Provide No Financial Support
- Apply For Grants

Fuel Operations At Reservoir

Minimum Annual Program Cost Estimates:

Sampling and Analytical Costs	\$ 52,500
Data Management Costs	\$ 38,000
Other (Project, Legal, Tabor)	\$ 19,500

Total Costs	\$ 110,000



Fact Sheet # 15. Management: 2004 Authority Activities

Plum Creek At Titan Road



The Chatfield Watershed Authority implements a water quality planning and implementation program for Chatfield Watershed. The 2004 management program addressed a number of complex water quality, fire runoff impacts, wastewater planning and management and watershed protection implementation issues that were driven by both internal (e.g., increased nutrient loading to the reservoir from storms, fire runoff, drought and growth

issues) and external processes (e.g., proposed changes to state water quality regulations). The Authority is responsible for water quality management only within the Chatfield Watershed. Yet, over 70% of the inflow volume reaching the reservoir on an annual basis derives from the South Platte River and the South Platte River Watershed.



Reservoir At Low Pool Volume

The 2004 management program issues and activities included:

Plum Creek Above Reservoir



- 1) Development project reviews and comments, including activities at the reservoir and community development; the Authority is an active referral agency for counties;
- 2) Wastewater utility planning activities associated with Plum Creek Wastewater Authority, Town of Castle Rock, City of Littleton, Centennial Water and Sanitation District, Law Enforcement Foundation, Ponderosa Center, Lockheed Martin, Roxborough Park, Perry Park and Louviers;
- 3) Wastewater planning for Highland Ranch Law Enforcement training facility new treatment plant;

- 4) Established Authority Web Site;
- 5) Involved in 319 nonpoint source project proposal for Massey Draw and continued water quality monitoring effort for dry and wet weather events;
- 6) Members addressing stormwater runoff programs;
- 7) Involvement of state agencies and relation to parks and recreation;
- 8) Links with programs & activities (e.g., open space planning & *Preble Meadow Jumping Mouse*);
- 9) Reviewed monitoring program to provide essential data and address up stream loading concerns and improve the efficiency of the monitoring program;
- 10) Addressing drought and fire management implications (Hayman burn area) and impacts to standards and uses; and
- 11) Roxborough Park, Lockheed Martin and City of Littleton wastewater pipeline project planning.

Fact Sheet # 16. Management: Consolidation Of Roxborough Park Metropolitan District and Lockheed Martin Space Systems Company Wastewater Discharges

In March 2003, the local and regional authorities approved a significant consolidation and regionalization of wastewater facilities — the transmission of wastewater from Roxborough Park Metropolitan District (“Roxborough”) and Lockheed Martin Space Systems Company (“Lockheed”) to the Littleton Englewood Wastewater Treatment Plant (WWTP).

South Platte River Above Reservoir



Chatfield Reservoir With Outlet Structure



The Authority reviewed plans by Roxborough and Lockheed to combine and transmit by pipeline their wastewater flows for treatment at the Littleton Englewood wastewater treatment plant. Authority actions during this four-year planning process promote and support this wastewater consolidation project. The Authority anticipates this project will result in a net improvement in water quality within

Chatfield Reservoir. Additionally, the project is a cost effective alternative to upgrading the existing treatment plants.

The Authority continues to track implementation by Roxborough and Lockheed regarding their intent to combine wastewater flows for treatment at the Littleton Englewood wastewater plant. The Littleton Englewood wastewater treatment plant has included the proposed pipeline in their wastewater utility plan. Lockheed’s wastewater treatment plant will still retain treatment of groundwater.



Fact Sheet # 17. **Management: Jefferson & Douglas County Stormwater Programs**



Jefferson County stormwater permit activities

- Applied for and received coverage under the General Permit for Stormwater Discharges Associated with Municipal Separate Storm Sewer Systems
 - Prepared a 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
- Jefferson County provides opportunities for residents and visitors to learn and be involved in environmental stewardship.



Douglas County Stormwater management

East Plum Creek Near Castle Rock

- Douglas County has a permitting program for grading, erosion, and sediment control on public and private construction projects within unincorporated limits of the County.
- Douglas County meets Stormwater Phase II permitting requirements set forth by the Water Quality Control Division.
- The county has a new Grading, Erosion and Sediment Control (GESC) Criteria Manual to promote environmentally-sound county construction practices
- The Douglas County Storm drainage design and technical criteria manual, used for design, inspection and enforcement of stormwater systems, have updates to include provisions for water quality systems.
- Douglas County Floodplain Management Department issues floodplain development permits.



Fact Sheet # 18. Management: Reduction in Phosphorus Loading Through Erosion Controls at the Lockheed Martin Waterton Facility

Lockheed Martin Site

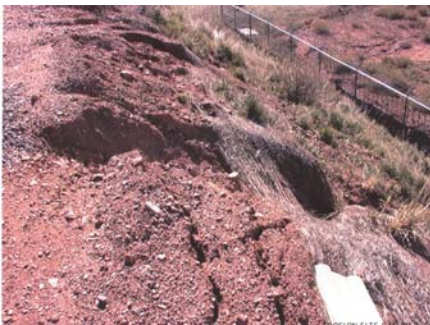


Erosion is a continuing concern at the Lockheed Martin Space Systems Company Waterton Facility because of the topography, erosive soils, and impervious roadways and parking areas. Erosion is a potential source of phosphorus and sediment loading to waterways that are tributary to the Chatfield Reservoir. Using best management practices (BMPs) to prevent erosion and remediate eroded areas is part of the stormwater management plan required by Lockheed Martin's CDPS Stormwater Permit.

In order to prevent erosion, Lockheed Martin developed an erosion control manual that discusses causes of erosion and recommends BMPs to be implemented during design and construction. BMPs include temporary measures to be implemented during construction activities, and permanent features to ensure proper drainage and dispersal of stormwater. To prevent erosion from snow plowing operations, Lockheed Martin has constructed structures where snow is piled and allowed to melt. These areas allow the road sand to drop out of the snow for collection and removal.



Lockheed Martin uses a systematic approach to permanently remediate eroded areas including:



- Maintaining a budget for erosion control
- Formal and informal inspections to locate eroded areas
- Identification of root causes of erosion



- Engineering solutions to remediate areas and prevent further erosion

Lockheed Martin implementation of erosion controls reduces potential on-site annual phosphorus loading by more than 340 lbs/year.



Fact Sheet # 19. Management: City of Littleton Stormwater In Trailmark Subdivision

The City of Littleton requires a comprehensive stormwater management system for the Trailmark Subdivision west of Chatfield Reservoir. This stormwater management system protects the Chatfield Nature Preserve operated by the Denver Botanical Gardens south of the project. These stormwater structures help reduce over 200 pounds of total phosphorus from reaching the Chatfield Reservoir on an annual basis.

Retention & Water Quality Ponds; Detention Ponds; Wetlands; Outlet Site



Fact Sheet # 20. Nonpoint Source Management: Program & Priorities

The *Chatfield Reservoir Control Regulation* requires the Authority to develop and maintain a nonpoint source control strategy (*Long-range Nonpoint Source Strategies and Priorities: 1998-2020*, Chatfield Watershed Authority, June 8, 1998). The Authority cooperates with counties, municipalities, special districts, corporations, proprietorships, agencies, or other entities with responsibility for activities or facilities that cause or could reasonably be expected to cause nonpoint source pollution of waters.

The *Nonpoint Source Management Plan for Chatfield Reservoir, Colorado* (Woodward-Clyde 1992) divides the watershed into 30 drainage areas. For each drainage basin, total phosphorus loads were developed for base-load, point source and stormwater runoff conditions. The Authority reviews sediment and erosion control ordinances of general-purpose governments. The Authority reviews major development activities that have a potential to cause sediment or erosion problems and maintains an erosion workgroup to address sediment and erosion control issues. Nonpoint source activities and specific planning elements involving the Authority are listed below.

Program Elements	Activity
<i>Planning</i>	
Jefferson & Douglas County erosion control programs	Local
Jefferson & Douglas County, City of Littleton, Town of Castle Rock stormwater management and permit program	Permit
Base Maps - update informational maps	Available
Drainage system prioritization	Local
Local BMPs - Identify preferred local BMPs	Local
Evaluate land cover and water quality Linkages	Continuing
Evaluate Reservoir Phosphorus Standard	Control Regulation
Total Maximum Daily Load Screening	Control Regulation
<i>Structural Best Management Practices</i>	
Establish a regional water quality detention facility	
Establish regional detention/retention facility	Castle Rock Roxborough Park
Establish project specific detention/ retention basins	Lockheed Martin
Establish a nutrient tracking demonstration project	Massey Draw
Establish a stream bank restoration program	Massey Draw
Establish a riparian corridor restoration program	Douglas County
New highway and construction practices	Douglas County
Prioritize a stream channel modification program, Massey Draw erosion control and phosphorus reduction project	Lockheed Martin, Jefferson County
<i>Nonstructural Best Management Practices</i>	
Recommend sediment & erosion control ordinances	Available
Develop a customized BMPs manual or handouts	Available
Maintain specific loading targets for developments	Available
Support sediment and erosion control inspection staff	Continuing
Develop & implement water quality education efforts	Continuing

Fact Sheet # 21. Nonpoint Source Management: Projects & Activities

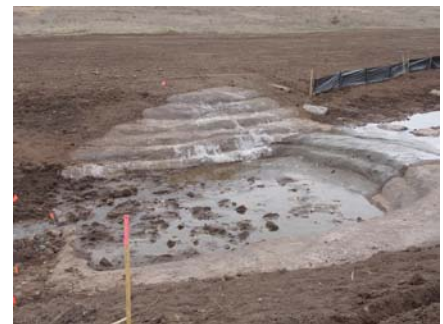
The Chatfield Watershed Authority cooperates with counties, municipalities, special districts, corporations, proprietorships, agencies, or other entities with responsibility for activities or facilities that reduce or potentially reduce the total nonpoint source phosphorus load in the watershed.

Lockheed Martin - During the period 1999-2004 Lockheed Martin completed a number of erosion control/sediment reduction projects. The projects reduce non-point phosphorus loadings by at least 340 lbs/year. Additional non-point phosphorus reductions are anticipated as additional projects are completed in the near future.

Castle Rock - Castle Rock has runoff detention systems that reduce the amount of nonpoint source total phosphorus reaching adjacent waters. The Authority is working with Castle Rock to help document the effectiveness of their detention systems.

Massey Draw

Massey Draw Project - This active project (completion in 2005) provides streambank stabilization and wetlands for a lower portion of Massey Draw that experiences severe erosion with deposition of sediment reaching Chatfield Reservoir. An estimated 2,400 annual pounds of nonpoint source phosphorus can be kept out of the reservoir. The Authority is cooperating with Lockheed Martin, Jefferson County, U.S. Army Corp of Engineers, City of Lakewood and the Urban Drainage and Flood Control District on project. The Authority monitors water quality.



Roxborough Park - Roxborough Park has a runoff detention system that reduces the amount of nonpoint source total phosphorus reaching adjacent waters. The Authority works with Roxborough Park to help document the effectiveness of the detention system.

Jefferson County - Jefferson County maintains an erosion and sediment control program. The county maintains a small-site erosion control manual that explains the basic principles of erosion control and illustrates techniques to control sediment from small development sites.

Douglas County - Douglas County maintains an erosion control program. The county is updating their Erosion Control Manual and Drainage Criteria Manual to provide greater emphasis on water quality. While the county has not determined the total phosphorus poundage reduction from the county erosion control program, the program has clearly reduced nonpoint source phosphorus loads. The county is involved with the fire recovery activities associated with the Hayman burn.

City of Littleton - The City of Littleton project in the watershed is within the Chatfield Green development, marketed as the Trailmark Subdivision. Several detention ponds and wetland areas were constructed over the past 10 years. The goal of these systems is to reduce the total phosphorus load in runoff by 45-50%. The estimated stormwater detention system reduction of nonpoint phosphorus load was over 200 pounds in 2004.

Fact Sheet # 22. Nonpoint Source Management: Sources In Chatfield State Park

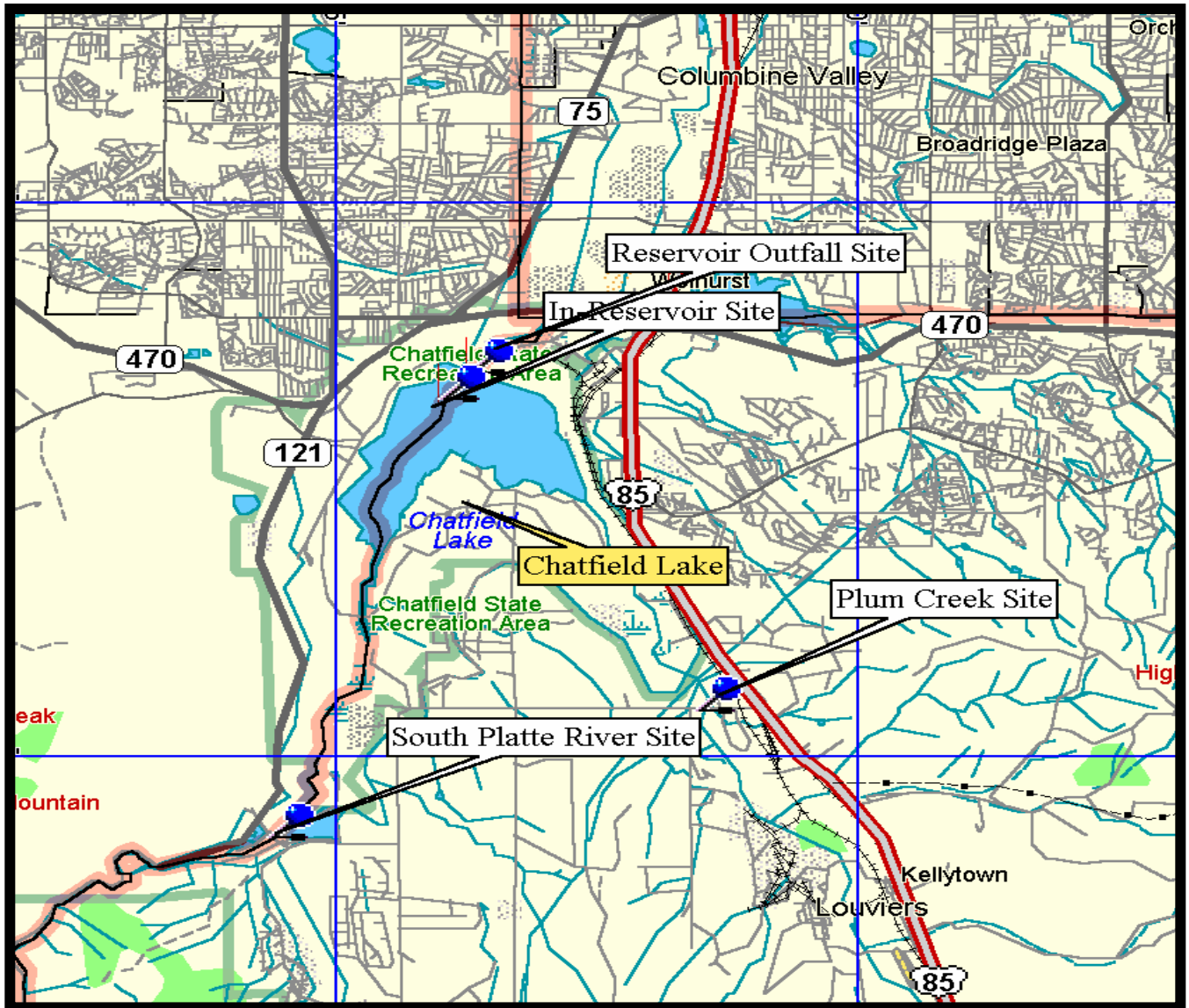
Direct and indirect discharge of pollutants from a variety of nonpoint sources occurs within Chatfield State Park. Potential pollutant types include sediment erosion (sloughing of steep shorelines, construction activities and drainage channel erosion), trash, floatables and debris (in Park, shoreline and within water column), petroleum products (gas, oil and grease), paint and associated dock and boat products; excess nutrient loading (wildlife, possible septage tank leaks), and atmospheric deposition.



Fact Sheet # 23. Watershed Monitoring: Sampling Sites and Parameters

The water quality-monitoring program samples selected parameters at reservoir inflow (South Platte River and Plum Creek) and reservoir output (South Platte River) stations and within Chatfield Reservoir.

- Field parameters (temperature, pH, specific conductance, dissolved oxygen, instantaneous flow, and Secchi depth)
- Miscellaneous analyses (total suspended sediments, E. coli, and total organic carbon)
- Nutrient analyses (phosphorous and nitrogen species)
- Biological analyses (chlorophyll-a, phytoplankton, and zooplankton)
- Metals analyses (16 metals including hardness)

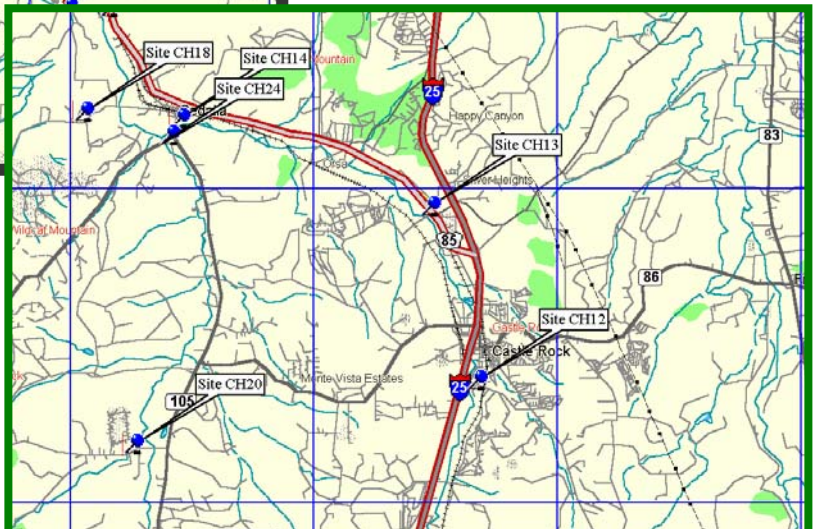
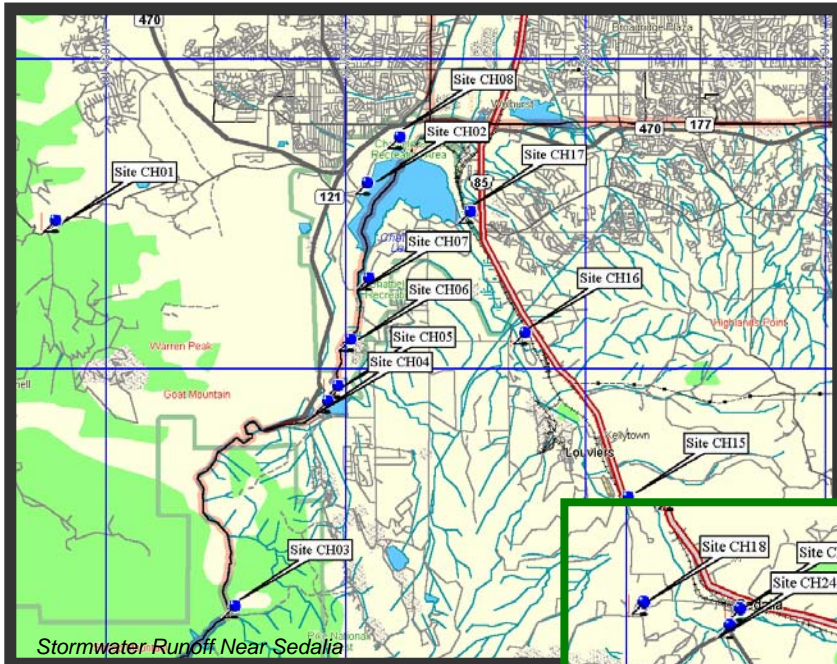


Fact Sheet # 24. Watershed Monitoring: Nutrient Screening Survey Potential Projects

Selected field nutrient screening surveys of small tributaries and drainages previously performed at 24 locations in the watershed to establish a watershed baseline. Nitrate and phosphorous were target parameters. These surveys indicate substantial background levels of nutrients are measurable in the watershed. This data will assist the Authority in identifying potential sites for nutrient reduction projects.

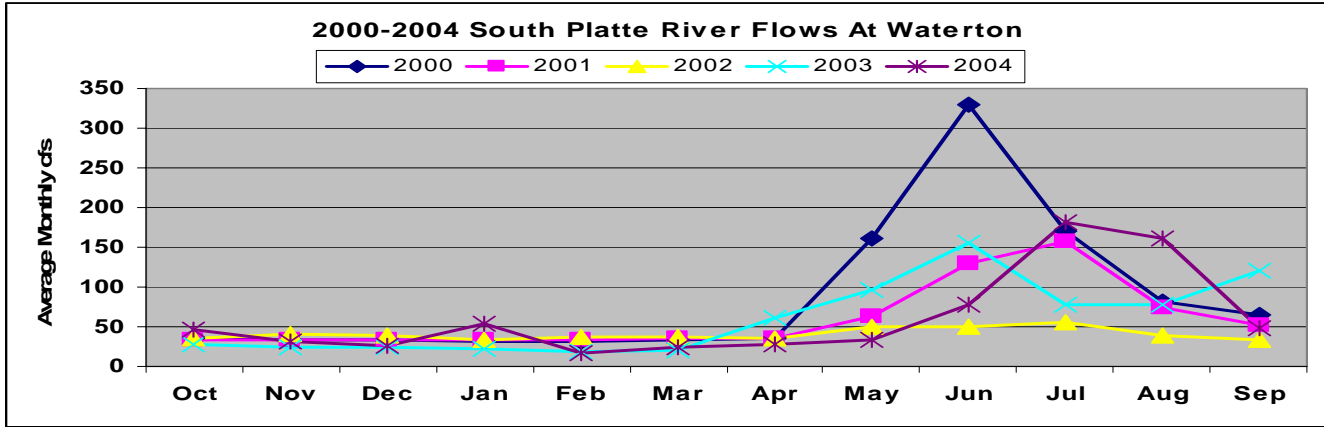
Nutrient load potential

- Elevated concentrations of nitrogen and phosphorus at many upstream sites and tributaries
- Maximum nitrate-nitrogen 5 mg/l
- Maximum phosphorus 4.3 mg/l
- Elevated nutrient loading associated with runoff events
- Tributary nutrients are higher than mainstem concentrations
- Erosion control practices can reduce nutrient loading in watershed

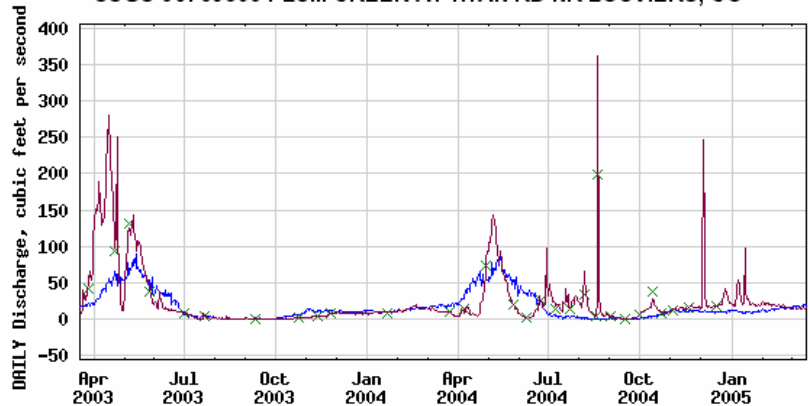


Fact Sheet # 25. Watershed Hydraulics: USGS 2004 Flow Trends at Gauged Sites

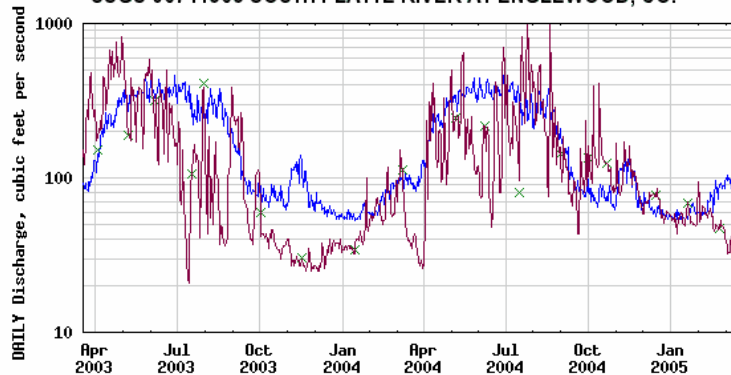
The 2004 USGS flows (red line) in the South Platte River were near or below the median daily streamflow (blue line). Flows in the South Platte River remain below normal as seen in the Denver Water Department Waterton flows. Plum Creek was near normal with several storm runoff events (red line).



USGS 06709530 PLUM CREEK AT TITAN RD NR LOUVIERS, CO



USGS 06711565 SOUTH PLATTE RIVER AT ENGLEWOOD, CO.



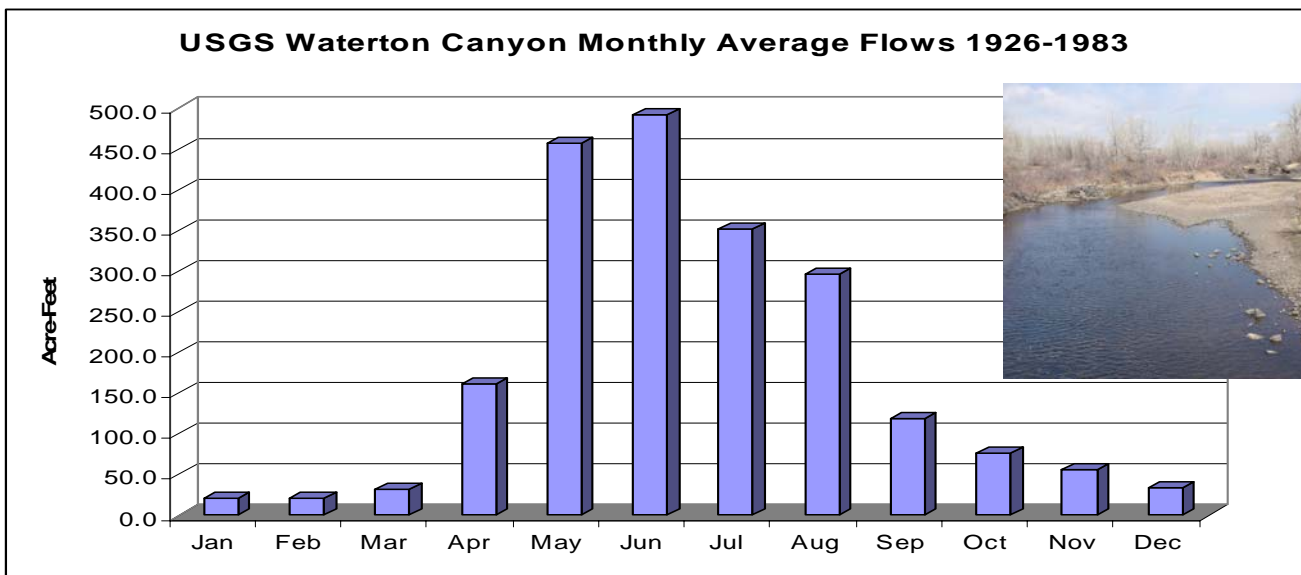
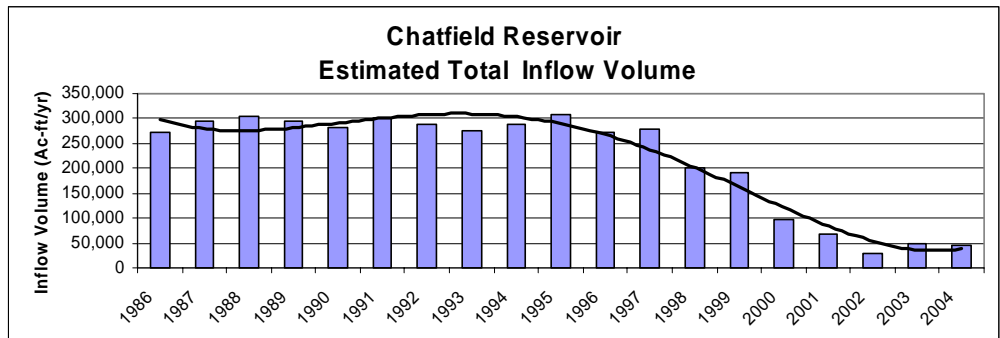
EXPLANATION
 — MEDIAN DAILY STREAMFLOW BASED ON 21 YEARS OF RECORD
 x MEASURED Discharge
 — DAILY MEAN DISCHARGE

Provisional Data Subject to Revision

Fact Sheet # 26. Watershed Hydraulics: Chatfield Reservoir 2004 Storage Trends

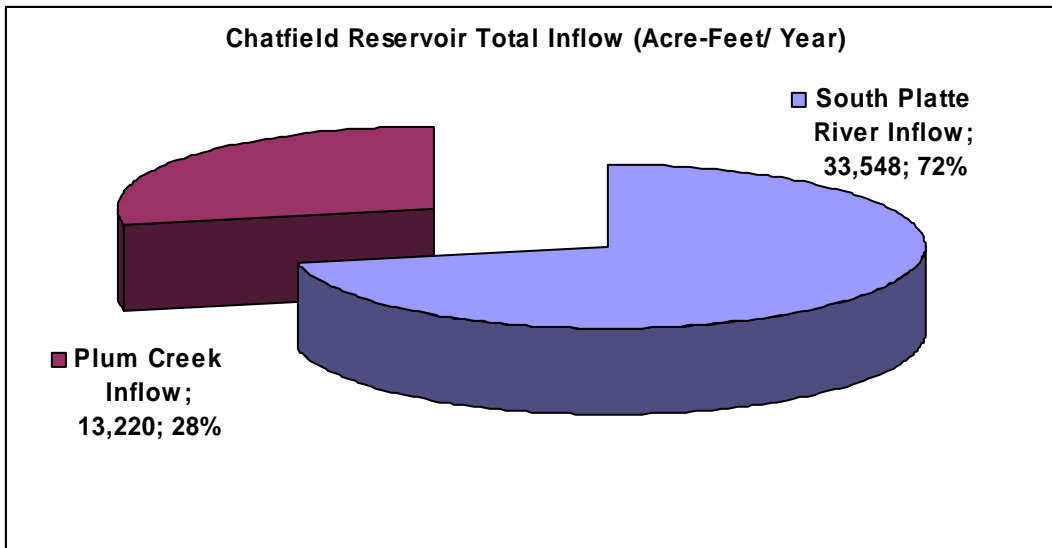
Chatfield Dam was the second of three dams built to protect the Denver region from floods. Construction of the dam began in 1967 and was completed in 1975. The dam measures approximately 13,136 feet in length with a maximum height of 147 feet from the streambed to the top of the dam. Chatfield Reservoir is 2 miles long and has an average depth of 47 feet. The reservoir drains an area of approximately 3,018 square miles. The 1,479-surface-acre reservoir has a multi-purpose pool storage capacity of 27,046 acre-feet. The maximum storage capacity is 355,000 acre-feet with maximum pool surface acres of 4,822 acres.

The Authority monitoring program estimated flow through the reservoir in 2004 at about 46,800 acre-feet. U.S. Army Corp of Engineers records shows the average flow into Chatfield Reservoir from 1986 through mid 2004 as 239,000 acre-feet per year. The Authority estimate is 80% lower than the monitored average and the second lowest monitored flow for the reservoir on record. The U.S. Army Corp of Engineers estimated an outflow from the reservoir in 2004 of about 50,000 acre-feet. The multi-purpose pool storage capacity in 2004 was generally below normal pool size. The 2004 total inflow was associated with continued drought conditions.



Fact Sheet # 27. Watershed Hydraulics: 2004 South Platte River and Plum Creek Flows with Water Balance for Chatfield Reservoir

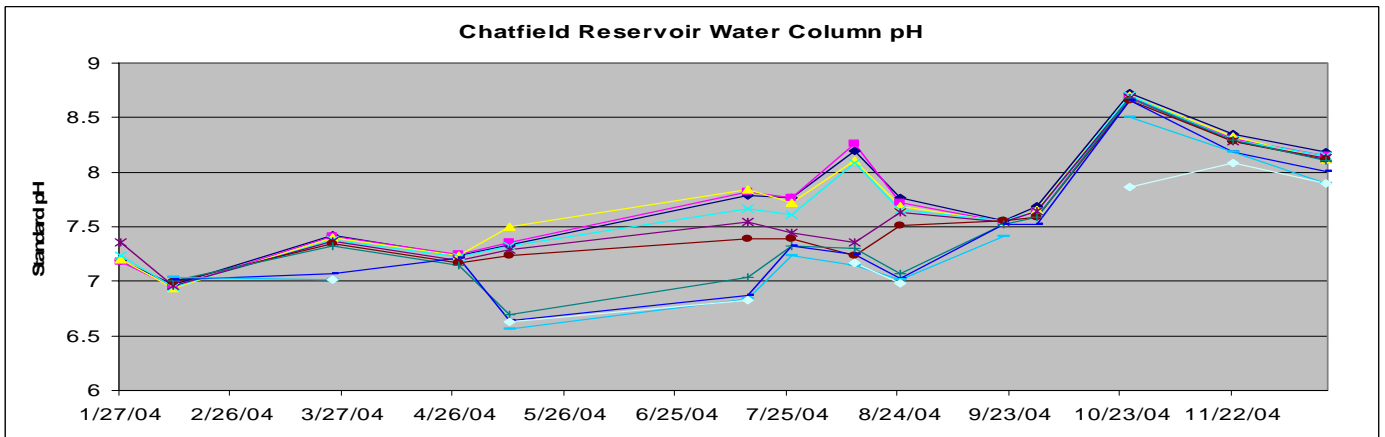
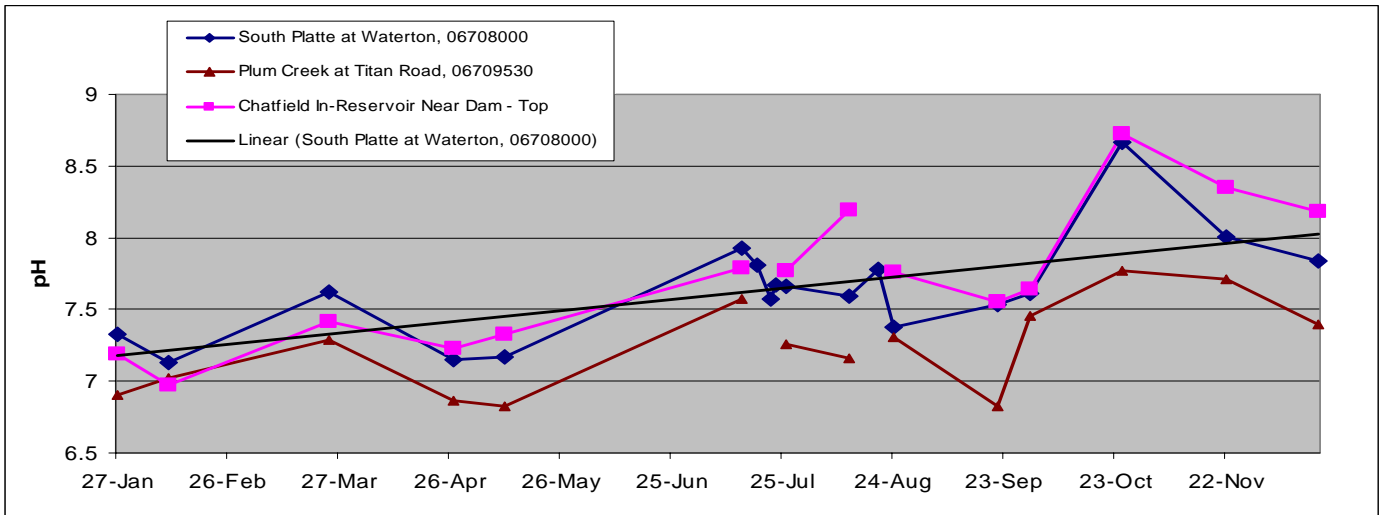
The monitoring program estimates flow from the South Platte River and Plum Creek as inflow into Chatfield Reservoir. The Authority flow data crosschecked against monthly average and cumulative gaging data from the USGS Titan Road station on Plum Creek and the Denver Water Department Waterton Canyon station on the South Platte River. The flow data used to calculate water quality loading. The loading compliance formulas are flow-dependent. Total flow through the reservoir in 2004 was 47,000 acre-feet based on data from the Authority monitoring program. The U.S. Army Corp of Engineers measured average flow in the last decade was 239,000 acre-feet. The 2004 total inflow was well below normal for the combined Chatfield and Upper South Platte Watersheds and is associated with a current drought.



2004	South Platte River Inflow	Plum Creek Inflow	Total Inflow	Reservoir Outflow	Reservoir Retention
	ac-ft/mo				
Jan	3,258	588	3,846	6,639	-2,793
Feb	888	838	1,727	2,460	-733
Mar	1,537	645	2,182	1,844	338
Apr	1,666	1,172	2,838	1,922	916
May	2,090	4,106	6,196	7,500	-1,303
Jun	4,795	971	5,766	8,852	-3,086
Jul	8,781	1,499	10,280	22,933	-12,654
Aug	3,219	1,386	4,605	11,711	-7,105
Sep	2,079	134	2,213	604	1,609
Oct	1,904	565	2,469	178	2,290
Nov	1,963	952	2,915	1,731	1,184
Dec	1,368	363	1,731	1,190	541
Annual	33,548	13,220	46,768	67,564	-20,795
% of Flow	71.73%	28.27%			

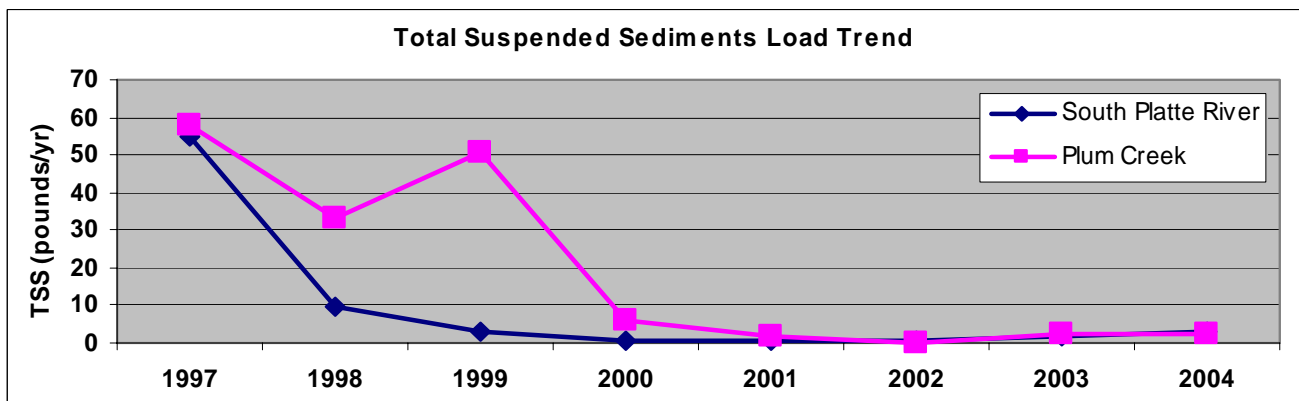
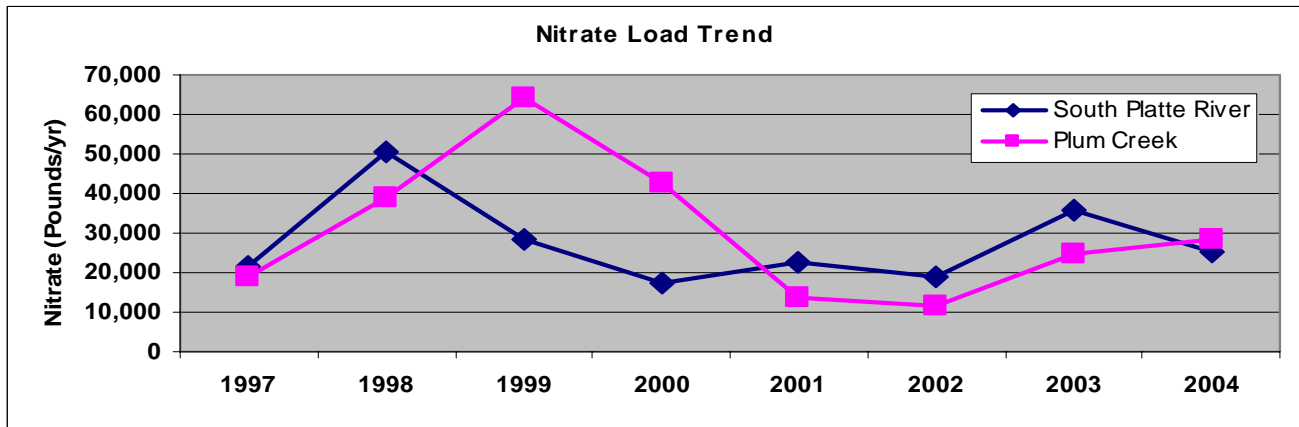
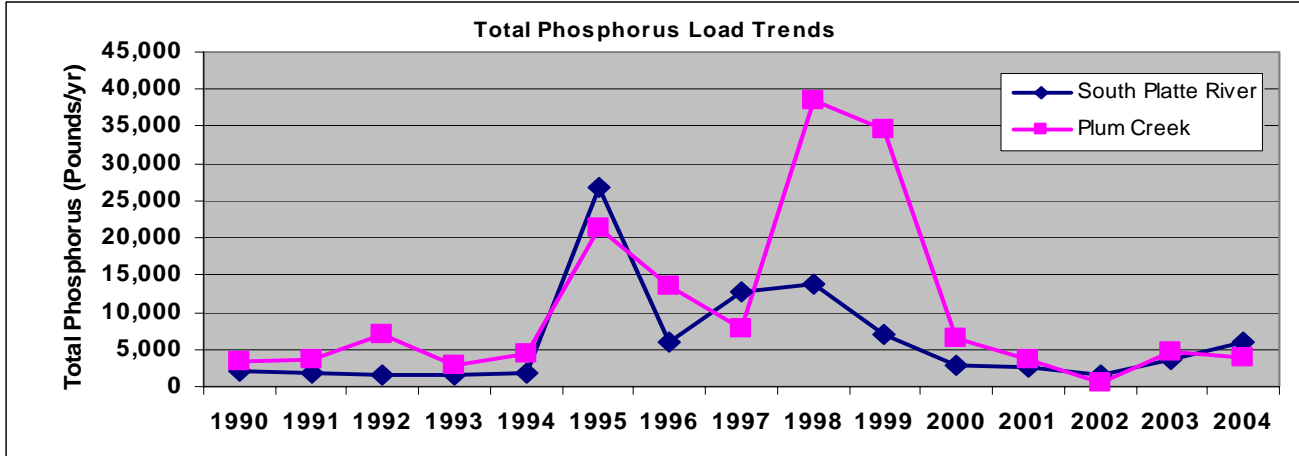
Fact Sheet # 28. Watershed Trends: Changing pH Trends In South Platte River and Chatfield Reservoir

Water column pH is a reservoir trophic indicator measure, where pH values above 9.0 or below 6 indicate a potential trout fishery, water quality or other biological problem. The pH standard for stream segments 6a (South Platte River) and segment 6b (Chatfield Reservoir) is a range of 6.5-9.0. 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 zero 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 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] and acidic water [pH < 6.5] 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, such as trout. The drought conditions beginning in 2001 through 2004 and subsequent fire runoff impacts have caused the river and reservoir pH to fluctuate within a range of 6.8 to 8.7. The reservoir generally maintains pH values within the standard range.



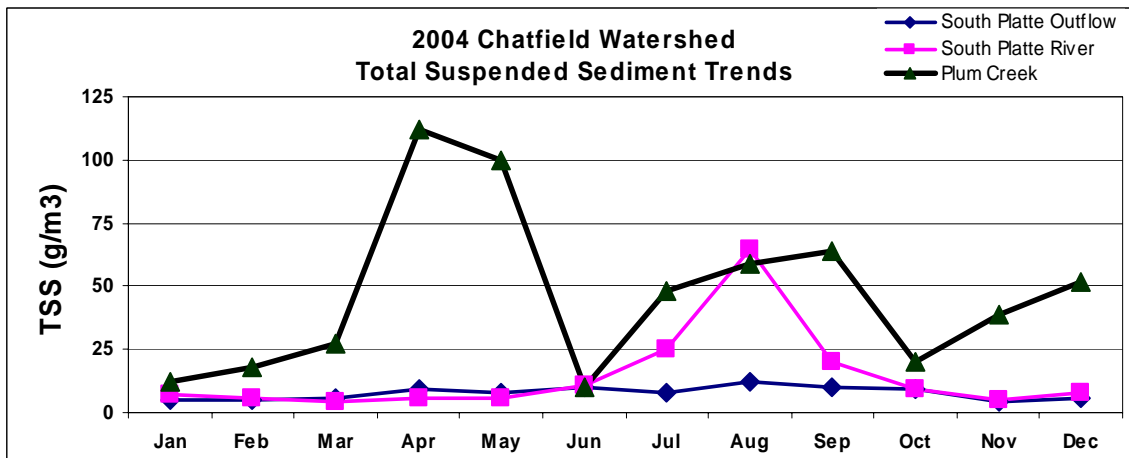
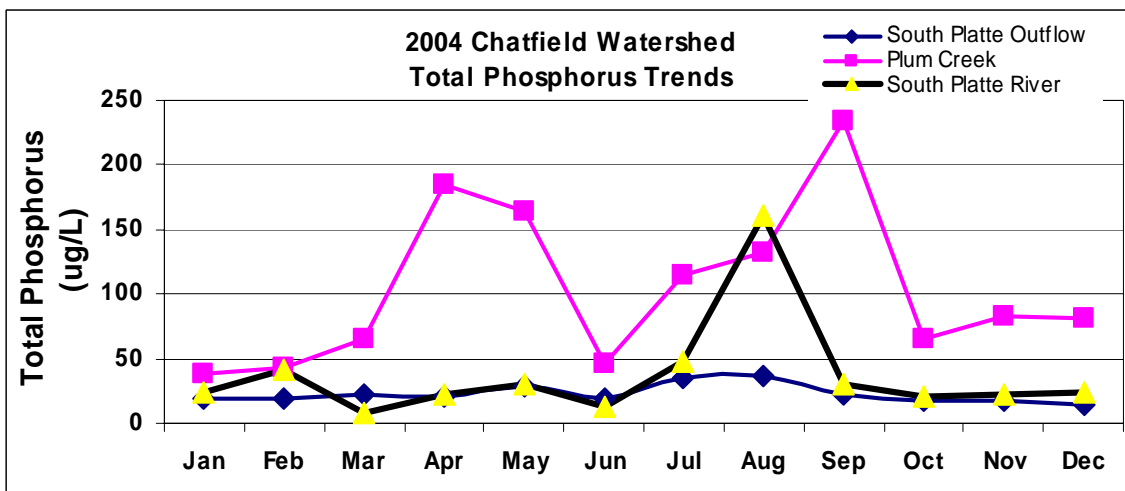
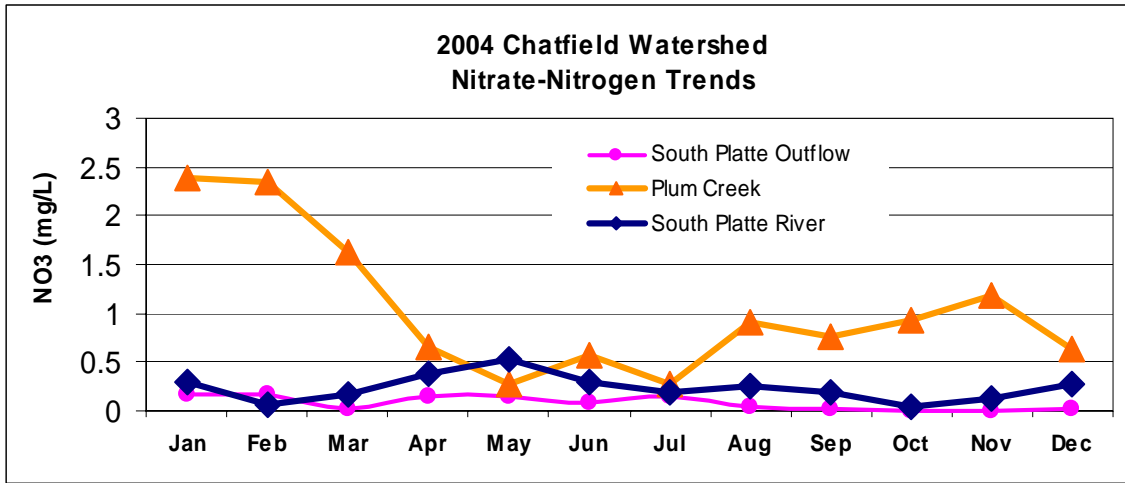
Fact Sheet # 29. Watershed Trends: Long-Term Nutrients & Suspended Sediments

Nutrients and suspended sediment load trends are used to predict water quality responses to environmental changes within drainages to Chatfield Reservoir. Data record load trends are shown in the following graphics.



Fact Sheet # 30. Watershed Trends: 2004 Nutrients & Suspended Sediments

The 2004 nutrient (nitrate and total phosphorus) trends and total suspended sediments inputs and output from the reservoir. The reservoir acts as a nutrient and sediment sink.



Fact Sheet # 31. Watershed Trends: 2004 Metal Monitoring

The Authority supplemental monitoring program in 2004 characterized metal concentrations associated with spring and summer runoff events coordinated with stormwater events in or near the Hayman burn area. The Authority estimated the time lag from storm events and captured samples near peak flows periods in the South Platte River and taken from bottom waters of the reservoir. Four metals exceeded standards (light orange highlights) in following table. The high mercury value is a water quality and fishery concern. The Authority continues stormwater characterization in the 2005 monitoring program. The elevated metals are generally associated with runoff from wildfire burn areas.

Metal	South Platte River 2003 Data		South Platte River 2004 Data		Standard		
	Segment 6a River	Segment 6b Reservoir	Segment 6a River	Segment 6b Reservoir	Assessed Water Quality Standard		
	Max ug/l	Max ug/l	Max ug/l	Max ug/l	Standard Type	Standard (ug/l)	
Silver (Dissolved)	0	0	0	0	Ag(ac)=TVS	2.39	Trout=0.089 ug/l
Arsenic (Total)	0.79	0.96	0.4	0.9	As(ac)=50(Trec)	50	
Cadmium (Dissolved)	0.1	0	0.1	0.1	Cd(ac)=TVS	4.96	Trout=4.11 ug/l
Chromium VI (Dissolved)	0	0	0	0	CrVI(ac)=TVS	16	
Copper (Dissolved)	0	0	100	10	Cu(ac)=TVS	15.3	
Nickel (Dissolved)	0	0	0	0	Ni(ac)=TVS	507	
Iron (Dissolved)	0	0	60	80	Fe(ch)=300(dis)	300	Drinking water
Iron (Total)	1540	350	1480	810	Fe(ch)=1000(Trec)	1000	
Mercury (Dissolved)	0	0	31.7	0.9	Hg(ch)=0.01(Tot)	1.4	dissolved
Manganese (Dissolved)	0	5	21	293	Mn(ch)=50(dis)	50	
Lead (Dissolved)	0.1	0	1.9	2	Pb(ac)=TVS	75	
Selenium (Dissolved)	0	0	0	0	Se(ac)=10(Trec)	18.4	dissolved
Zinc (Dissolved)	20	10	10	20	Zn(ac)=TVS	132	

SP Hardness 111 mg/l

South Platte Winter Flow



South Platte Summer Flow



Fact Sheet # 32. Chatfield Reservoir: 2004 Trophic Status Summary

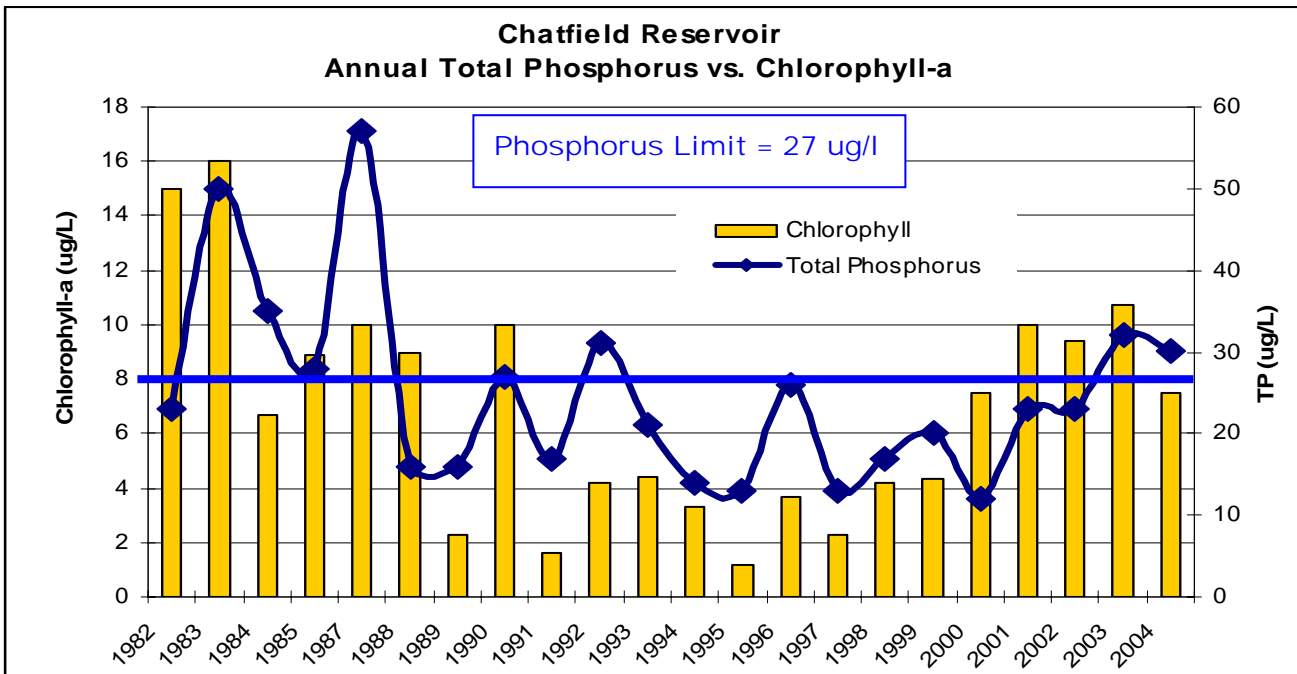
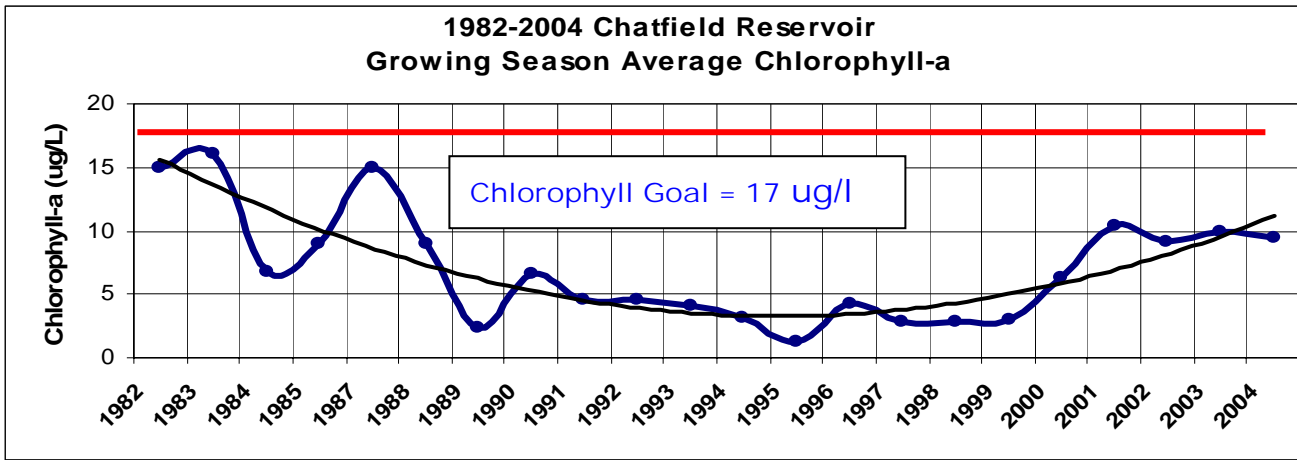
The following table summaries selected trophic state categories from the 2004 data set.

Trophic Parameters	Reservoir
Chlorophyll	
Average Growing Season Chlorophyll-a [ug/l]	9.5
Peak Chlorophyll-a [ug/l]	22.4
Phosphorus	
Average Annual Total Phosphorus [ug/l]	30.1
Seasonal Annual Total Phosphorus [ug/l]	39.5
Peak Annual Total Phosphorus [ug/l]	84
Average Annual Ortho Phosphorus ug/l]	4
Seasonal Average Ortho Phosphorus [ug/l]	7.5
Peak Annual Ortho Phosphorus [ug/l]	32
Total Nitrogen	
Average Annual Total Nitrogen [ug/l]	808
Seasonal Average Total Nitrogen [ug/l]	807
Peak Annual Total Nitrogen [ug/l]	6,558
Clarity	
Average Annual Secchi Depth [meters/feet]	2.5/8.0
Seasonal Average Secchi Depth [meters/feet]	2.3/7.4
Total Suspended Sediments	
Annual Average Total Suspended Sediments [mg/l]	9.8
Seasonal Average Total Suspended Sediments [mg/l]	10.8
Peak Total Suspended Sediments [mg/l]	15.4
Trophic State Index	
Walker Index - Annual	35 - Mesotrophic
Walker Index - Seasonal (July-September)	37 - Mesotrophic-Eutrophic
Carlson Index - Annual	50 - Mesotrophic-Eutrophic
Carlson Index - Seasonal (July-September)	53 - Eutrophic
Phytoplankton Species	
Peak Phytoplankton Density	Bluegreens 72%; Greens 23%
	71,000 cells/ml



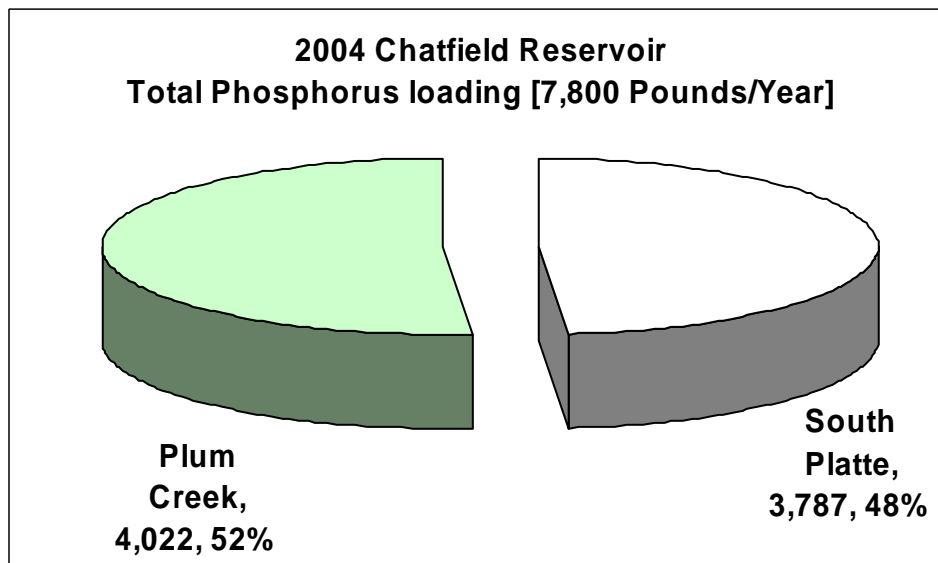
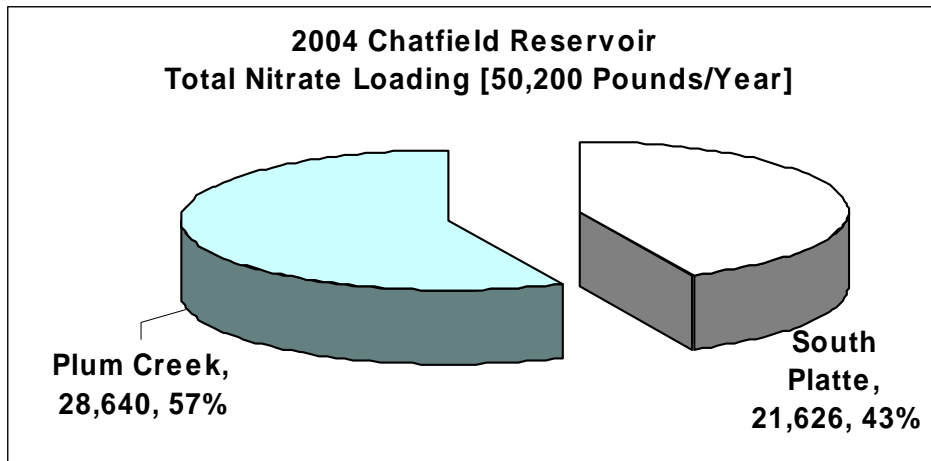
Fact Sheet # 33. Chatfield Reservoir: Chlorophyll & Total Phosphorus Growing Season Trends

The monitoring program measures total phosphorus and chlorophyll-a in the Chatfield Reservoir water column. The near surface chlorophyll goal for the reservoir is 17 ug/l. The total phosphorus standard is 27 ug/l as a water column average. Controlling total phosphorus source inputs is a control strategy for reducing chlorophyll levels in the reservoir. Consequently, the relation of total phosphorus to chlorophyll monitors that relationship. Although the reservoir growing season chlorophyll-a value is below the goal, recent nutrient and chlorophyll values show increasing trends associated with current low flow conditions.



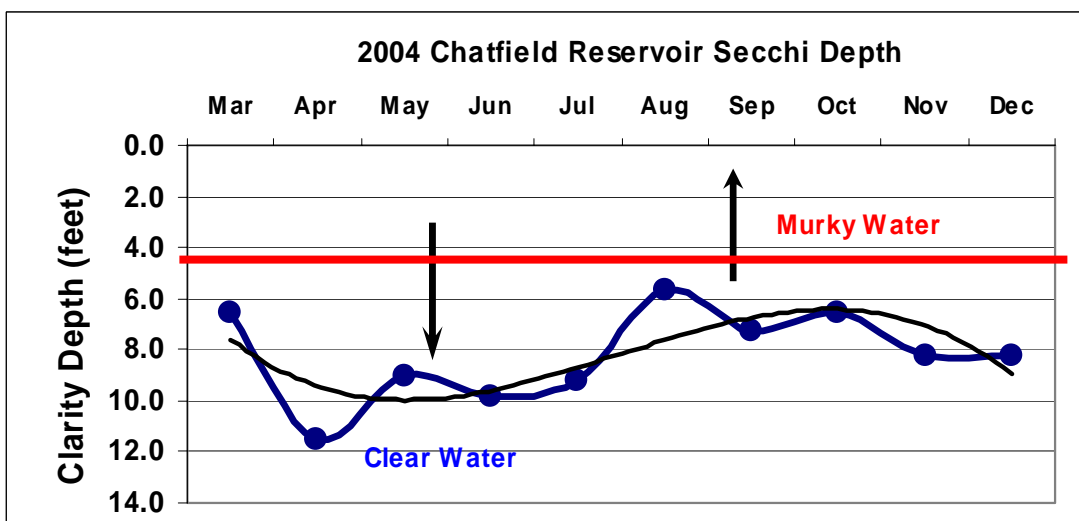
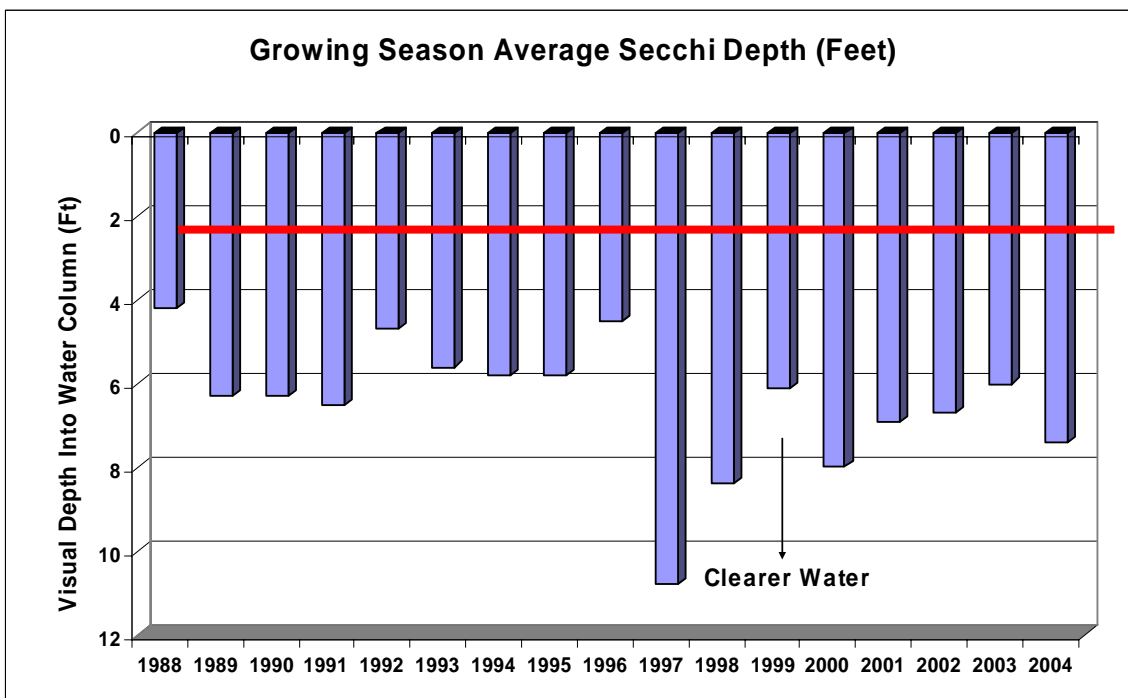
Fact Sheet # 34. Chatfield Reservoir: 2004 Nitrate & Total Phosphorus (Nutrient) Loading

The monitoring program measures chemical loading into Chatfield Reservoir from the South Platte River and Plum Creek. The total phosphorus load is derived from wastewater treatment plants within the Plum Creek drainage and as nonpoint source load from both the Chatfield Watershed and the Upper South Platte River Watershed. The 2004 drought had a significant impact on nutrient loading into the reservoir in 2004. Extremely low load of both phosphorus and nitrogen reached the reservoir. The total phosphorus load in 2004 from all sources was 7,800 pounds at a total inflow of 46,800 acre-feet. This is the second lowest total phosphorus loading recorded for the reservoir by the Authority. The nitrate loading was also well below historic conditions with only 50,200 pounds derived from all sources. However, greater proportion of nitrogen comes from the South Platte River drainage compared with historical trends. There was no significant nutrient-loading problem associated with Chatfield Reservoir in 2004.



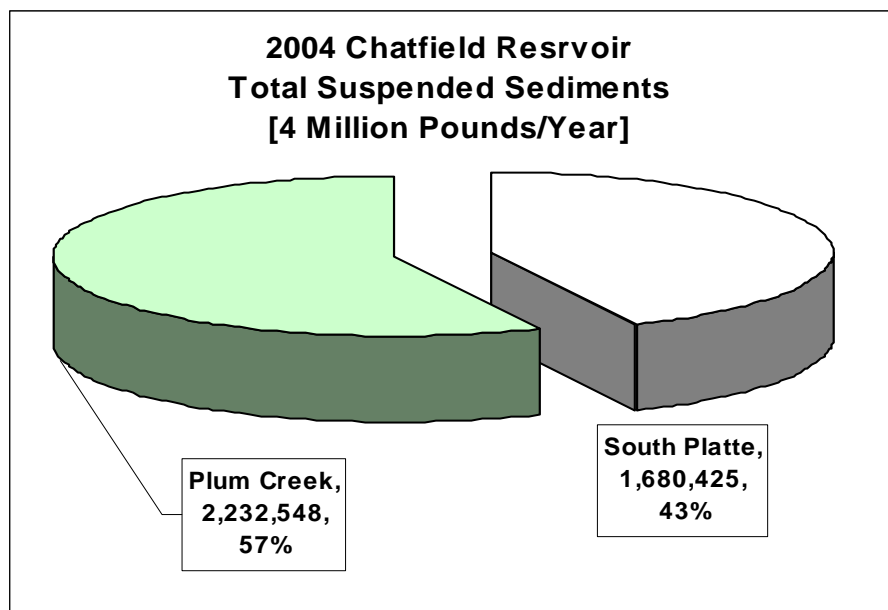
Fact Sheet # 35. Chatfield Reservoir: 2004 Water Clarity (Secchi)

The clarity (how much matter is suspended in the water) of the reservoir water column can be estimated by taking a Secchi disk measurement. A special disk is lowered into the water column until an observer can no longer see it. This measurement equates to declining or improving water quality based many lake and reservoir studies. The Secchi depth is also a factor used to estimate the trophic status (overall water quality) of a waterbody. Deeper Secchi readings indicate clearer water. Secchi measurements of about 3 feet (one-meter) or less characterize very turbid or sediment laden water or an algal bloom (Red Line on Graph). The reduced Secchi depth in the fall was associated with minor runoff events from the Hayman burn area. The long-term trend in the reservoir has been toward less murky or clearer water; however, this trend is expected to change as runoff increases from the Hayman burn area.



Fact Sheet # 36. Chatfield Reservoir: 2004 Total Suspended Sediment Loading

The monitoring program measures the amount of total suspended solids or fine sediments (TSS) that flow into Chatfield Reservoir from the South Platte River (Waterton) and Plum Creek (Titan Road), because phosphorus can attach to sediment particles. In addition, TSS contributes to poor clarity in the reservoir. Generally, the TSS loads are much greater from the Plum Creek drainage compared to the South Platte River. Upstream reservoirs on the South Platte River are capturing a large portion of the potential sediment load before this load reaches Chatfield Reservoir. The total 2004 TSS loading to the reservoir is 80% below normal. The Plum Creek 2004 loading is much less than average due to drought conditions and far fewer storm events. The table shows most of the instream sediment load is captured and retained within Chatfield Reservoir.



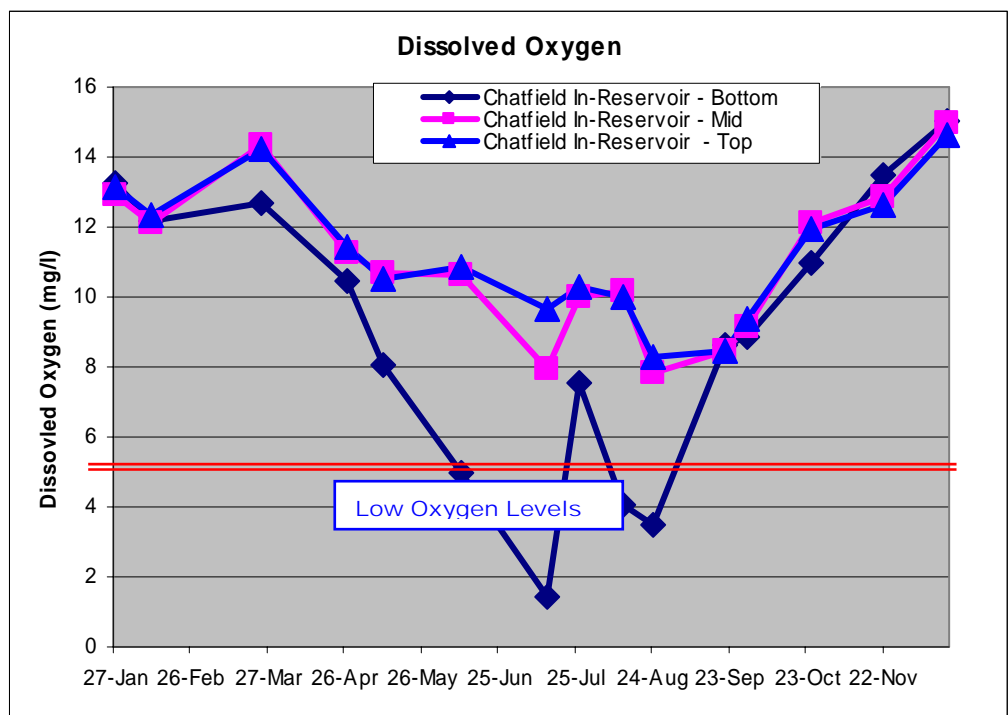
TSS	South Platte	Plum Creek	Reservoir	Outflow	Retention
	Pounds/Mo	Pounds/Mo	Pounds/Mo	Pounds/Mo	Pounds/Mo
Jan	62,034	19,182	81,216	90,391	-9,176
Feb	14,498	41,049	55,547	33,489	22,058
Mar	16,721	47,403	64,124	30,130	33,993
Apr	27,185	357,024	384,208	47,091	337,117
May	34,110	1,116,940	1,151,050	163,374	987,676
Jun	143,463	26,419	169,882	241,043	-71,161
Jul	597,089	195,729	792,818	499,581	293,237
Aug	569,143	222,460	791,603	382,656	408,947
Sep	113,107	23,301	136,408	16,442	119,966
Oct	46,602	30,744	77,347	4,374	72,973
Nov	26,699	100,971	127,670	18,856	108,815
Dec	29,774	51,327	81,101	19,439	61,662
Total	1,680,425	2,232,548	3,912,973	1,546,865	2,366,108

Fact Sheet # 37. Chatfield Reservoir: 2004 Dissolved Oxygen Trends

The dissolved oxygen concentrations in the water column profiled in 1-meter intervals at the central sampling site. Dissolved oxygen is a reservoir trophic indicator measure, where dissolved oxygen concentrations below 5 mg/l can indicate a potential water quality and biological problem. Low dissolved oxygen concentrations can stress aquatic life species. The lower the dissolved oxygen concentration, the greater the potential stress. Oxygen levels that remain below 1-2 mg/l for a few hours can result in fish kills. Fish within the reservoir can migrate to better-oxygenated water, provided good oxygenated water remains in the water column. Consequently, the amount of water column with low dissolved oxygen is an important trophic indicator.

Low dissolved oxygen concentrations occur below 7 meters (about 23 feet) during summer months of June and July. Dissolved oxygen concentrations were in expected ranges for the remainder of the year. However, this lower summer oxygen data doesn't represent a regulatory problem since compliance monitoring is in the epilimnion and metalimnion portions (upper water column) of the reservoir. Any potential stress on the reservoir fishery is minimal. Reservoir systems like Chatfield have inherent low dissolved oxygen concentrations in bottom waters during summer months. Part of the low summer dissolved oxygen problem caused by reservoir design. The reservoir is a flood control structure and not designed for water quality management. Consequently, the reservoir experiences seasonal low dissolved oxygen in bottom waters.

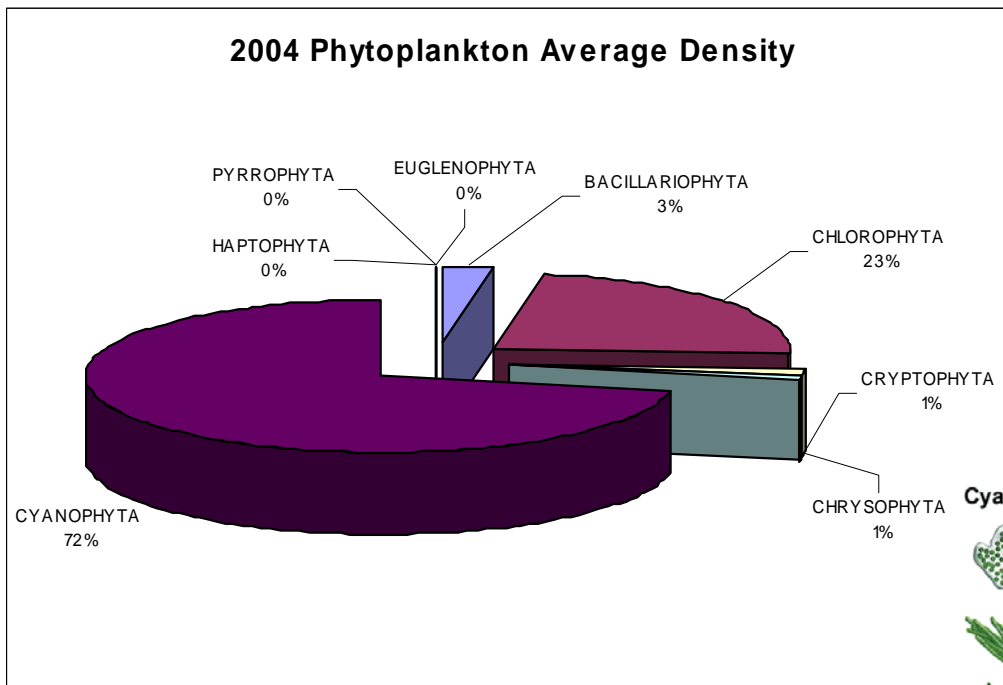
Monthly Minimum Dissolved Oxygen Profile (mg/l)	
Jan	13.13
Feb	12.1
Mar	12.7
Apr	10.45
May	8.04
Jun	4.97
Jul	1.45
Aug	3.46
Sep	8.47
Oct	11
Nov	12.65
Dec	14.64



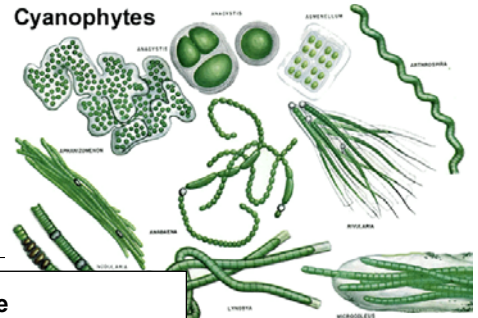
The Basic Standards and Methodologies for Surface Water (5 CCR 1002-31, Regulation #31) -The dissolved oxygen criterion is intended to apply to the epilimnion and metalimnion strata of lakes and reservoirs. Dissolved oxygen in the hypolimnion may (due to the natural conditions) be less than the table 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 # 38. Chatfield Reservoir: 2004 Phytoplankton & Zooplankton Species Distributions

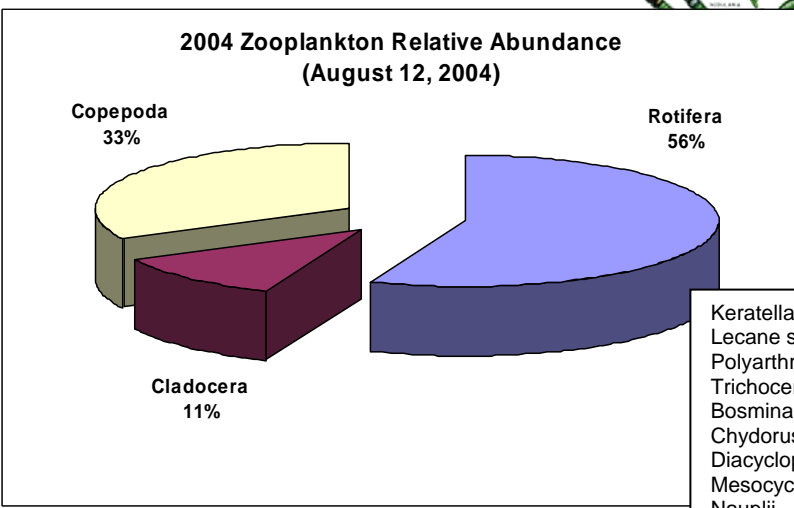
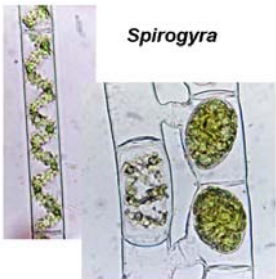
The biological integrity of Chatfield Reservoir can be assessed by monitoring changes in plant (phytoplankton) and animal (zooplankton) communities. The increased abundance within a reservoir of certain types of algae or plants (e.g., blue-green algae or Cyanophyta) can indicate declining water quality. In 2001 the blue-green species made up on the average 91% of plants present in the reservoir and in 2002 the green algae dominated the species mix. In 2004, the blue-green again dominated the species mix at 74%. The increased nutrient conditions are more favorable to blue-green algae compared to greens. The 9-zooplankton species from three functional groups are typical of front-range reservoirs.



CHLOROPHYTA (Greens)
Chlorella minutissima
Scenedesmus intermedius



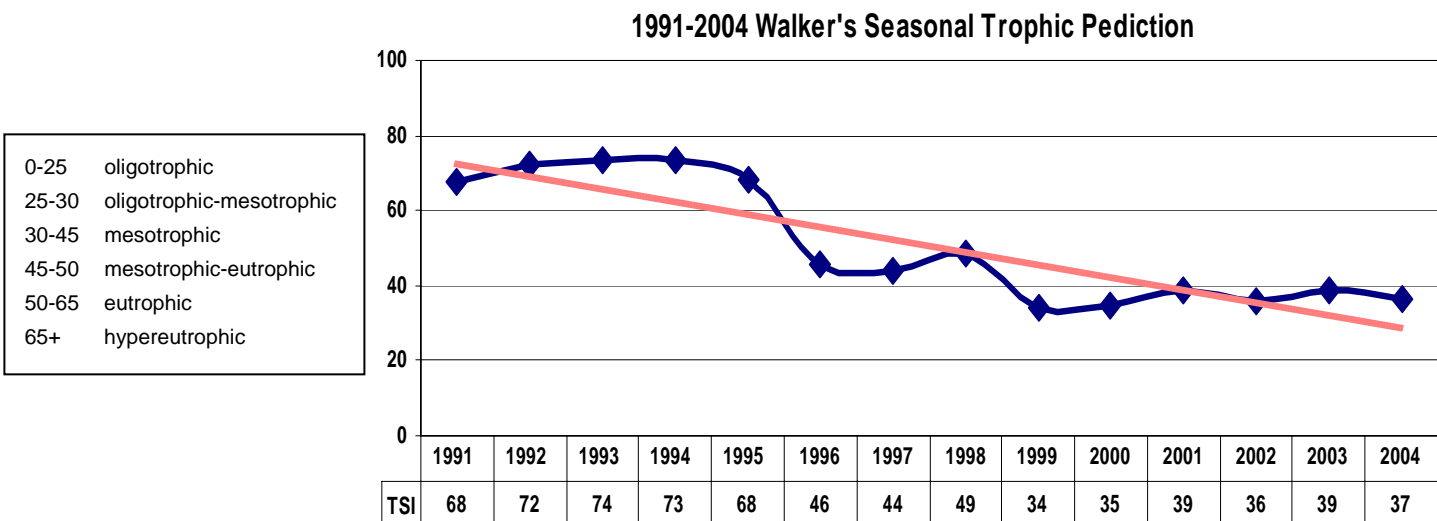
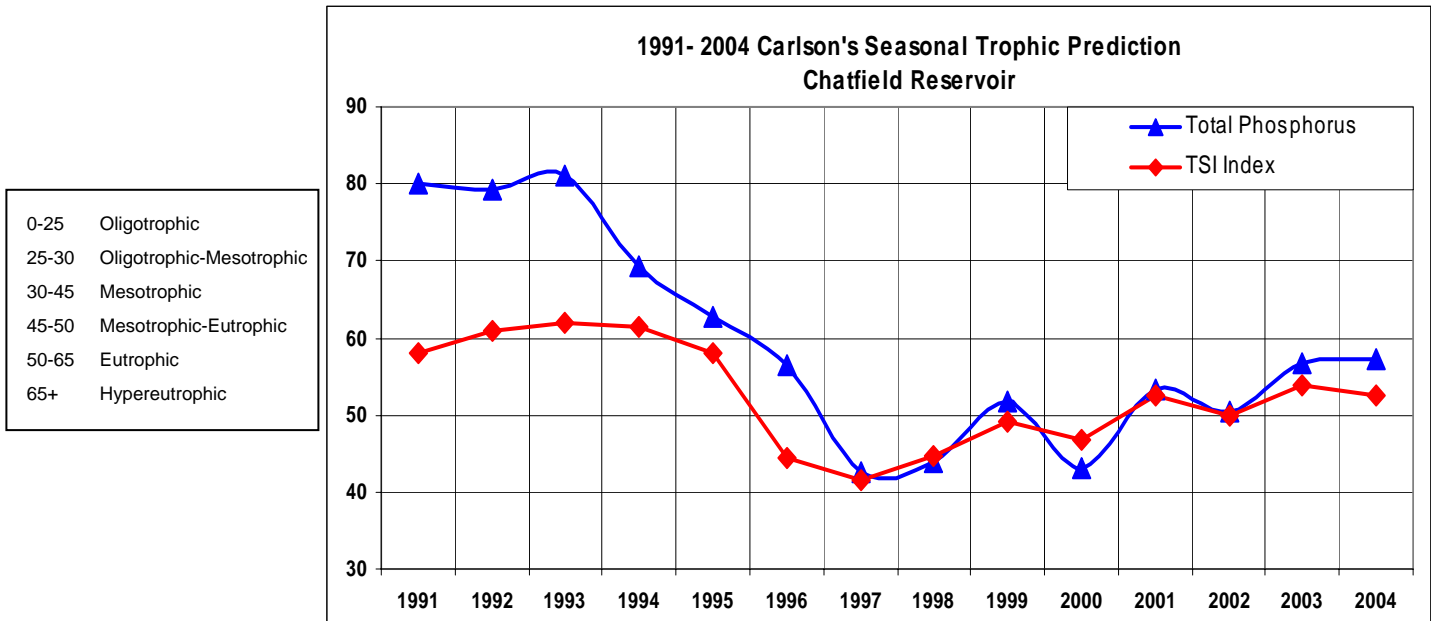
CYANOPHYTA (Bluegreens)
Aphanothece minutissima
Aphanothece smithii
Dactylococcopsis fascicularis
Pseudanabaena limnetica
Aphanocapsa delicatissima



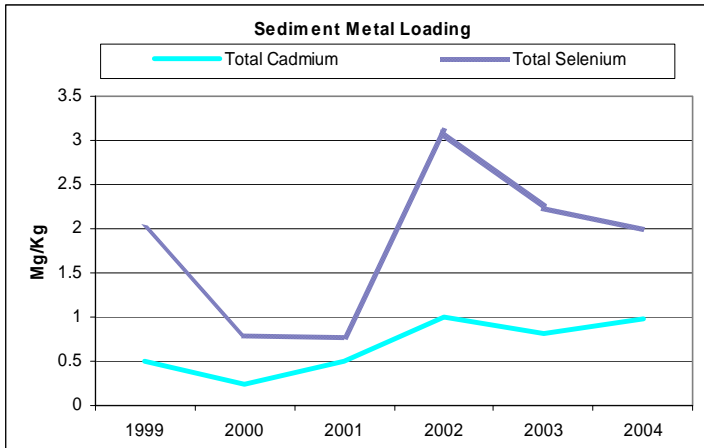
Keratella cochlearis (Gosse)
Lecane sp.
Polyarthra vulgaris
Trichocerca sp.
Bosmina longirostris
Chydorus sp.
Diacyclops thomasi (S.A. Forbes)
Mesocyclops edax (Forbes)
 Nauplii

Fact Sheet # 39. Chatfield Reservoir: Walker & Carlson Trophic State Indexes (TSI)

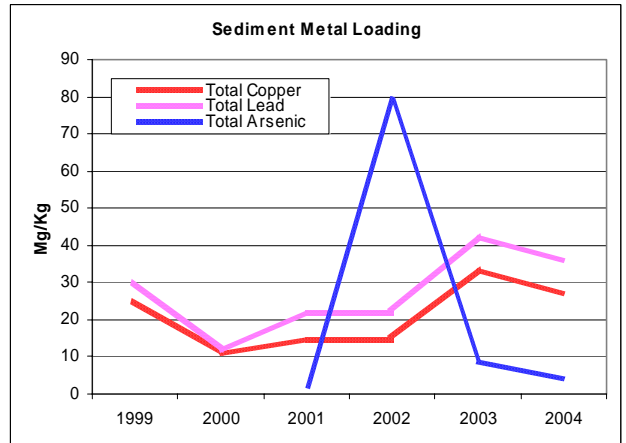
The ongoing trend-monitoring program characterizes Chatfield Reservoir chemical and biological quality, along with South Platte River and Plum Creek inputs and outflow from the reservoir. The reservoir trophic status evaluation determines overall water quality trends. The two trophic models (TSI) look at chemical and biological parameters to produce a growing season or annual estimate of water quality. The models show the reservoir at the desirable mesotrophic-eutrophic boundary. This quality meets the goal of the watershed management strategy.



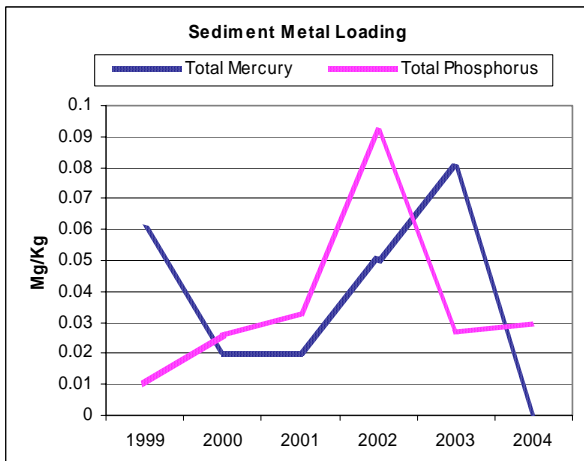
Fact Sheet # 40. Chatfield Reservoir: Sediment Base-Line Data



A single sediment box core sample of surface sediments is obtained at the profile monitoring station. The sediment analyses include five indicator metals, total organic carbon, percent silts and clays, and total phosphorus. Bed



sediments in the Chatfield Reservoir come from a variety of sources. They wash off surrounding land surfaces into the South Platte River during rainstorms. Sediment also comes from direct deposition of airborne dust and particles. Over time, these sediments accumulate and form a layer on the reservoir bottom. The chemical

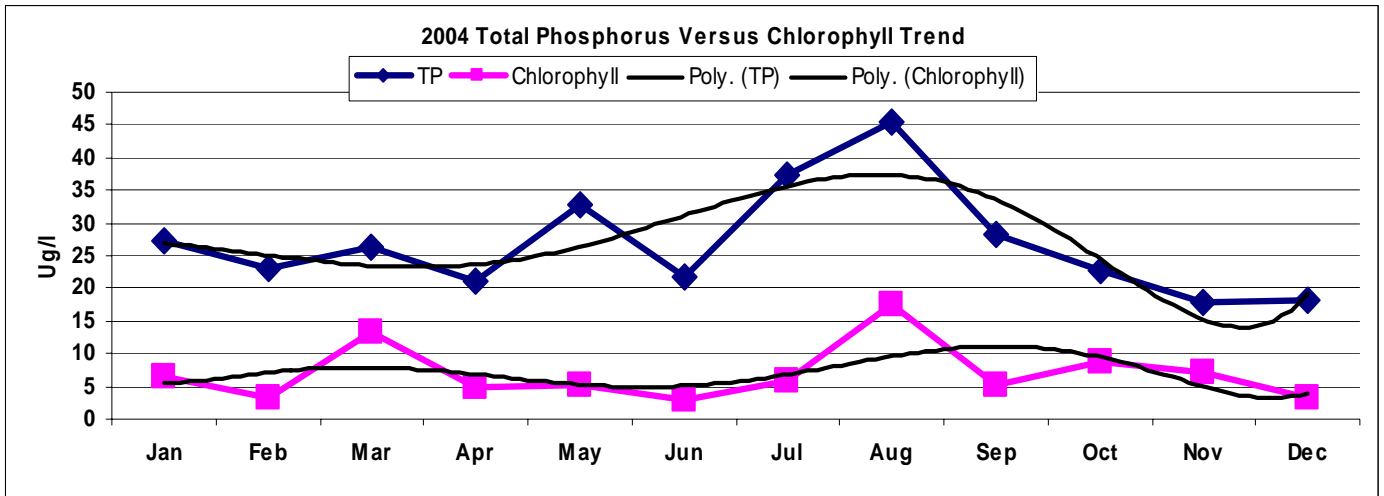


composition of the deposited sediments changes over time and can reflect the historical activity in the watershed. The Chatfield Authority is collecting sediment data to form a base line for future analysis and trend characterization. Bottom sediments range from a silty-clay to a silty sand. The total copper and lead values were higher than previously monitored. However, these data points are not a water quality problem. The concentration of total organic carbon reflects the accumulation of organic matter in the reservoir sediments. Total phosphorus concentrations are relatively stable. The bottom sediments in the reservoir are not homogenous with a wide variation in the sand/clay ratio between monitoring periods. This variation in sand/clay mix can greatly affect the concentration of metals, phosphorus and organic matter in the sediments.

The data record is not large enough to detect any trends on an annual basis. The Authority will continue bottom sediment analysis and develop a longer-term trend data set.

	Total Cadmium	Total Copper	Total Lead	Total Mercury	Total Phosphorus	Total Selenium	Total Arsenic
	Mg/Kg	Mg/Kg)	Mg/Kg	Mg/Kg	Mg/Kg	Mg/Kg	Mg/Kg
Minimum Detection Limit	0.5	2	7	0.02	0.0004	0.2	0.001
Practical Quantitation Limit	2	8	30	0.1	0.002	0.8	0.005
1999	0.5	25	30	0.06	0.01	2	
2000	0.25	11	12	0.02	0.026	0.8	
2001	0.5	14.9	22	0.02	0.0328	0.77	2.00
2002	1	14.9	22	0.05	0.0916	3.1	79.00
2003	0.82	33.6	42.4	0.08	0.027	2.25	8.95
2004	0.99	27.2	36.2	0	0.03	2	4.30

Fact Sheet # 41. Chatfield Reservoir: Chlorophyll and Phosphorus Correlation In Chatfield Reservoir



The original assumption accepted by the WQCC in setting a growing season total phosphorus standard of 27 ug/l for Chatfield Reservoir was this concentration would protect growing season 17 ug/l chlorophyll-a target. This maximum chlorophyll target is assumed to protect reservoir designated uses. Further it was assumed that a linear relationship existed between phosphorus and chlorophyll. Subsequent Authority data does not support the linear relationship assumptions (upper graph) or the linearity of growing season data (right graph). A poor correlation ($R^2=0.34$) exists between total phosphorus and chlorophyll-a concentrations during the growing season. While annual correlation data (lower graph) suggests some relationship, it is not a 27TP:17CHL ug/l ratio, but closer to a 65TP:17CHL ug/l ratio.

