

Chatfield Watershed Report 2006:

Annual Summary and Water Quality Fact Sheets

September 2007



Established 1984

Working for Water Quality

Watershed Management Agency

Chatfield Watershed Authority

The Chatfield Watershed Authority promotes protection of water quality in the Chatfield Watershed for recreation, fisheries, drinking water supplies, and other beneficial uses.

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Watershed Characterization and Regulatory Framework

Chatfield Dam and Reservoir

Construction of a dam and reservoir at the Chatfield site, which is located about eight miles upstream from Denver, was authorized in 1950 for flood control, silt control, recreation, fish and wildlife, and water supply storage. Chatfield Dam and Reservoir is managed by the U.S. Army Corps of Engineers (USACE; Omaha District) to protect the Denver metropolitan area from catastrophic floods that devastated the area for more than 100 years. Construction of Chatfield Dam began in 1967 and was completed in 1975.



Figure 1 Chatfield Reservoir (Looking SE)

Chatfield Dam is a rolled earthfill dam 13,136 feet long with a top width of 30 feet, an ungated concrete spillway 500 feet wide located in the left abutment, and a gated concrete outlet works located in the right abutment (see Figure 1). The normal depth of the lake is about 47 feet at its deepest point. The dam towers about 100 feet above the mean surface of the reservoir.

Chatfield Reservoir is located at the confluence of the South Platte River and Plum Creek within the South Platte Basin. The reservoir itself is located southwest of Denver in Douglas and Jefferson counties. The drainage area for the South Platte River basin upstream of the reservoir encompasses 3,018 square miles and originates at the headwaters in Park County, Colorado. The U.S. Forest Service (USFS) manages most of the lands along the mainstem of the South Platte River upstream of the reservoir. Plum Creek, the second largest of the reservoir's tributaries, flows through a mixture of rangelands and suburban areas.

Chatfield Reservoir flood control storage space was designed to store flood flows within the reservoir and to release stored water at a maximum rate of 5,000 cubic feet per second (cfs). To provide the best downstream flood control, operational procedures call for no releases during flood events. Chatfield Reservoir storage is operated to store floodwater for five days then initiate release of 500 cfs per day increasing incrementally until a release of 5,000 cfs is achieved.

Chatfield Reservoir is administered by USACE, which leases its land and water to other agencies. Chatfield Reservoir has a total gross storage of 350,043 acre-feet. This storage is distributed into four zones (i.e., inactive, multipurpose, flood control, surcharge) defined by elevation. The inactive zone extends from the bottom of the reservoir, 5,377 to 5,385 feet mean sea level (msl), with a storage volume of 28 acre-feet. The multipurpose zone extends from 5,385 to 5,432 feet msl, with a storage volume of 27,018 acre-feet. The flood control zone extends from 5,432 to 5,500 feet msl, with a storage volume of 206,729 acre-feet. The

surcharge zone extends between 5,500 to 5,521.6 feet msl, with a storage volume of 116,268 acre-feet. Under USACE's current operating plan, Denver Water Department holds all of the water rights up to the multipurpose pool level at 5,432 feet msl. Once the pool rises above 5,432 feet msl, USACE is responsible for the management of water in the flood control pool.

Colorado Department of Natural Resources, Division of Parks and Outdoor Recreation, has a park and recreation lease from USACE for 5,381 land and water acres, including the area covered by Chatfield Reservoir. The area was leased to Colorado State Parks for recreational purposes in 1974 and then eventually developed into Chatfield State Park in 1976 (Figure 2).

The Dam

Type-Rolled Earth Fill
 Height-147 feet
 Length-13,136 feet
 Width of Top-30 feet
 Fill Quantity-14,650,000 cubic yards

The Spillway

Type-Ungated Chute
 Capacity-188,000 cubic feet per second

The Outlet Works

Type-Circular 7 feet in diameter
 Capacity-2,000 cubic feet per second

The Lake

Drainage above dam-3,018 square miles
 Storage Capacity-355,000 acre feet
 Surface Acres (max. pool)-4,822 acres
 Surface Acres (multi-purpose pool)-1,479 acres
 Maximum depth-47 feet
 Length of multi-purpose pool 2 miles
 Width of multi-purpose pool-1.5 miles
 Capacity of multi-purpose pool-27,046

CHATFIELD STATE PARK



Figure 2 Chatfield State Park

Chatfield Watershed

The Denver Regional Council of Governments (DRCOG) is the designated water quality planning agency for the Denver region. The Chatfield Watershed (Figure 3) is recognized by the Denver Regional Council of Governments in *the Metro Vision 2020 Clean Water Plan* (DRCOG 1998) as a specific geographic area requiring special water quality management. 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.

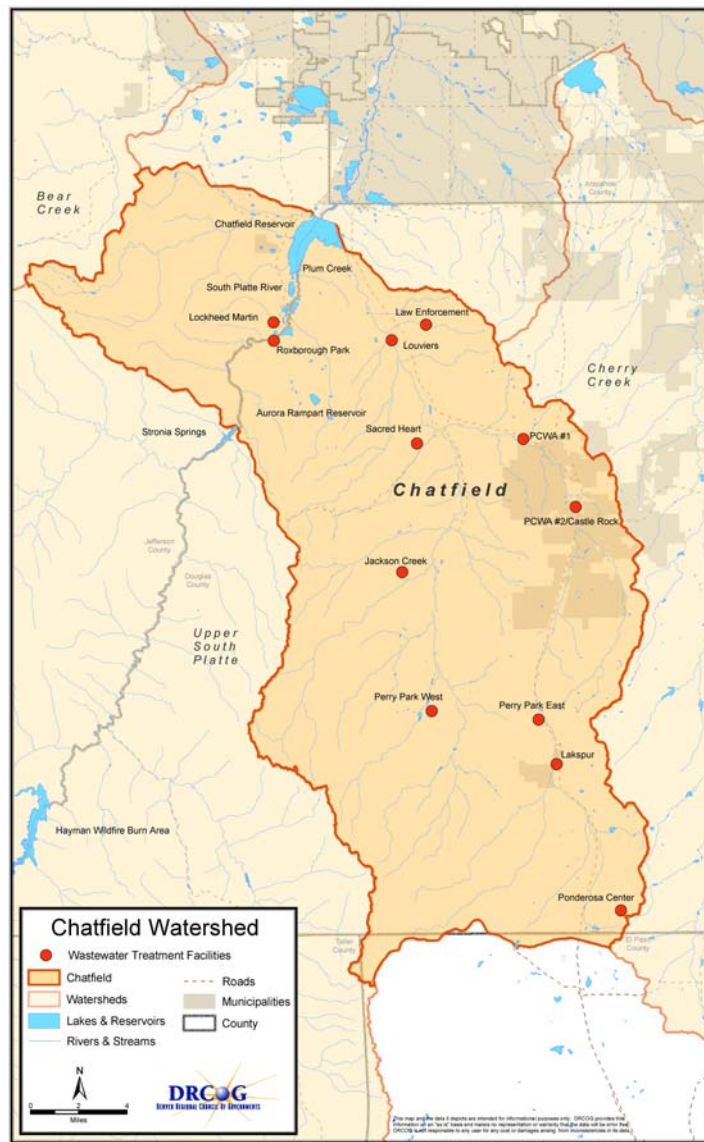


Figure 3 Chatfield Watershed

Water Quality Regulatory Framework

Standards and Classifications

The Chatfield Reservoir Clean Lakes Study identified potential water quality problems for Chatfield Reservoir and targeted total phosphorus concentrations as a method to prevent advanced eutrophication of the reservoir and potential harmful impacts to the classified uses (DRCOG 1984). The study recommended preferred standards and treatment options to protect the water quality at the reservoir. Based upon this Clean Lakes Study, the Colorado Water Quality Control Commission (WQCC) adopted a total phosphorus standard of 27 ug/l targeted to maintain a chlorophyll a goal of 17 ug/l in Chatfield Reservoir (Regulation 5 CCR 1002-38; Regulation No. 38). 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 13 out of 24 years.

The adopted standards and classifications for the reservoir and associated watershed are shown in Tables 1 and 2.

Table 1 Chatfield Watershed Classifications and Temporary Modifications

REGION: 3 and 4 BASIN: Upper South Platte River	Design	Classifications	Temporary Modifications & Standards
Stream segment Description			
6a. Mainstem of the South Platte River from a point immediately above the confluence with the North Fork of the South Platte River to the inlet of Chatfield Reservoir.		Aq Life Cold 1 Recreation 1a Water Supply Agriculture	
6b. Chatfield Reservoir.		Aq Life Cold 1 Recreation 1a Water Supply Agriculture	Mean total phosphorous P=0.027 mg/L measured throughout the water column in Chatfield Reservoir only for months of July, August and September.
6c. Mainstem of the South Platte River from the outlet of Chatfield Reservoir to Bowles Avenue.		Aq Life Cold 1 Recreation 1a Water Supply Agriculture	*Cu (ac/ch) = TVS *2.7 below the confluence with Marcy Gulch to Bowles Avenue.
7. All tributaries to the South Platte River, including all lakes, and reservoirs and wetlands from a point immediately below the confluence with the North Fork of the South Platte River to the outlet of Chatfield Reservoir except for specific listings in Segments 8, 9, 10, 11, 12, and 13.	UP	Aq Life Cold 2 Recreation 1a Agriculture	
8. Mainstems of East and West Plum Creek from the source to the boundary of National Forest lands, including all tributaries, lakes, reservoirs and wetlands within the Plum Creek drainage which are on National Forest Lands, except for the specific listing in Segments 9 and 10b.		Aq Life Cold 1 Recreation 1a Water Supply Agriculture	
9. Mainstem of Bear Creek, including all tributaries, lakes, and reservoirs, and wetlands from the source to the inlet of Perry Park Reservoir (Douglas County).		Aq Life Cold 1 Recreation 1a Water Supply Agriculture	
10a. Mainstem of East and West Plum Creek and Plum Creek from the boundary of National Forest lands to Chatfield Reservoir, except for specific listings in Segment 10b.	UP	Aq Life Warm 1 Recreation 1a Water Supply Agriculture	Cu (ac/ch) = TVS *2.4 on East Plum Creek and Plum Creek below the Plum Creek Wastewater Authority Discharge. Temporary modification: NH ₃ (ac/ch) =TVS (old) (Type i). Expiration date of 12/31/2011.

REGION: 3 and 4 BASIN: Upper South Platte River	Designation	Classifications	Temporary Modifications & Standards
10b. Mainstem of West Plum Creek including all tributaries, lakes, reservoirs, and wetlands from its source to Perry Park Pond.		Aq Life Cold 1 Recreation 1a Water Supply Agriculture	
11a. All tributaries to the East Plum Creek system, including all lakes, reservoirs and wetlands which are not on national forest lands.	UP	Aq Life Warm 2 Recreation 1a Agriculture	
11b. All tributaries to the West Plum Creek system, including all lakes, reservoirs and wetlands, which are not on national forest lands, except for specific listings in Segments 9 and 12.	UP	Aq Life Warm 2 Recreation 1a Agriculture	Temporary modification: NH ₃ (ac/ch) =TVS (old) (Type i). Expiration date of 12/31/2011.

Table 2 Chatfield Watershed Standards

REGION: 3 and 4 BASIN: Upper South Platte River		Numeric and standards					
Stream segment Description		Physical and Biological	Inorganic mg/l			Metals ug/l	
6a	Mainstem of the South Platte River from a point immediately above the confluence with the North Fork of the South Platte River to the inlet of Chatfield Reservoir.	D.O. = 6.0 mg/l D.O. (sp)=7.0 mg/l pH = 6.5-9.0 F. Coli=200/100ml E. Coli=126/100ml	NH ₃ (ac/ch)=TVS Cl ₂ (ac)=0.019 Cl ₂ (ch)=0.011 CN=0.005	S=0.002 B=0.75 NO ₂ =0.05 NO ₃ =10 Cl=250 SO ₄ =WS	As(ac)=50(Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=WS(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ac/ch)=TVS Mn(ch)=WS(dis) Hg(ch)=0.01(Tot)	Ni(ac/ch)=TVS Se(ac/ch)=TVS Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac/ch)=TVS
6b	Chatfield Reservoir.	D.O. = 6.0 mg/l D.O. (sp)=7.0 mg/l pH = 6.5-9.0 F. Coli=200/100ml E. Coli=126/100ml	NH ₃ (ac/ch)=TVS Cl ₂ (ac)=0.019 Cl ₂ (ch)=0.011 CN=0.005	S=0.002 B=0.75 NO ₂ =0.05 NO ₃ =10 Cl=250 SO ₄ =WS	As(ac)=50(Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=WS(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ac/ch)=TVS Mn(ch)=WS(dis) Hg(ch)=0.01(Tot)	Ni(ac/ch)=TVS Se(ac/ch)=TVS Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac/ch)=TVS
6c	Mainstem of the South Platte River from the outlet of Chatfield Reservoir to Bowles Avenue.	D.O. = 6.0 mg/l D.O. (sp)=7.0 mg/l pH = 6.5-9.0 F. Coli=200/100ml E. Coli=126/100ml	NH ₃ (ac/ch)=TVS Cl ₂ (ac)=0.019 Cl ₂ (ch)=0.011 CN=0.005	S=0.002 B=0.75 NO ₂ =0.05 NO ₃ =10 Cl=250 SO ₄ =WS	As(ac)=50(Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS*	Fe(ch)=WS(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ac)=TVS Mn(ch)=90µg/l(dis) Hg(ch)=0.01(Tot)	Ni(ac/ch)=TVS Se(ac/ch)=TVS Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac/ch)=TVS
7	All tributaries to the South Platte River, including all lakes, and reservoirs and wetlands from a point immediately below the confluence with the North Fork of the South Platte River to the outlet of Chatfield Reservoir except for specific listings in Segments 8, 9, 10, 11, 12, and 13.	D.O. = 6.0 mg/l D.O. (sp)=7.0 mg/l pH = 6.5-9.0 F. Coli=200/100ml E. Coli=126/100ml	NH ₃ (ac/ch)=TVS Cl ₂ (ac)=0.019 Cl ₂ (ch)=0.011 CN=0.005	S=0.002 B=0.75 NO ₂ =0.05	As(ch)=100(Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS Cr III(ac)=TVS CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ac/ch)=TVS Hg(ch)=0.01(Tot)	Ni(ac/ch)=TVS Se(ac/ch)=TVS Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac/ch)=TVS
8	Mainstems of East and West Plum Creek from the source to the boundary of National Forest lands, including all tributaries, lakes, reservoirs and wetlands within the Plum Creek drainage which are on National Forest Lands, except for the specific listing in Segments 9 and 10b.	D.O.=6.0 mg/l D.O.(sp)=7.0 mg/l pH=6.5-9.0 F.Coli=200/100ml E. Coli=126/100ml	NH ₃ (ac/ch)=TVS Cl ₂ (ac)=0.019 Cl ₂ (ch)=0.011 CN=0.005	S=0.002 B=0.75 NO ₂ =0.05 NO ₃ =10 Cl=250 SO ₄ =WS	As(ac)=50(Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=WS(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ac/ch)=TVS Mn(ch)=WS(dis) Hg(ch)=0.01(Tot)	Ni(ac/ch)=TVS Se(ac/ch)=TVS Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac/ch)=TVS
9	Mainstem of Bear Creek, including all tributaries, lakes, and reservoirs, and wetlands from the source to the inlet of Perry Park Reservoir (Douglas County).	D.O.=6.0 mg/l D.O.(sp)=7.0 mg/l pH=6.5-9.0 F.Coli=200/100ml E. Coli=126/100ml	NH ₃ (ac/ch)=TVS Cl ₂ (ac)=0.019 Cl ₂ (ch)=0.011 CN=0.005	S=0.002 B=0.75 NO ₂ =0.05 NO ₃ =10 Cl=250 SO ₄ =WS	As(ac)=50(Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=WS(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ac/ch)=TVS Mn(ch)=WS(dis) Hg(ch)=0.01(Tot)	Ni(ac/ch)=TVS Se(ac/ch)=TVS Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac/ch)=TVS
10a	Mainstem of East and West Plum Creek and Plum Creek from the boundary of National Forest lands to Chatfield Reservoir, except for specific listings in Segment 10b.	D.O.= 5.0 mg/l pH = 6.5-9.0 F.Coli=200/100ml E. Coli=126/100ml	NH ₃ (ac/ch)=TVS Cl ₂ (ac)=0.019 Cl ₂ (ch)=0.011 CN=0.005	S=0.002 B=0.75 NO ₂ =0.5 NO ₃ =10 Cl=250 SO ₄ =WS	As(ac)=50(Trec) Cd(ac/ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS*	Fe(ch)=WS(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ac/ch)=TVS Mn(ch)=WS(dis)	Hg(ch)=0.01(Tot) Ni(ac/ch)=TVS Se(ac/ch)=TVS Ag(ac)=TVS Ag(ch)=TVS Zn(ac/ch)=TVS
10b	Mainstem of West Plum Creek including all tributaries, lakes, reservoirs, and wetlands from its source to Perry Park Pond.	D.O.=6.0 mg/l D.O.(sp)=7.0 mg/l pH=6.5-9.0 F.Coli=200/100ml E. Coli=126/100ml	NH ₃ (ac/ch)=TVS Cl ₂ (ac)=0.019 Cl ₂ (ch)=0.011 CN=0.005	S=0.002 B=0.75 NO ₂ =0.05 NO ₃ =10 Cl=250 SO ₄ =WS	As(ac)=50(Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=WS(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ac/ch)=TVS Mn(ch)=WS(dis) Hg(ch)=0.01(Tot)	Ni(ac/ch)=TVS Se(ac/ch)=TVS Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac/ch)=TVS
11a	All tributaries to the East Plum Creek system, including all lakes, reservoirs and wetlands which are not on national forest lands.	D.O.=5.0 mg/l pH=6.5-9.0 F.Coli=200/100ml E. Coli=126/100ml	NH ₃ (ac/ch)=TVS Cl ₂ (ac)=0.019 Cl ₂ (ch)=0.011 CN=0.005	S=0.002 B=0.75 NO ₂ =0.5	As(ch)=100(Trec) Cd(ac/ch)=TVS CrIII(ac/ch)=TVS CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ac/ch)=TVS Hg(ch)=0.01(Tot) Ni(ac/ch)=TVS	Se(ac/ch)=TVS Ag(ac)=TVS Zn(ac/ch)=TVS
11b	All tributaries to the West Plum Creek system, including all lakes, reservoirs and wetlands, which are not on national forest lands, except for specific listings in Segments 9 and 12.	D.O.=5.0 mg/l pH=6.5-9.0 F.Coli=200/100ml E. Coli=126/100ml	NH ₃ (ac/ch)=TVS Cl ₂ (ac)=0.019 Cl ₂ (ch)=0.011 CN=0.005	S=0.002 B=0.75 NO ₂ =0.5	As(ch)=100(Trec) Cd(ac/ch)=TVS CrIII(ac/ch)=TVS CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ac/ch)=TVS Hg(ch)=0.01(Tot) Ni(ac/ch)=TVS	Se(ac/ch)=TVS Ag(ac)=TVS Zn(ac/ch)=TVS

Chatfield Reservoir Control Regulation

The Colorado Water Quality Control Commission adopted the Chatfield Reservoir Control Regulation (Regulation 5 CCR 1002-73; Regulation No. 73) on July 10, 1989 and last amended the regulation on November 1, 2005. The control regulation consists of definitions and geographic boundary, a total maximum annual total phosphorus load with wasteload allocations, wastewater effluent limits and the associated trading program method for determining wasteloads, monitoring and annual reporting requirements and nonpoint source controls.

In 2005, the Authority and Division proposed revisions and updates to the Chatfield Reservoir Control Regulation (Regulation 5 CCR 1002-73; Regulation No. 73). These proposed changes were presented to the Water Quality Control Commission through rulemaking in November 2005. The amended changes took effect January 30, 2006. Changes to the control regulation as listed in the statement of basis and purpose were:

The Commission adopted changes, which include the addition of revised and new definitions, recognition that the margin of safety in the total maximum annual load equation is not an implicit margin of safety, adjusting the wasteload allocations for total phosphorus based on nonpoint source to point source trades and a reallocation within the Chatfield Watershed, identified how reclaimed wastewater applies to the wasteload allocation, recognizing four new wastewater treatment facilities, directed the Authority and the Division to coordinate review and actions on trade applications, clarified that the Division shall consider the Authority's decisions on trades in rendering its final decisions on such trades, incorporating an opportunity for public comment on trades, noticing that the Division's decisions on trades are subject to an adjudicatory process, identified the Authority as the monitoring and reporting authority, identified the quality assurance project plan as the mechanism to identify data collection, compilation and transfer protocols, recognized that the Authority is responsible for the development of an implementation program of best management practices, specified that the Authority will implement a nonpoint source management program, identified additional components of the annual report including trades and modeling efforts, and added a revised watershed map with all point sources located.

Total Maximum Annual Load (TMAL)

The Chatfield Reservoir Control Regulation #73 (5 CCR 1002-73:) incorporates the total maximum annual load (TMAL) that maintains wasteload allocations for point sources and the allowable nonpoint source load of 58,824 pounds of total phosphorus per year (Table 3). While the TMAL total phosphorus poundage allocation formula remains unchanged, the amount of total phosphorus assigned to the Chatfield Watershed is reduced because of approved nonpoint source to point source trades. The TMAL formula 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 7,533 lbs/yr with 51,291 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 reservoir base-load is derived from a five-year rolling average (annually adjusted for preceding 5-years of data) of total phosphorus load reaching Chatfield Reservoir. The TMAL incorporates an error based margin of safety.

Table 3 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	40,894
Reservoir Base-Load	13,400
Background Sources	19,961
Wasteload Allocation (Point Sources)	7,533
Upper South Platte River Watershed ¹	17,930
Reservoir Base-Load	6,000
Background Sources	11,842

Beneficial Use and Water Quality Standard Indicators

The reservoir trophic parameters reflect overall water quality trends. The trophic state indicators show a generally stable water quality state through 2006 (Figure 4). However, the 2003-04 water quality data showed a shift toward poorer 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 40).

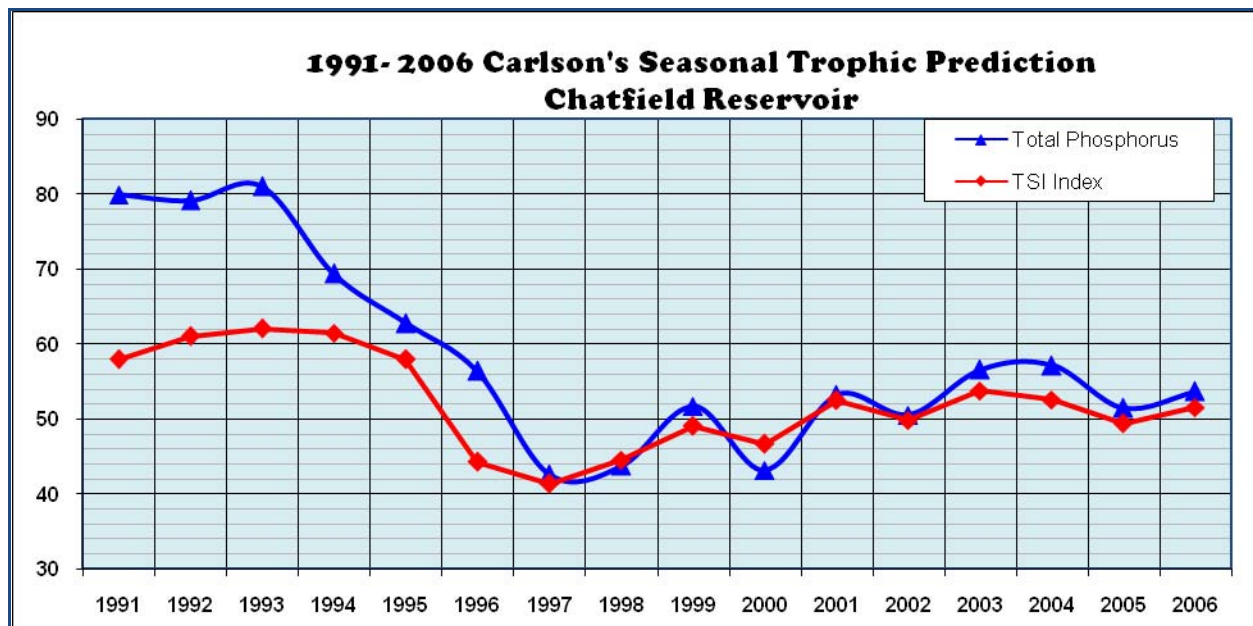


Figure 4 Carlson Season Trophic Index Trend

The reservoir water quality management program evaluates seasonal as well as long-term changes in seven categories:

- 1) Nutrient (nitrogen and phosphorus) concentrations and long-term 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 and zoological characteristics;
- 5) Reservoir trophic state as measured using both the Carlson Trophic Index and the Walker Trophic Index;
- 6) Characterization of mass loading into and from 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.

TMAL Compliance

The TMAL, 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. Chatfield Reservoir met the TMAL for all years except 1998 (Figure 5). However, this value is within the margin of safety and it was associated with a single large stormwater runoff event. The relationship of flow data and total phosphorus data are shown in Figure 6. Annual measured TMAL compliance values are shown in Table 4. Data shows a good record of compliance with the adopted TMAL, including basin sub-allocations. The assumptions and nonpoint source load allocations assigned to the Chatfield and Upper South Platte River source watersheds are reasonable.

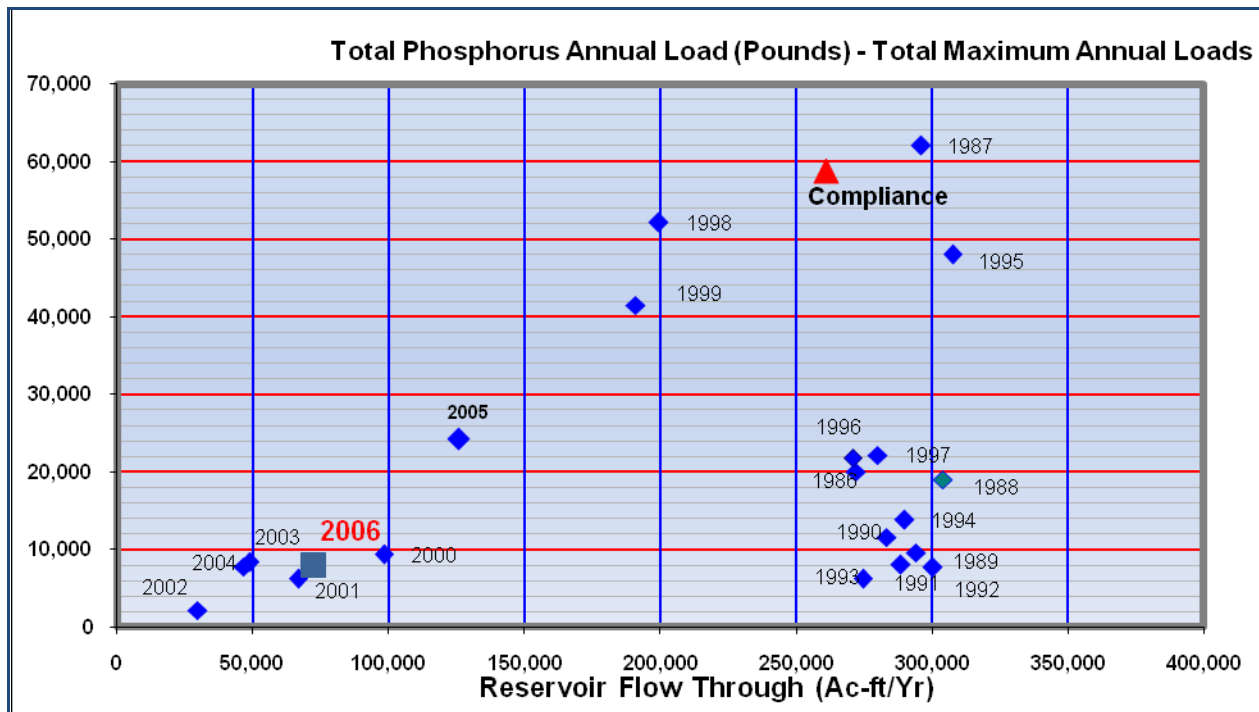


Figure 5 Annual Measured TMAL Values versus Control Regulation Target

Table 4 Total Phosphorus Loading 1986-2006

Annual	Total Volume acre-ft (Estimate)	Total Phosphorus Loading			
		Reservoir TP Load (Measured)	South Platte TP Load (Calc)	South Platte Average Conc. mg/l	Reservoir Average Conc. 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
2005	125,848	24,243	14,126	0.036	0.024
2006	72,518	7,848	5,965	0.027	0.026
Average	219,124	20,823	6,458	0.022	0.026

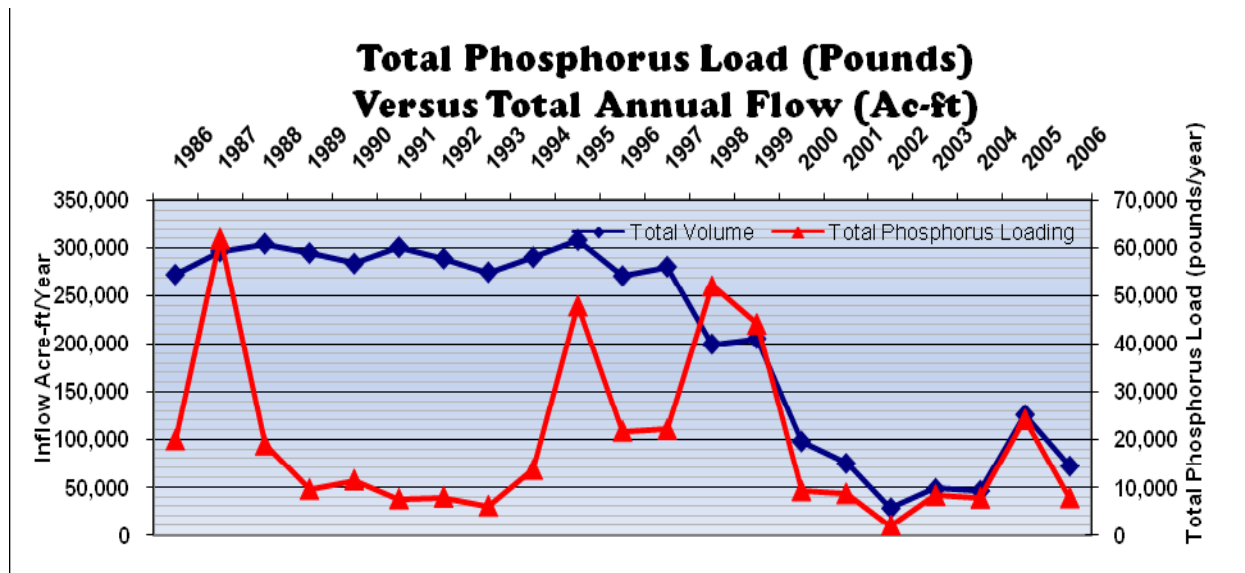


Figure 6 Phosphorus Load Versus Reservoir Inflow

Seasonal Total Phosphorus Compliance

The growing season (July-September) total phosphorus standard as listed in Regulation #38 is 27 ug/l as measured throughout the water column. The reservoir compliance with this total phosphorus standard is only 54% of the time (Table 5; Figure 7) with exceedance occurring in 4

out of the last six growing seasons. The growing season mean total phosphorus is 28 ug/l with a standard deviation of 11 ug/l. The total phosphorus seasonal concentrations have ranged from 12-60 ug/l. Although the seasonal total phosphorus concentrations remain elevated, the total maximum annual load of phosphorus reaching the reservoir remains well below the TMAL limit as listed in the control regulation (see Table 4)

The Chlorophyll *a* target of 17 ug/l has been met in all 24 years of monitoring record. The correlation between total phosphorus loading and chlorophyll productivity is a generally poor fit. The Authority believes increased external loading of nutrient from fire runoff in the upstream watershed has contributed to this increased seasonal total phosphorus loading and resulted in exceedance of the seasonal total phosphorus standard. The Authority is working with Douglas County to better quantify upstream nutrient loading attributable to fire runoff.

Table 5 Total Phosphorus Compliance

Total Phosphorus and Chlorophyll Compliance (Growing Season)		
Total Phosphorus Standard for Growing Season	27 ug/l	
Chlorophyll a Target	17 ug/l	
Years of seasonal record	1982-2006	24
Years of seasonal compliance for Total Phosphorus	13	54%
Years of seasonal attainment for Chlorophyll a	24	100%

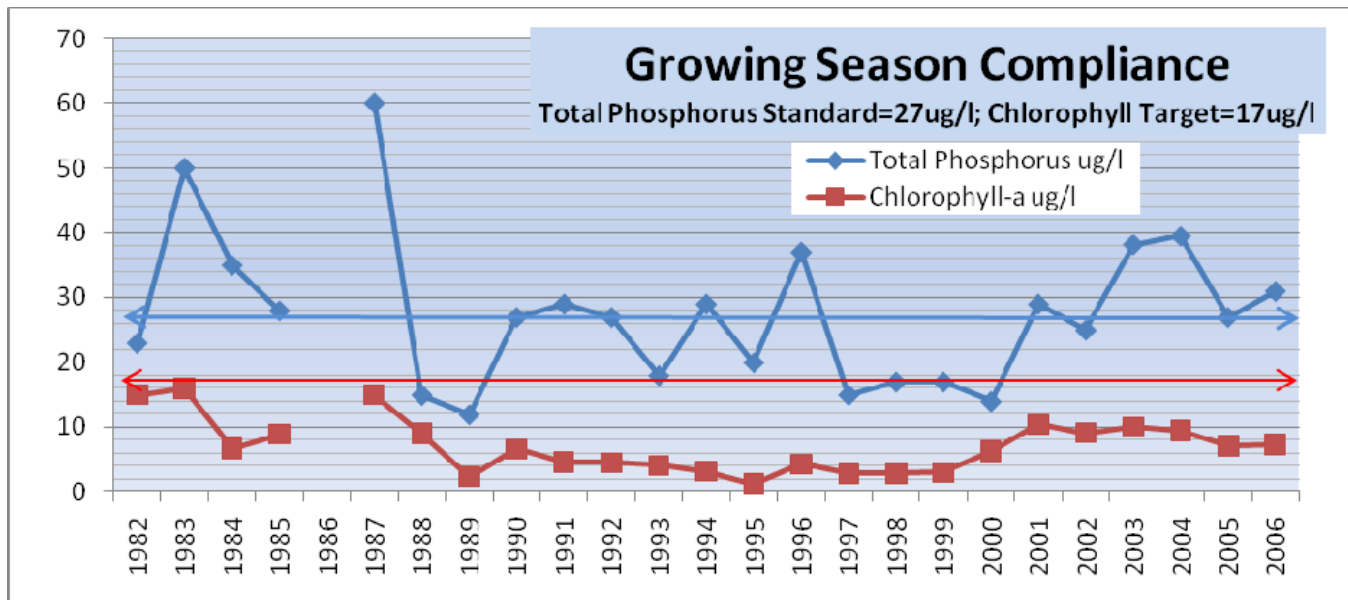


Figure 7 Reservoir Growing Season Compliance

Chatfield Watershed Partnership

The Chatfield Watershed Authority (Table 6) is the designated water quality management agency for the Chatfield Watershed. Associate members of the Authority are listed in Table 7. The Authority implements the *Chatfield Reservoir Control Regulation* (Regulation #73). The control regulation outlines the point source and nonpoint source wasteload allocations to implement the total maximum annual load (TMAL) for total phosphorus. Water quality data

collection for Chatfield Reservoir commenced with the *Clean Lakes Study* (DRCOG 1984). A continuous collection of surface water quality data in the watershed and reservoir began in 1990. Data collection includes specific chemical, physical and biological parameters.

Table 6 Authority Membership Entities and Wastewater Treatment Plants

Towns & Communities	Counties	Special Districts and Industry		Church Camps & Special Interests
<ul style="list-style-type: none"> • City of Littleton • Town of Castle Rock • Town of Larkspur 	<ul style="list-style-type: none"> • Jefferson • Douglas 	<ul style="list-style-type: none"> • Plum Creek Wastewater Authority • Castle Pines Metro District • Centennial Water & Sanitation District • Louviers Mutual Service Company 	<ul style="list-style-type: none"> • Lockheed Martin Space Systems Company • Roxborough Water & Sanitation District • Jackson Creek Ranch Metro District • Perry Park Water & Sanitation District • South Santa Fe Metropolitan Districts 	<ul style="list-style-type: none"> • Ponderosa Retreat & Recreation Center • Sacred Heart Retreat • Highlands Ranch Law Enforcement Center

Table 7 Chatfield Watershed Authority Associates

Level of Participation	Authority Associates
Intermittent	City of Aurora
Intermittent	Coalition for the Upper South Platte (CUSP)
Active	Colorado Department of Public Health & Environment - Water Quality Control Division
None	Colorado Department of Parks and Outdoor Recreation - Chatfield State Park ¹
Active	Denver Regional Council of Governments ²
Active	Tri-County Health Department
Active	U.S. Army Corp of Engineers ³

¹The 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.

²208 planning agency

³The U.S. Army Corps of Engineers operates Chatfield Reservoir (Figure 8)), including storage and releases of water. The Corps is an active and valuable member of the Authority.



Figure 8 Outlet Structure at Chatfield Reservoir

Authority Vision and Mission

The Authority vision statement is as follows:

The Chatfield Watershed Authority promotes protection of water quality in the Chatfield Watershed for recreation, fisheries, drinking water supplies, and other beneficial uses.

The Authority mission is as follows:

Protect the water quality of the Chatfield Watershed through a collaborative partnership to monitor, plan and implement necessary measures to ensure compliance with applicable water quality standards and classifications.

Wastewater Management and Publicly-Owned Treatment Works

The wastewater treatment facilities within the Chatfield Watershed include Plum Creek Wastewater Authority, Roxborough Water and Sanitation District, Centennial Water & Sanitation District, Louviers Mutual Service Company, Perry Park Water and Sanitation District, Lockheed Martin Space Systems Company, Sacred Heart Retreat, and South Santa Fe Metropolitan Districts (Table 8). 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 and Lockheed Martin are implementing 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. Construction of the pipeline began in 2006 and will be completed in 2007. The Plum Creek Wastewater Authority treatment plant completed expansion to 4.9 million gallons per day.

Table 8 Wastewater Treatment facilities and Permit Actions

Facility	Facility Type (Major/Minor)	Wastewater Utility Plan (Y/N)	Any Updates, Lift Station Reports, or Amendments (last 12-months, Y/N)	Expect Facility Upgrades within 5-years (Y/N)
<i>Town of Larkspur</i>	Major	No	no	yes
<i>Lockheed Martin</i>	Major	Yes	Outfall	Pipeline
<i>Louviers Mutual Service Company</i>	Major	Yes	Amendment	no
<i>Perry Park W&SD: Wauconda</i>	Major	Yes	no	no
<i>Perry Park W&SD: Sage Port</i>	Major	Yes	no	yes
<i>Plum Creek Wastewater Authority</i>	Major	Yes	No	yes
<i>Roxborough Park W&SD</i>	Major	Yes	lift station	Pipeline
<i>Jackson Creek Ranch</i>	Minor	Yes	no	unknown
<i>Law Enforcement Foundation: Centennial</i>	Minor	Yes	no	unknown
<i>Ponderosa</i>	Minor	Yes	permit	yes
<i>Sacred Heart</i>	Minor	No	no	no
<i>South Santa Fe Metro Districts</i>	Minor	Yes	yes	Build

Water Quality Monitoring

The Chatfield Watershed Authority maintains a water-quality monitoring program in the Chatfield Watershed (Figure 3, Fact Sheet 24). 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 in cooperation with the Colorado Water Quality Control Division (WQCD). 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 loads in compliance with the TMAL?*

Water-quality data were collected to 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 monitoring program characterizes inputs into the reservoir, the reservoir water column and outflow from the reservoir.

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 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 was 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

The Massey Draw Watershed and Ecosystem Improvements Pilot Project completed channel improvements in the section of Massey Draw from Wadsworth to C-470 (June 30, 2005; Jefferson County Section 319 Report). The Massey Draw drainage forms the northeast boundary of the Chatfield Watershed and this small drainage gulch discharges into the northwest corner of Chatfield Reservoir near the boat launching area. The project installed three enhanced drop structures, contoured eroded banks, made selected wetland and riparian habitat improvements, and included vegetation of trees, shrubs and groundcover. The project was designed to reduce sediment and nutrient loading into Chatfield Reservoir caused by

severe erosion. The vegetation and riparian improvements incorporate water quality mitigation features, which allow vegetation to further reduce nutrient loads carried in Massey Draw runoff.

The Authority provides water quality assessment of the project for both pre-construction and post-construction periods beginning in late 2002 and has continued data collection through the current year. Field parameters included specific conductance, pH, temperature and dissolved oxygen. Laboratory analysis included nitrate-nitrogen, total phosphorus, total suspended solids, and limited ammonia-nitrogen and ortho-phosphorus. The monitoring protocols for the Massey Draw monitoring program are consistent with the Authority's Quality Assurance Project Plan (Chatfield Authority January 2003). The Authority is responsible for quality control and quality assurance of the data.

The Chatfield Watershed Authority incorporated a limited water quality monitoring in Massey Draw from 2003 through 2006 into the standard monitoring program (Authority Supplemental Report Titled: *Water Quality Assessment of the "Massey Draw Watershed and Ecosystem Improvements Pilot Project"*, June 2006)

The 2002-through late 2004 data set characterizes the pre-construction water quality conditions. Beginning in 2005, the monitoring information was obtained to characterize both the effectiveness of the pilot project and the efficiency in nutrient and sediment reduction from the combined set of restoration practices. The Authority has not obtained enough information to assess the project's effectiveness or efficiency. The Authority committed to limited additional monitoring through 2006.

Supplemental Metal Monitoring

In 2006, the Authority reviewed the metal data collection frequency and modified sampling for metals. This supplemental metal sampling evaluates the expected increase in metal loading from the Hayman fire. Limited metal loading associated with the Hayman Fire runoff was recorded in 2006 by the Authority (see fact sheet #32).

2006 Data Report and Data Record

The Authority produced and distributed the 2006 Water Quality Monitoring Annual Data Report, (Authority March 2006). 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.

Authority Management Activities

Chatfield Reservoir Storage Reallocation Project

The Authority is a cooperating and review agency with the U.S. Army Corps of Engineers in the development of an Environmental Impact Statement on the Chatfield Reservoir 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 increase 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.

Referral Agency

The Authority is a referral agency for Douglas and Jefferson Counties' land use decisions. The Authority reviews land use documents for water quality and wastewater management implications. Through this review process, the Authority has adopted several policies and is developing new, appropriate policies to provide bases for review comments and establish a water quality management preference. Authority policies are intended to assist with water quality management within the watershed and are developed in cooperation with the Authority membership and specific involvement of the counties.

The Authority has established direction and policies for six review areas (www.chatfieldwatershed.org) and is developing five additional review policies:

1. Wastewater Service – Wastewater planning is consistent with the wastewater utility planning process of the DRCOG Metro Vision Plan.
2. Wastewater Treatment System Consolidation - the Authority promotes and facilitates discussion directed toward consolidation of wastewater treatment plants and/or works.
3. Reclaimed Water - the Authority supports the beneficial use of reclaimed water for irrigation applications within the Chatfield Watershed.
4. Floodplain Protection – the Authority discourages developments in the floodplain that will have a negative water quality aspect.
5. Data Transfer – the Authority will make data and information available to any requesting agencies or individuals; the Authority encourages the use of water quality data in the decision making process.
6. Best Management Practices – the Authority promotes use of best management practices that minimize the movement of sediments and nutrients off-site from development activities. The Authority supports BMPs that have water quality benefits.

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, Douglas County, City of Littleton and Town of Castle Rock have stormwater permitting programs.

Hayman Wildland Fire Special Monitoring

The Authority continues a special monitoring program for South Platte River inflow and reservoir water quality for selected fire related runoff parameters.

Duration of Recovery and Cooperative Efforts

Figure 9 Sediment Impacts From Hayman Runoff



The U.S. Forest Service estimates 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 assisting with the fire mitigation efforts necessary to restore damage from the Hayman burn (figure 9). The Coalition is extremely concerned about the water quality impact from fire area runoff. Additionally, the Denver Water Department is 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 Cheseman Reservoir.

Fire Recovery Downstream Monitoring

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. Chatfield Reservoir exceeded the growing season total phosphorus standard in 2003 and 2004 with the drought influenced runoff at extremely low flow. Increasing runoff in the South Platte River could have 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.

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 remains extreme. Downstream water quality data for 2003-2005 show some 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.

A summary of 2006 exceedances of measured metal standards from the South Platte River and Chatfield Reservoir are shown in Table 9. This table shows copper, mercury, manganese and zinc are parameters of concern. Due to detection of dissolved mercury and exceedance of the table value standard in August for total mercury of 1.4 ug/l, the Authority also obtained additional samples from the reservoir outfall in 2006. The 2006 dissolved mercury data or the South Platte River and Chatfield Reservoir is shown in Table 10. There was a larger runoff event associated with the Hayman area in 2006.

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. Long-term erosional potential causes uncertainty about sediment, nutrient & metal loading to downstream waterbodies.

Table 9 2006 Metal Values and Stream Standards

Hardness: South Platte River =111 mg/l; Reservoir = 133 mg/l	2006				Standards	
	Seg 6a River		Seg 6b Reservoir		Estimated Water Quality Standards 6a/6b	
	Maximum ug/l	Average ug/l	Maximum ug/l	Average ug/l	Standard Type	Standard (ug/l)
Silver (Dissolved)	0		280		Ag(ac)=TVS	2.39 Trout= 0.089 ug/l
Arsenic (Dissolved)	0.5	0.1	1	0.5	As(ac)=50(Trec)	50
Cadmium (Dissolved)	0		0		Cd(ac)=TVS	4.96 Trout= 4.11 ug/l
Chromium VI (Dissolved)	0		0		CrVI(ac)=TVS	16
Copper (Dissolved)	13.7	3	68.8	7	Cu(ac)=TVS	15.3
Nickel (Dissolved)	0		0		Ni(ac)=TVS	507
Iron (Dissolved)	2320	2030	60		Fe(ch)=300(dis)	300 Drinking water
Iron (Total)	1810		420	217	Fe(ch)=1000(Trec)	1000
Mercury (Dissolved)	0.4	0.07	0.8	0.26	Hg(ch)=0.01(Tot)	1.4 dissolved
Manganese (Dissolved)	26		248		Mn(ch)=50(dis)	50
Lead (Dissolved)	0		0		Pb(ac)=TVS	75
Selenium (Dissolved)	0		0		Se(ac)=10(Trec)	18.4 dissolved
Zinc (Dissolved)	43	13	40	23	Zn(ac)=TVS	132

Table 10 Dissolved Mercury (ug/l) for South Platte River & Chatfield Reservoir

	South Platte River	Reservoir
Jan-06	0	0
Feb-06	0	
Mar-06	0.2	0.2
Apr-06	0	0
May-06	0	0.8
Jun-06	0	0.4
Jul-06	0	0.3
Aug-06	0	0.4
Sep-06	0.4	0.5
Oct-06	0.3	0.3
Nov-06	0	0
Dec-06	0	0
N	12	11
Average	0.075	0.26364

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 instantaneous flow data) in 2006 was 75,500 acre-feet, which is about 29% of the “normal” condition identified in the control regulation. The measured load from the South Platte River in 2006 was 6,500 pounds total phosphorus, which was below the assigned base-load allocation. The 2006 total phosphorus load to the reservoir was 20,800 pounds of total phosphorus, which is below the TMAL limit.

Table 11 summarizes 2006 growing season nutrient concentrations. The total phosphorus loading in the South Platte River increased following the Buffalo Creek and Hayman Wildfire events (Figure 10). Although 2006 inflow into Chatfield Reservoir was below normal, the flow-based loading was increased as a result of runoff from the Upper South Platte Watershed. The historic growing season total phosphorus concentration trends as reservoir inputs compared with reservoir growing season averages are shown in Table 12 and Figures 10 and 11.

Table 11 2006 Growing Season Nutrients and 2002-2006 Fire Runoff Affects

2006 Growing Season Nutrients				
	South Platte Inflow	South Platte Outflow	Plum Creek	Reservoir Average
Nitrate/Nitrite as N, dissolved (ug/l)				Total Nitrogen (ug/l)
July	171	69	167	588
August	112	145	34	471
September	490	0	161	517
Phosphorus, ortho (ug/l)				
July	2	4	33	6
August	4	5	18	4
September	5	2	15	3
Phosphorus, total (ug/l)				
July	32	33	11	27
August	54	37	75	29
September	27	32	104	35

Table 12 Historic Growing Season Total Phosphorus Concentration Trends

Historic Total Phosphorus (Growing Season)				
	South Platte Inflow	South Platte Outflow	Plum Creek	Reservoir Average
1995	9	3	100	20
1996	179	60	56	37
1997	92	23	105	15
1998	44	38	100	17
1999	14	19	113	17
2000	20	23	30	14
2001	14	23	90	29
2002	25	23	38	25
2003	62	49	40	38
2004	79	31	138	40

Historic Total Phosphorus (Growing Season)				
	South Platte Inflow	South Platte Outflow	Plum Creek	Reservoir Average
2005	27	35	126	27
2006	38	34	63	31

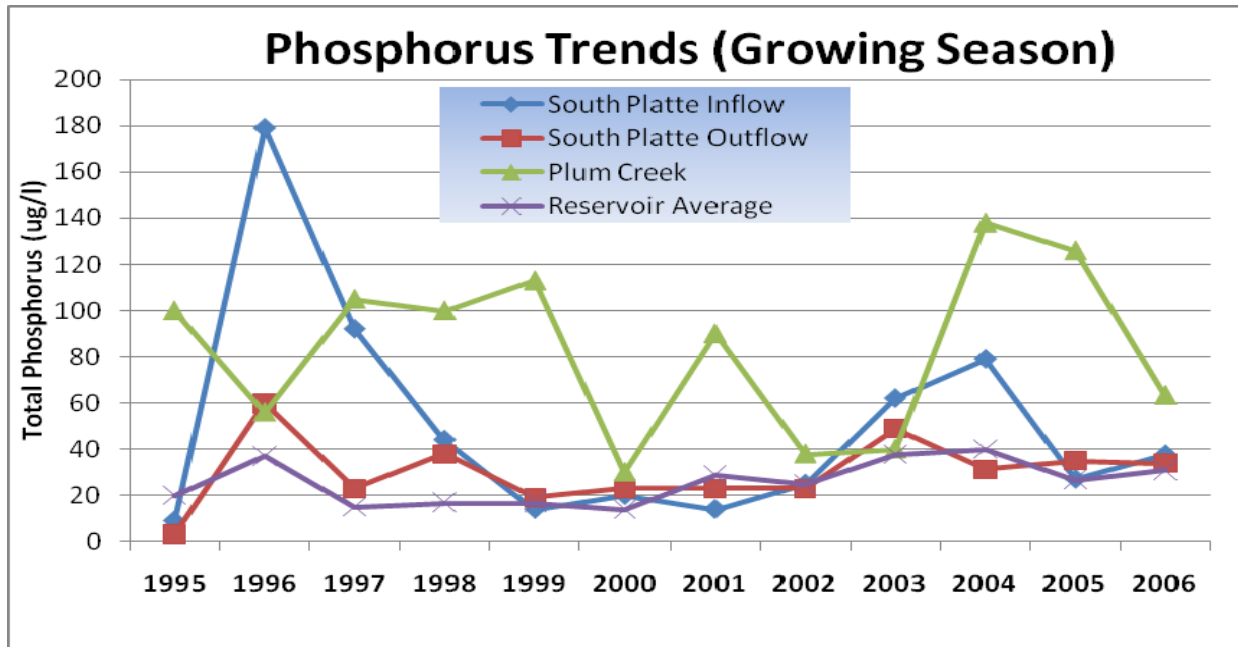


Figure 10 Total Phosphorus Reservoir Input Trends

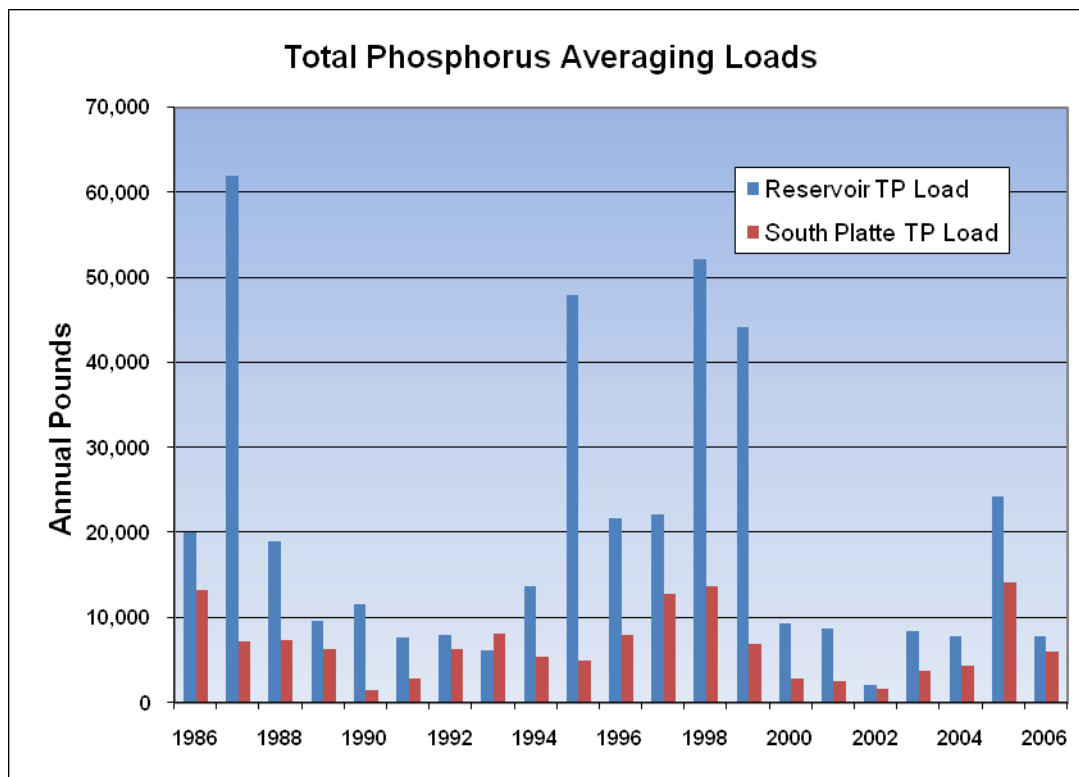


Figure 11 Comparison of SPR and Reservoir Total Phosphorus Loads

Supplemental Grant – Fire Runoff Research Needs

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

- 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.

Nonpoint Source Load Assumption Review Project

The Authority, in cooperation with the Division and the Coalition for the Upper South Platte (CUSP), contracted for a special review of nonpoint source load assumptions contained in this Control Regulation (Chatfield Authority March 2005). The independent review was conducted to determine the validity of nonpoint source load assumptions used to allocate total phosphorus between the Chatfield and the Upper South Platte River Watersheds as defined in this control regulation and as part of the adopted TMAL. The two goals of the review were:

1. *Review the nonpoint source and total maximum annual phosphorus load allocation assumptions incorporated into this Control Regulation as requested by the Water Quality Control Commission;*
2. *Independently certify assumptions and nonpoint source load allocations assigned to the Chatfield and Upper South Platte River source watersheds.*

A summary of the special project as contained in the control regulation statement of basis and purpose is as follows:

This review required 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 review provided specific comments in the form of a technical memorandum addressing the TMAL assumptions and distribution of the total phosphorus allocations contained in the control regulation. The special study summary, conclusions and recommendations are in a technical memorandum. (Stednick, March 31, 2005). The special evaluation concluded that the Authority should revise the original model, underlying assumptions, load variability, runoff coefficients, impacts from the Hayman Wildfire, and the relationship of total phosphorus and chlorophyll in the reservoir based on the long-term available data. The evaluation further determined that the Authority reached a reasonable conclusion on the distribution of total phosphorus pounds between the Upper South Platte River and Chatfield Watersheds. The special study did not see the need to readjust these watershed distributions of total phosphorus as listed in the control

regulation. The Commission finds that the assumptions and nonpoint source watershed distributions of 40,894 pounds of total phosphorus for the Chatfield Watershed and 17,930 pounds of total phosphorus for the Upper South Platte Watershed are supported by ongoing monitoring data, are reasonable. The study did note that the proposed expansion of the Chatfield Reservoir may affect water quality and any new operational plans should consider water quality concerns.

Based on these observations from the Stednick special review, the total phosphorus allocations between the Chatfield Watershed and the Upper South Platte Watershed remain reasonable and are supported by the ongoing water quality monitoring data. Additionally, the data collected and analyzed by the Chatfield Authority supports the watershed distributions of 40,894 pounds of total phosphorus for the Chatfield Watershed and 17,930 pounds of total phosphorus for the Upper South Platte Watershed. The Commission recognizes that the Authority and the Division do not agree on all of the findings of the Stednick study and directs both parties to work together cooperatively to examine the TMAL and underlying assumptions. With the understanding that implementation of the existing controls is resulting in attainment of the water quality standard for phosphorus and the goal for chlorophyll a for Chatfield Reservoir, the Commission directs the Division and the Authority, subject to available resources, to examine the TMAL and its underlying assumptions. The Authority and Division will report to the Commission at the next triennial review on progress made towards developing a plan, obtaining funding, and a schedule of future activities for such study.

Correlation Between Phosphorus and Chlorophyll

An underlying assumption of the TMAL is that phosphorus and chlorophyll are significantly correlated. Figure 12 shows the relationship between chlorophyll and total phosphorus using Authority data records. The data correlation shows a poor linear fit, no polynomial fit or a log relationship. The data suggests growing season phosphorus and chlorophyll are not significantly correlated for this waterbody. 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-a 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.

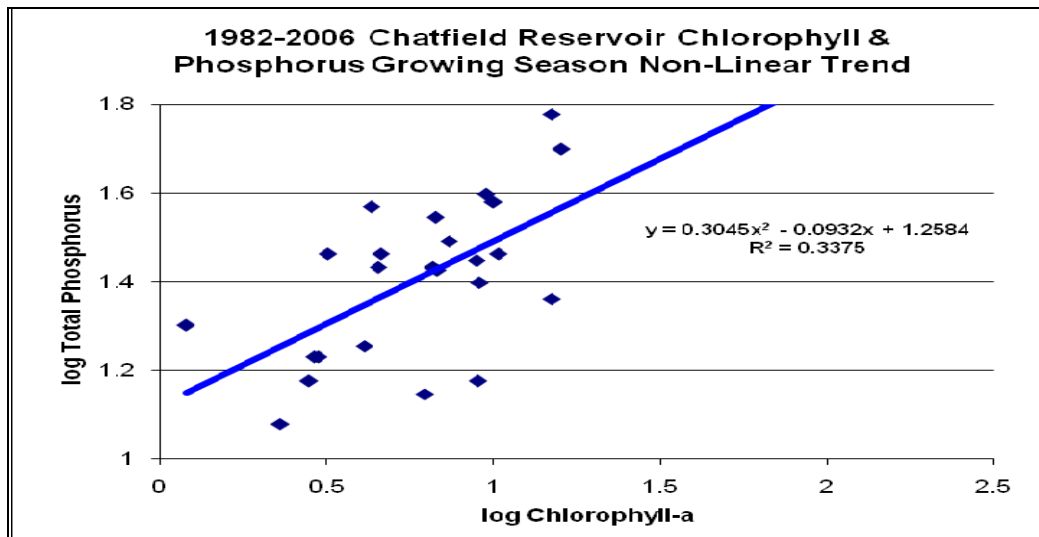


Figure 12 Growing Season Correlation between Phosphorus and Chlorophyll

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Fact Sheet 2006 Series

This series of fact sheets describe compliance with the adopted control regulation, the watershed management activities (Figure 13), water quality-monitoring program and analytical results from the 2006 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



Figure 13 Massey Draw Restoration

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. The TMAL allocations were adjusted by the Water Quality Control Commission in November 2005 (Effective January 30, 2006) to reflect nonpoint source to point source trades. Water quality modeling predicts total phosphorus loading in Chatfield Reservoir of 59,000 pounds of total phosphorus assimilated with an inflow volume of 261,000 ac-ft per year won't exceed the water quality standard of 0.027 mg/l. The total phosphorus load from point sources is limited to 7,533 lbs/yr with 58,824 lbs/yr allocated to all 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. A margin of safety incorporates error terms into the TMAL allocation of 59,000 pounds/year of phosphorus. Continuous water quality monitoring by the Authority confirms 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	
<hr/>	
Chatfield Watershed	40,894
Reservoir Base-Load	13,400
Background	19,961
Wasteload Allocation (point sources)	7,533 ¹
Upper South Platte River Watershed	17,930²
Reservoir Base-Load	6,000
Background	11,842
Summit County Wasteload Allocation	88
	58,824³

¹ 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 wildfires that are beyond the control of the permit holders.

² 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.

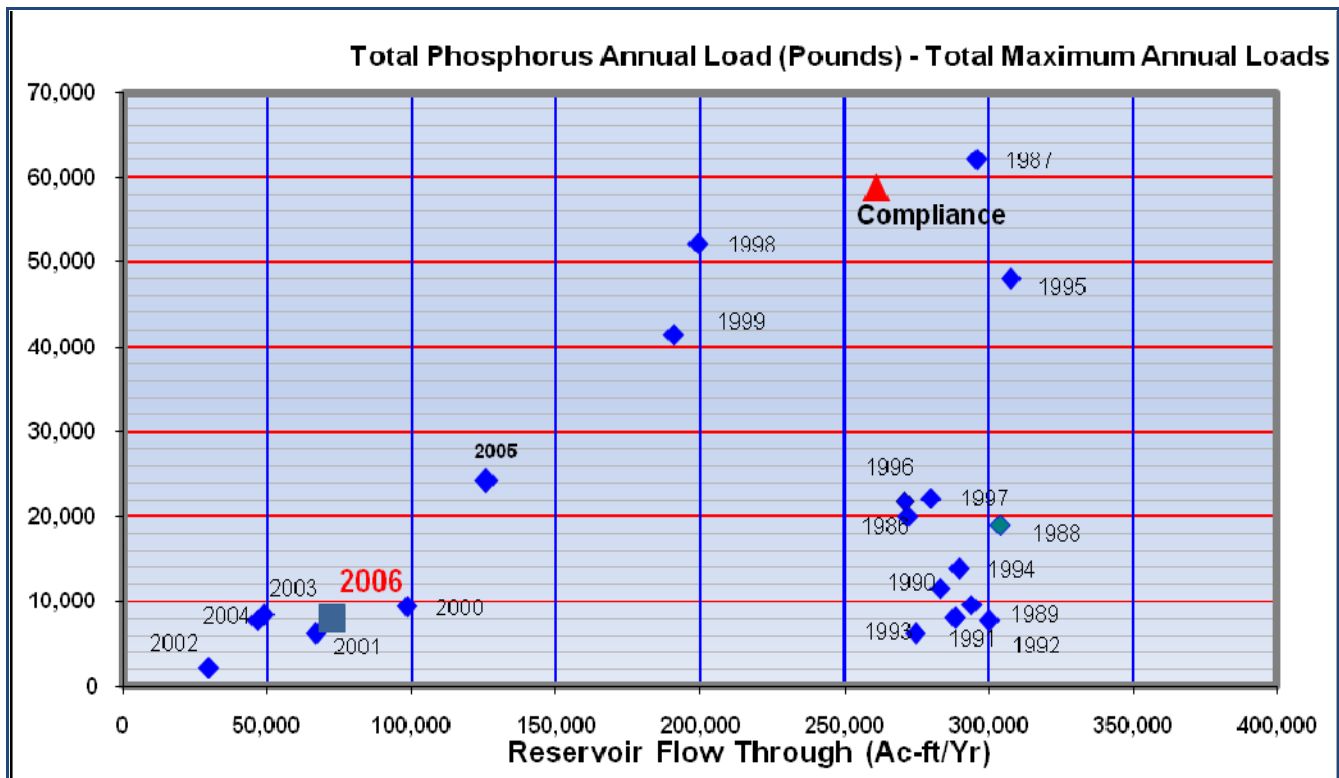
³ While the TMAL total phosphorus poundage allocation formula remains unchanged, the amount of total phosphorus assigned to the Chatfield Watershed is reduced because of approved nonpoint source to point source trades.

[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 phosphorus is related to 261,000 acre-feet total inflow. 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. A margin of safety protects the 17 ug/l chlorophyll growing-season goal based on error terms from the original model. This chlorophyll goal has been met in 24 years of continuous monitoring. There is not a linear relationship between the Total Phosphorus TMAL and reservoir inflow. While the Authority has noted compliance with the TMAL in 23 out of 24 years, there is a concern about compliance during low flow conditions and watershed events such as the Hayman Fire.

In 2006, the TMAL value of 7,845 pounds of total phosphorus appeared to be well below the compliance point based on an inflow of 72,525 acre-feet of water.



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 & 2006 Total Phosphorus Pounds Discharged From Treatment Plants in Chatfield Watershed

The total annual wasteload for point source phosphorus (among all permitted dischargers) in the Chatfield Watershed is 7,533 lbs/year.

In 2006, recorded total phosphorus discharges were 3,424.8 pounds/year or about 45% of the allowable total discharge poundage. Allocations for Sacred Heart, Ponderosa Center, Law Enforcement Foundation, and Jackson Creek were included in the Control Regulation #74 at the 2005 Rulemaking Hearing. All actively reporting dischargers were in compliance with the established wasteload allocations.

Allocation Sources	Regulatory Wasteload Allocation Pounds Per Year	2006 Point Source Total Pounds
Plum Creek Wastewater Authority	4,256	2,350
Lockheed Martin Space Systems Company	1,005	126
Roxborough Park Metro District	1,218	771.4
Perry Park Water & San. District-Waucondah	365	106.4
Perry Park Water & San. District-Sageport (Figure 14)	73	66
Town of Larkspur	231	0 ¹
Louviers Mutual Service Company	122	5
Sacred Heart Retreat	15 ²	No Monitoring
Ponderosa Center	75 ³	No Discharge ⁴
Jackson Creek Metropolitan District	50 ⁵	No Discharge ⁴
Centennial Law Enforcement Foundation	50 ⁶	No Discharge ⁴
Reserve/Emergency Pool	73	Not Used
Total Point Source Phosphorus Wasteload	7,533	3,424.8

1. Larkspur reported dry lysimeters in 2006 from their DMR Reports and claims no discharge.
2. Temporary five-year phosphorus allocation of 15 pounds for inclusion in discharge permit; obtained from the Reserve/Emergency Pool
3. Ponderosa Center received point source allocations through trades pursuant to the Authority Trading Guidelines.
4. No Discharge Data or Monitoring Program Not Established by Permit
5. Jackson Creek Ranch received point source allocations through trades pursuant to the Authority Trading Guidelines. Jackson Creek has a transfer agreement of 50 pounds with Roxborough Park that was temporarily decreased to 38.5 pounds in 2005.
6. Centennial received point source allocations through trades pursuant to the Authority Trading Guidelines.



Figure 14 Sageport POTW (Perry Park)

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

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 Authority trading guidelines were under update throughout 2006 as a result of changes made to the control regulation in 2005. Numerous review iterations of the trading guidelines were required by the WQCD and no final product was approved by the Authority or Division in 2006.

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 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 (Jackson Creek Ranch; South Santa Fe Metropolitan Districts, Ponderosa Retreat Center and Law Enforcement Foundation).
- Point source to point source transfers (Approved transfer from Roxborough Park for Jackson Creek Ranch; Temporary trade from Lockheed Martin to Plum Creek Metropolitan District).
- 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.

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.

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 RATIO
The amount of point source trade credit shall be based upon one pound of credit for two pounds of nonpoint source reduction.

Fact Sheet # 5. Control Regulation: Special Review of Nonpoint Assumptions as Published In the Chatfield Reservoir Control Regulation



This fact sheet reflects information taken from the Chatfield Control Regulation #74 statement of basis and purpose.

Chatfield Control Regulation Wasteload allocation load assumptions and distributions deemed "reasonable in independent evaluation"

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 special study summary, conclusions and recommendations are in an Authority technical memorandum. (Stednick, March 31, 2005). The review process did not alter the existing wasteload allocations. It evaluated the validity of nonpoint source load assumptions used to allocate total phosphorus between the Chatfield and Upper South Platte River Watersheds. This review process evaluated 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 TMAL developed nonpoint load allocations from a ten-year running average of water quality data 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 Stednick study found that the Authority reached a reasonable conclusion on the distribution of total phosphorus pounds between the South Platte River and Chatfield Watersheds. The study did not see the need to readjust these watershed distributions of total phosphorus as listed in the control regulation. The assumptions and nonpoint source load allocations assigned to the Chatfield and Upper South Platte River source watersheds were concluded as reasonable. The study also made a number of recommendations related to re-evaluation of the TMAL, reviewing underlying assumptions and assessing alternative modeling approaches. Some of these findings from the special study were incorporated into the update to the Chatfield Control Regulation.



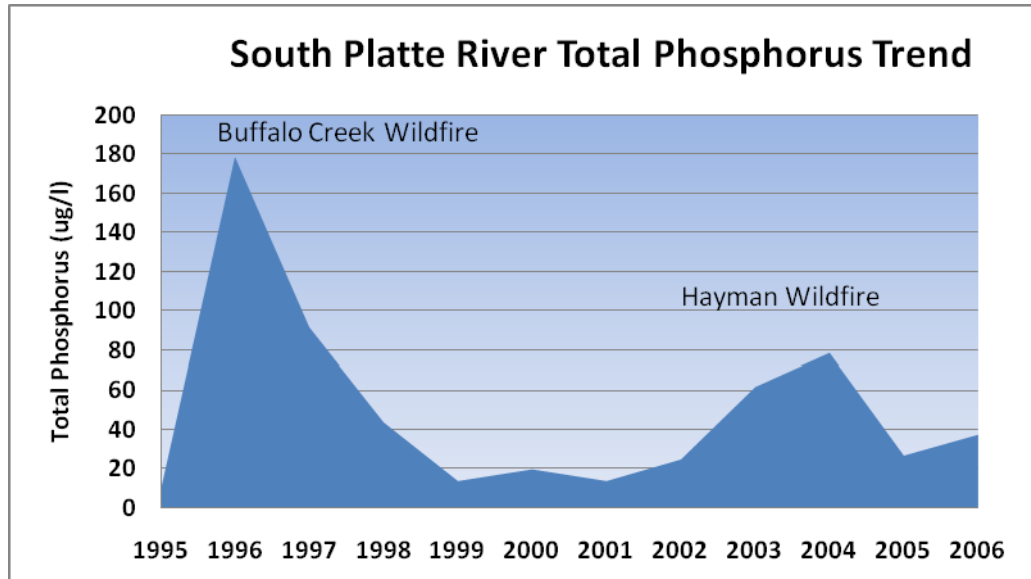
Fact Sheet # 6. Control Regulation: Underlying Watershed Total Phosphorus Annual Allocation Assumptions

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 2002-2006, 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 Downstream Growing Season Water Quality

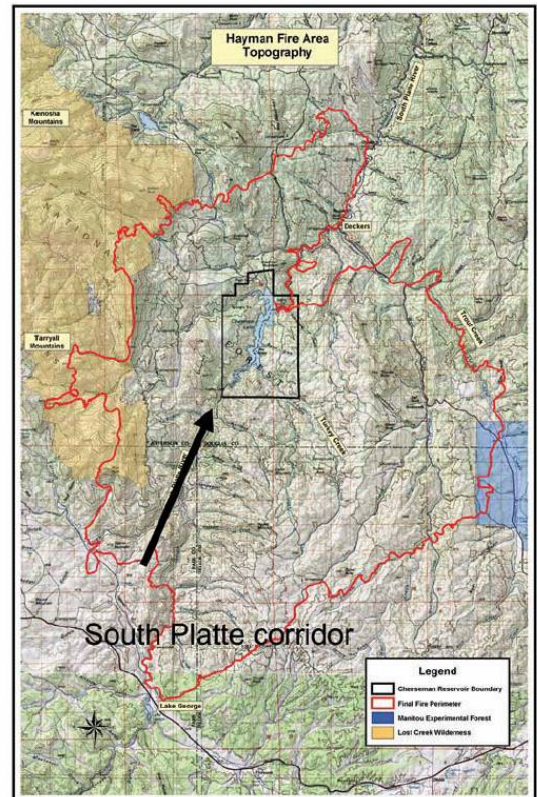
The Hayman fire burned over 137,000 acres of Ponderosa Pine and Douglas Fir forest. This extremely hot fire vitrified soils and produced large tracts of impermeable surface with greatly increased runoff. The fire severely damaged 11 watersheds and



threatens a major water supply for the Denver region. Over 188 miles of perennial streams and 182 miles of intermittent streams were damaged. 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 2002-2006 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 (Figure 15) from the 2002 Hayman Wildland Fire could exceed numeric water quality standards for decades. The 2003 and 2004 growing season total phosphorus was 38 and 37 ug/l, respectively with the standard set at 27 ug/l. In 2006, the reservoir average was 31 ug/l. The standard exceedances are of great concern to the Authority. Consequently, water quality management programs currently in place to address other pollution problems are now jeopardized. The Authority monitors both inflow and outflow water quality within Chatfield Reservoir in the hope that the effects will be attenuated and not as long lasting.



Figure 15 Erosion From Horse Creek



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

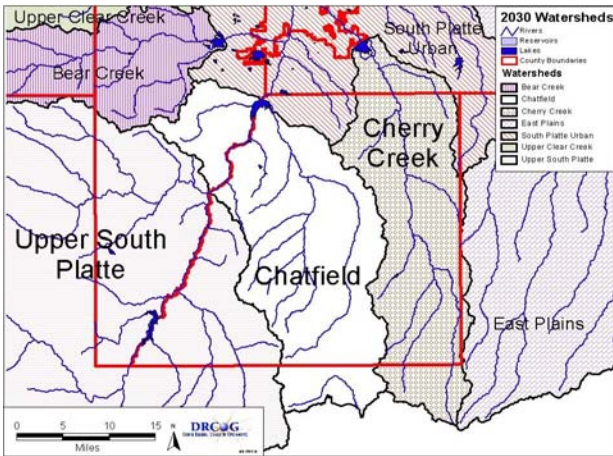
The reservoir is known as a top Walleye fishery. Spring and fall trout fishing is excellent. Bass, channel catfish, yellow perch and crappie are caught in summer. Ice fishing occurs in the winter. Year-round fishing and seasonal boating are major recreational uses.



More than 300 species of birds are observed in the 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, 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 Authority members and associates to the Authority are listed below:

Towns & Communities	Counties	Special Districts and Industry		Church Camps & Special Interest
<ul style="list-style-type: none"> • City of Littleton • Town of Castle Rock • Town of Larkspur 	<ul style="list-style-type: none"> • Jefferson • Douglas 	<ul style="list-style-type: none"> • Plum Creek Wastewater Authority • Castle Pines Metro District • Centennial Water & Sanitation District • Louviers Mutual Service Company 	<ul style="list-style-type: none"> • Lockheed Martin Space Systems Company • Roxborough Water & Sanitation District • Jackson Creek Ranch Metro District • Perry Park Water & Sanitation District • South Santa Fe Metro Districts 	<ul style="list-style-type: none"> • Ponderosa Retreat & Recreation Center • Sacred Heart Retreat • Highlands Ranch Law Enforcement Center

Level of Participation	Authority Associates
Intermittent	City of Aurora
Intermittent	Coalition for the Upper South Platte (CUSP)
Active	Colorado Department of Public Health & Environment - Water Quality Control Division
None	Colorado Department of Parks and Outdoor Recreation - Chatfield State Park ¹
Active	Denver Regional Council of Governments ²
Active	Tri-County Health Department
Active	U.S. Army Corp of Engineers ³

¹ 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.

² 208 planning agency

³ 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.

Fact Sheet # 11. Management: 2006 Wastewater and Review Activities
Dog Park BMPs Castle Rock

Treatment Plants

- South Santa Fe Metropolitan Districts
- Town of Larkspur
- Louviers Mutual Service Company Treatment Plant Planning
 - ✓ Regionalization
 - ✓ Site Application
 - ✓ Approved Wastewater Utility plan
- Ponderosa Retreat Center
 - ✓ Trade Agreement
- Plum Creek Metropolitan District utility plan
 - ✓ Lift Station amendments for Castle Rock
 - ✓ Plum Creek Treatment Plant expansion
- Roxborough Water and Sanitation Pipeline Project



Lift Station Reports Approved

- Roxborough Water and Sanitation Pipeline Lift Station
- Plum Creek Wastewater Authority



Review Process and Policies

- Low impact development guidance
- Manure management policy
- Active Referral Agency for Jefferson and Douglas Counties (15 reviews)
- Wastewater Service Planning for Titan Road
- Roxborough Park & Lockheed Martin wastewater management strategies (Fact Sheet #16)
- Chatfield Reservoir Reallocation Environmental Impact Scoping
 - Ravenna Development and Wastewater Service Options
 - Revise Data Management Protocols
 - Review Quality Assurance Plan & Sampling Protocols; Revised Monitoring Program
 - Water Reuse Policy
 - Reviewed Nonpoint Source Practices And Stormwater Management Role With Counties
 - Review Chatfield Control Regulation



Suspected illicit wastewater source at Chatfield State Park

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 \$29.4 million expansion of their advanced regional water reclamation wastewater treatment facility with a phased wastewater discharge capacity of 4.9 million gallons per day (MGD) to 10.7 MGD. The treatment plant serves the Town of Castle Rock, Castle Pines Metropolitan District, and Castle Pines North Metropolitan District.

“The new plant was everything we had hoped for and much more and positions PCWA for meeting the needs of the community for many years to come.”

New Treatment Plant Constructed

Plum Creek Wastewater Authority finished 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 Funding Plan 2006-2010

The Authority maintains a management program through funding provided by annual dues from Authority members and contributing participants. The Authority maintains a 5-year funding plan that is updated annually (current plan extends from 2006-2010).

The Authority faces 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 resources to other needed projects. The Authority has identified several nonpoint source project needs for the watershed including severe erosion areas, manure waste management, phosphorus load tributaries and fire runoff impacts



Horse Stable Manure Waste Requires Future Funding to Fix Problem and Protect Water Quality

The 2006 annual dues collected from members and contributing participants with interest payments are about \$130,000. The decision by any member not to participate will create a revenue shortfall and limit activities.

Beginning in 2004, the Authority devoted financial resources for development and construction of water quality improvement projects.

Program Work Element	Actual				Proposed			
	2003	2004	2005	2006	2007	2008	2009	2010
Dues Income	\$110,000	\$113,900	\$126,500	\$132,000	\$135,000	\$140,000	\$145,000	\$150,000
Base Program								
Water Quality Monitoring Program	\$52,000	\$52,000	\$52,000	\$53,000	\$54,000	\$55,000	\$56,000	\$57,000
Administration & Program Management	\$38,000	\$38,000	\$38,000	\$38,000	\$38,000	\$40,000	\$40,000	\$40,000
Audit and Legal (Minimum)	\$6,500	\$6,500	\$6,500	\$6,500	\$6,500	\$6,500	\$6,500	\$6,500
WQCC - Triennial Review & Rulemaking	\$0	\$5,000	\$5,000	\$0	\$0	\$5,000	\$0	\$5,000
Special Fire Monitoring		\$8,000	\$8,000	\$8,000	\$7,000	\$6,000	\$5,000	\$3,000
Nonpoint Monitoring & Management		\$3,000	\$3,000	\$3,000	\$5,000	\$5,000	\$5,000	\$5,000
Special Projects & Education	\$5,000	\$5,000	\$7,500	\$20,000	\$18,000	\$15,000	\$25,000	\$25,000
Contingency	\$5,500	\$5,500	\$5,500	\$6,000	\$7,000	\$7,500	\$8,000	\$8,500
Estimated Annual Expenses	107,000	123,000	125,500	134,500	135,500	140,000	145,500	150,000

The Authority applies for various grants and may 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

Monitoring Record = 1982-83 and 1986-2006

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	\$ 55,000
Management	\$ 50,000
Other (Project, Legal, Tabor)	\$ 25,000

Minimum Annual Costs	\$ 130,000



Fact Sheet # 15. Management: 2006 Authority Activities

Plum Creek At Titan Road



The Chatfield Watershed Authority implements a water quality planning and implementation program for Chatfield Watershed. The 2006 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 2006 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, Ponderosa Center, Lockheed Martin, Roxborough Water & Sanitation, Perry Park, Sedalia, South Santa Fe Metropolitan Districts and Louviers;
- 3) Maintained Authority Web Site;
- 4) Involved in 319 nonpoint source project proposal for Douglas County and at Massey Draw and continued water quality monitoring effort for dry and wet weather events;
- 5) Member involvement with stormwater runoff programs;
- 6) Involvement with federal, state & local agencies (e.g., U.S. Army Corps of Engineers, Douglas County, and parks and recreation);
- 7) Links with local programs & activities (e.g., open space planning & environmental review);
- 8) Reviewed monitoring program to provide essential data and address up stream loading concerns and improve the efficiency of the monitoring program;
- 9) Addressing drought and fire management implications (Hayman burn area) and impacts to standards and uses; and
- 10) Roxborough, 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

South Platte River Above Reservoir

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).



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. The Littleton Englewood wastewater treatment plant and Roxborough have 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

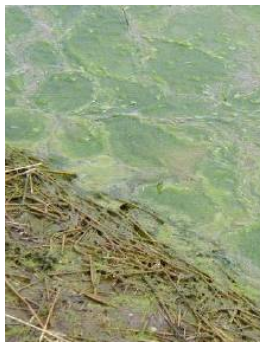
- Covered under the General Permit for Stormwater Discharges Associated with Municipal Separate Storm Sewer Systems
- Storm sewer outfall map to trace sources of potential illicit discharges and illegal dumping
- Added stormwater information to the County's web page
- Revised County's standard for storm 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 Grading, Erosion and Sediment Control (GESC) Criteria Manual promotes environmentally-sound county construction practices
- The Douglas County Storm drainage design and technical criteria manual, used for design, inspection and enforcement of stormwater systems, includes 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 on-site erosion controls reduces annual phosphorus loading by an average of 300 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 - Lockheed Martin completed a number of erosion control/sediment reduction projects. These projects reduce non-point phosphorus loadings by at least 300 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.

Massy Draw

Massey Draw Project - This active project (completed 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. The Authority monitors water quality.



Roxborough Water & Sanitation- Roxborough has a runoff detention system that reduces the amount of nonpoint source total phosphorus reaching adjacent waters. The Authority works with Roxborough 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 2006.

Tri-County Health Department operates the Douglas County Household Chemical Roundup Program. In 2006, the Program operated three, one-day Household Chemical Roundup events to collect household hazardous wastes from homeowners. A total of 2,304 vehicles participated from an estimated 2,650 households. Over 121 tons of hazardous materials were collected, including 6,204 gallons of hazardous liquids (oil, antifreeze, flammable liquids, and reactive chemicals), 12,825 pounds of pesticides, 150 pounds of mercury-containing devices and mercury-contaminated waste, and more than 91 tons of paint and paint products. In addition, 649 tires and 554 propane tanks were recycled. The Program's success is dependent on the numerous agencies and individuals. Individual participants at the Roundups donated more than \$35,620.

Fact Sheet # 22. **Nonpoint Source Management: Massey Draw Restoration Project**



Problem: Massey Draw drains directly into Chatfield Reservoir. This gulch has been extensively developed and urbanized within the upper portions and now delivers year-round flow (1 to 10 cubic feet per second per day) to the Chatfield Reservoir. A



100-year event can produce over 3,500 cfs flow. The lower portions of Massey Draw are subject to flooding, which has caused severe erosion and sediment transport. A 1992 special nonpoint source study by the Chatfield Authority estimated this entire drainage system could contribute over 7,000 pounds of total phosphorus to the reservoir on an annual basis. The sediment transport characterized by total suspended solids data suggests the drainage system could contribute 100s of tons of suspended sediment on an annual basis. Increased downstream erosion has exacerbated this sediment loading problem in recent years. Additionally, the drainage system is a source of nitrate-nitrogen that contributes to the eutrophication of Chatfield Reservoir.



Project: In 2004-05, the Massey Draw Watershed and Ecosystem Improvements Pilot Project constructed three enhanced drop structures, added wetlands and riparian habitat improvements to a portion of Massey Draw between Wadsworth and C-470. The restoration effort corrected



severe bank and channel erosion. The project is designed to reduce total phosphorous and sediment loading entering the reservoir. The project provides information and education opportunities, and demonstrates how erosion control practices can be naturally and aesthetically incorporated into a restoration effort while remaining practical.



Stakeholders: A diverse group of stakeholders implemented the project: Jefferson County, Urban Drainage & Flood Control District, and Lockheed Martin provided funding with support from Chatfield Watershed Authority, the United States Army Corps of Engineers, the Denver Botanic Gardens/Chatfield Nature Preserve, Roxborough Park District, and Volunteers for Outdoors Colorado (VOC), Colorado State Parks and the Denver Regional Council of Governments.



Project Status: Improvements to the channel and three drop structures were completed in the beginning of 2005. New wetland and riparian habitat was established, along with >100 plantings of Cottonwoods, willows and small shrubs by June 2005. Informational signs, viewing sites, benches & educational opportunities are being extensively used by the public. The project turned an eye-sore into asset and a water quality problem into a solution. Measurable sediment, nitrogen and phosphorus reduction effectiveness and efficiency testing of the restoration best management practices

is scheduled through the 2007 data collection season. However, the Authority predicts that it will take several additional years of Authority post-construction data collection to fully evaluate the project. The Authority is exploring options for additional funding to continue data collection and analyses.



Water Quality Monitoring: The Authority pre-construction monitoring program gathered background information to characterize natural runoff and stormwater loading in lower Massey Draw prior to discharge into the Chatfield State Park. Pre-construction estimates by the Authority suggest restoration of lower Massey Draw could reduce over 500 pounds per year of total phosphorus from reaching Chatfield Reservoir based on average daily flows without accounting for storm runoff loadings. The project should also reduce nitrogen and sediment loading, and related urban stormwater pollutants. The Authority collected limited water quality data in Massey Draw from 2003 through 2006, with an expectation to gather information for about one-years after project completion

(2006). The Massey Draw monitoring program is incorporated into the Authority's standard monitoring program. Pre-construction data and preliminary post-construction data are shown below:

	Pre-Construction				Post-Construction			
	Average	N	Minimum	Maximum	Average	N	Minimum	Maximum
Specific Conductance (uS/cm)	633	6	107	1,040	827	9	108	1,650
Nitrate Nitrogen (ug/l)	2,737	10	596	8,265	1.8	9	0.7	2.64
Total Phosphorus (ug/L)	161	10	2	532	141	9	29	388
pH (standard unit)	7.7	6	7.42	7.92	7	6	6.1	8.2
Total Suspended Sediments (mg/L)	120	9	8.4	475	41	9	1.4	151
Temperature (Degrees C)	14.5	6	7.2	21.1	14.6	9	8.9	21

Fact Sheet # 23. Nonpoint Source Management: Sources In Chatfield State Park

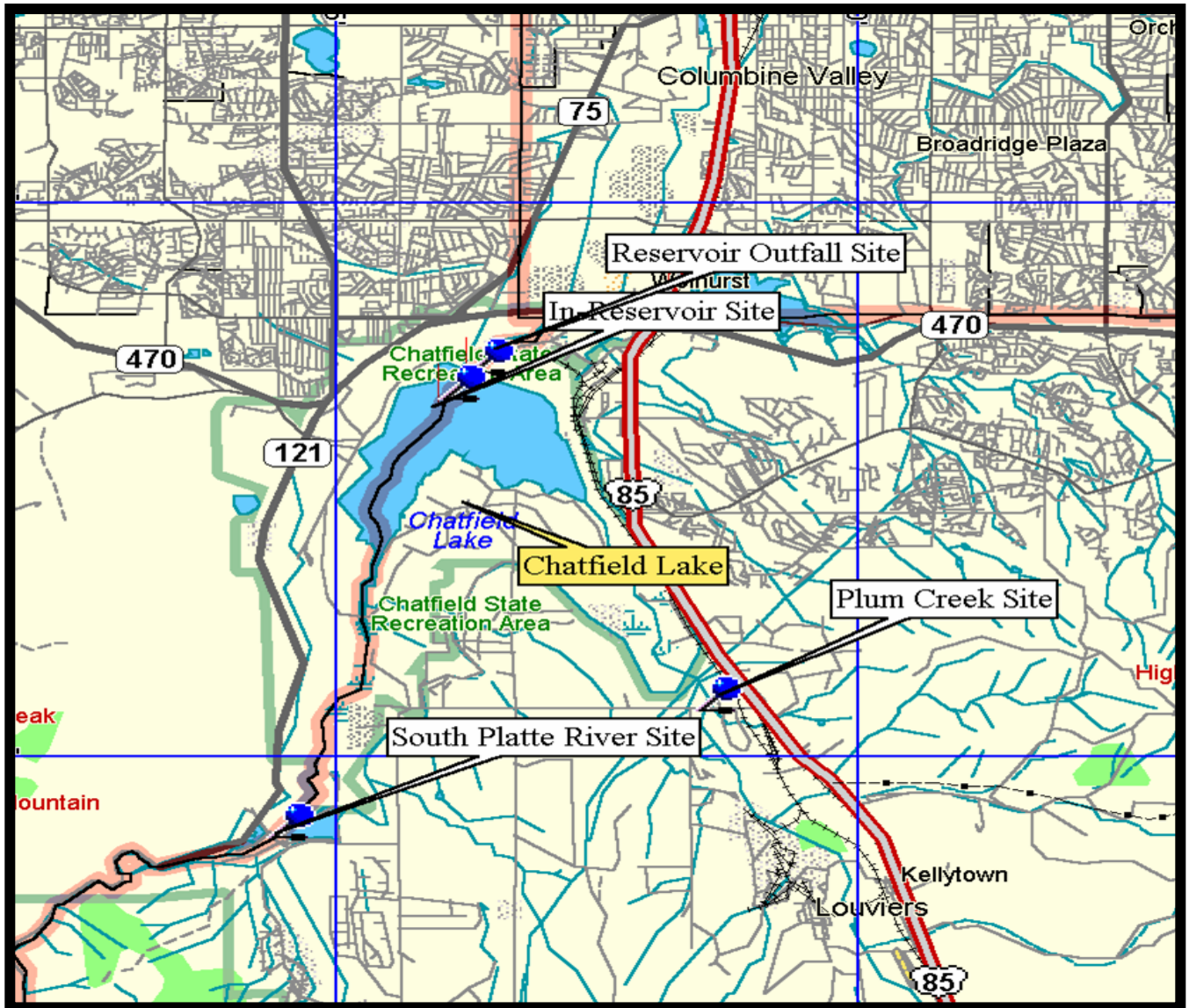
Direct and indirect discharge of pollutants from a variety of nonpoint sources occurs within Chatfield State Park. Potential pollutant types include sediment erosion (sloughing of steep shorelines, construction activities and drainage channel erosion), trash, floatables and debris (in Park, shoreline 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 # 24. 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)

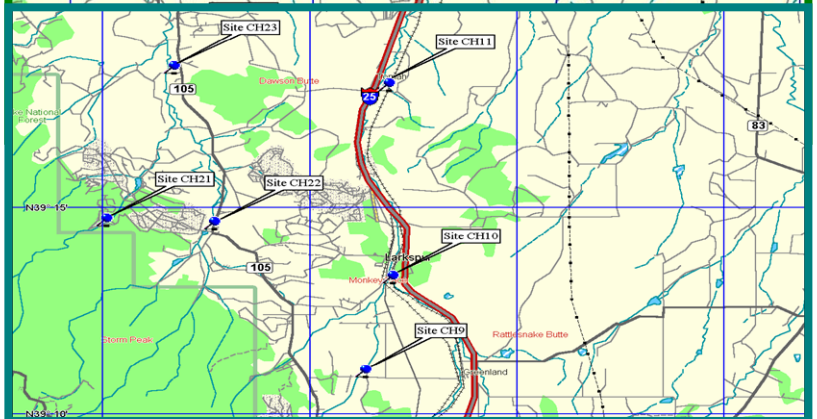
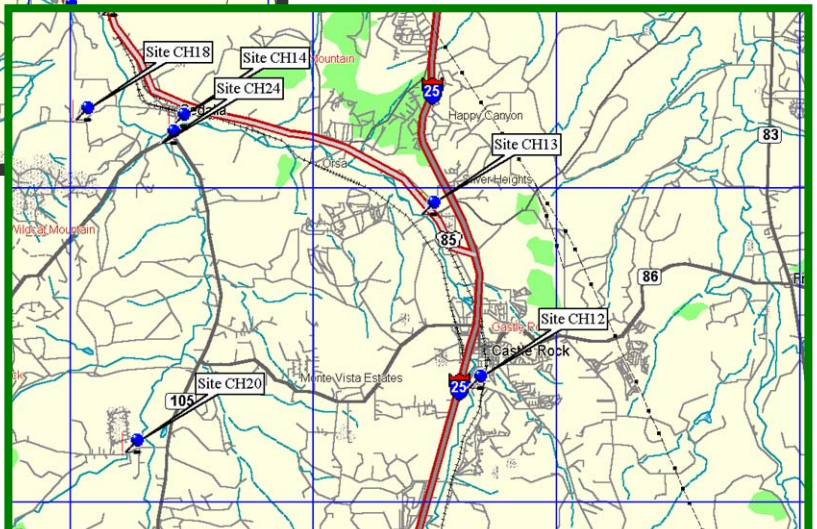
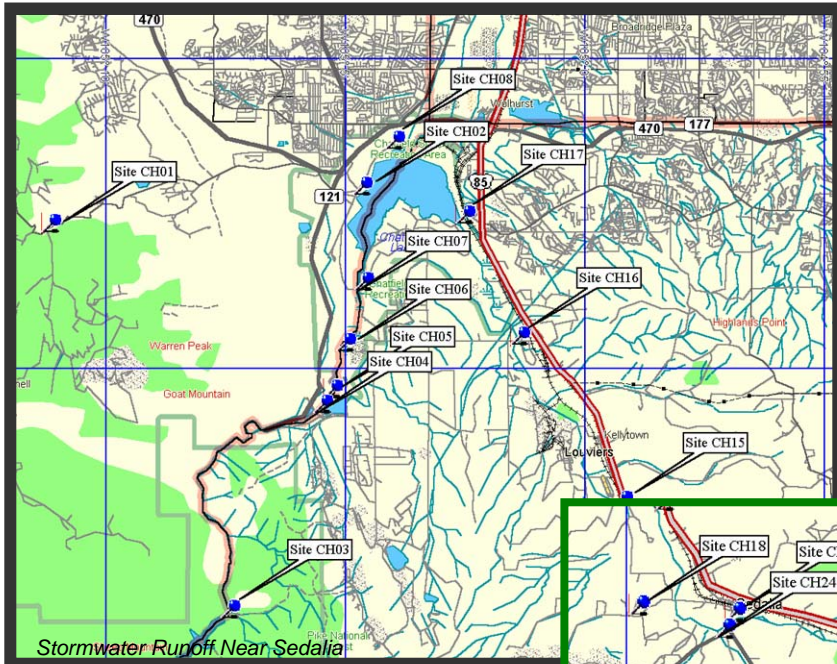


Fact Sheet # 25. Watershed Monitoring: Nutrient Screening Survey Potential Projects

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.

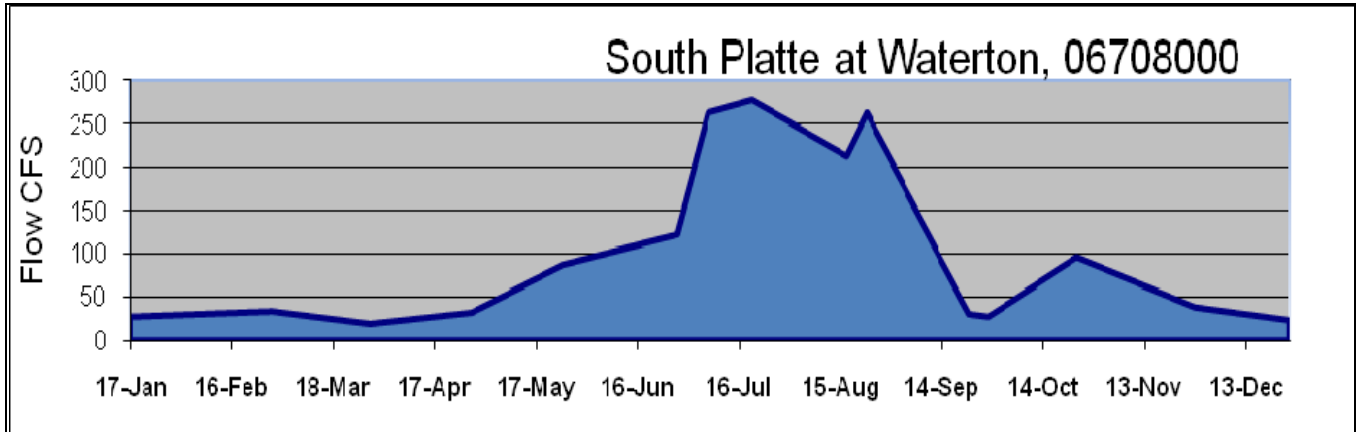
Nutrient load potential

- 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 # 26. Watershed Hydraulics: 2006 Flow Trends at Gauged Sites

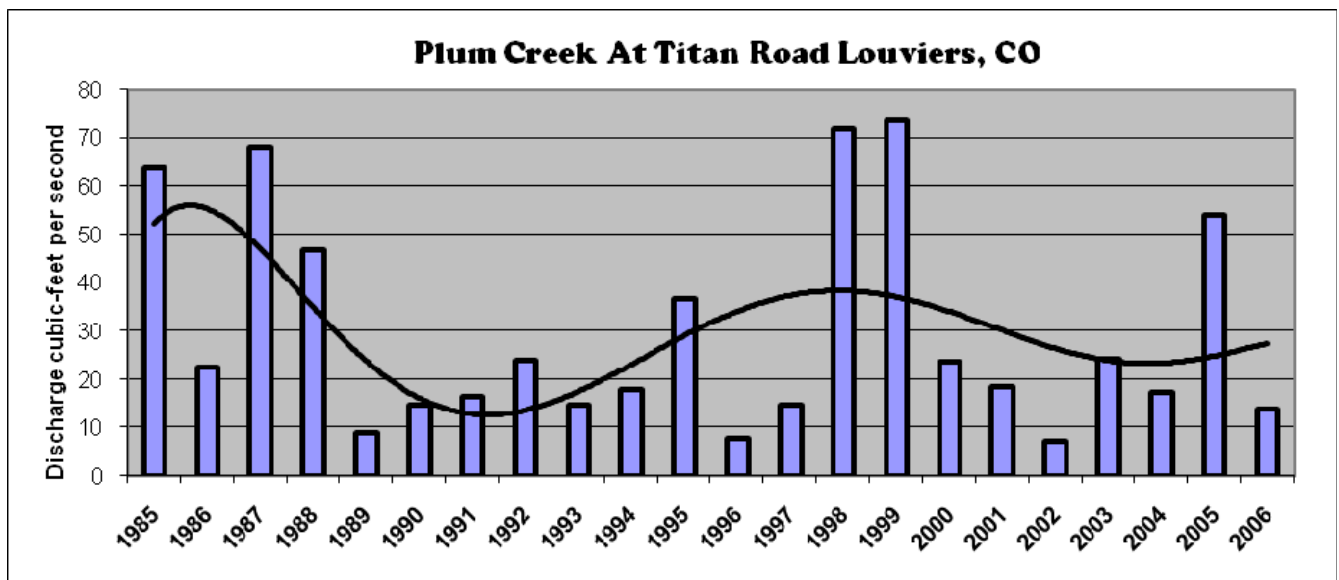
The 2006 Denver Water Department Waterton flows were below normal. Plum Creek was above normal with several storm runoff events producing higher flows. Plum Creek at Titan Road often goes dry in the summer months.



South Platte River



Plum Creek

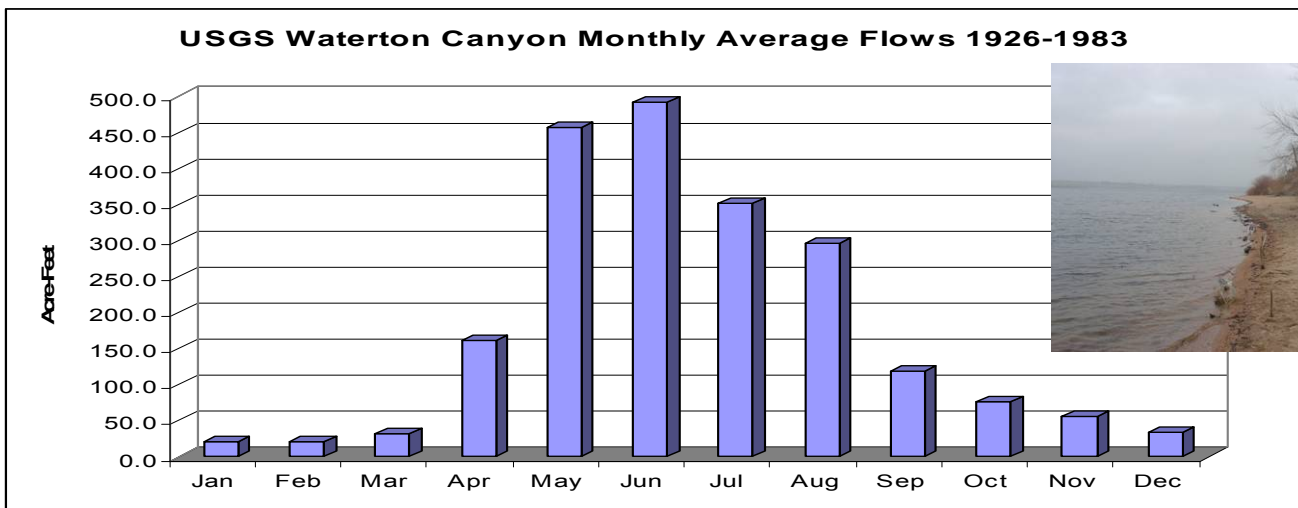
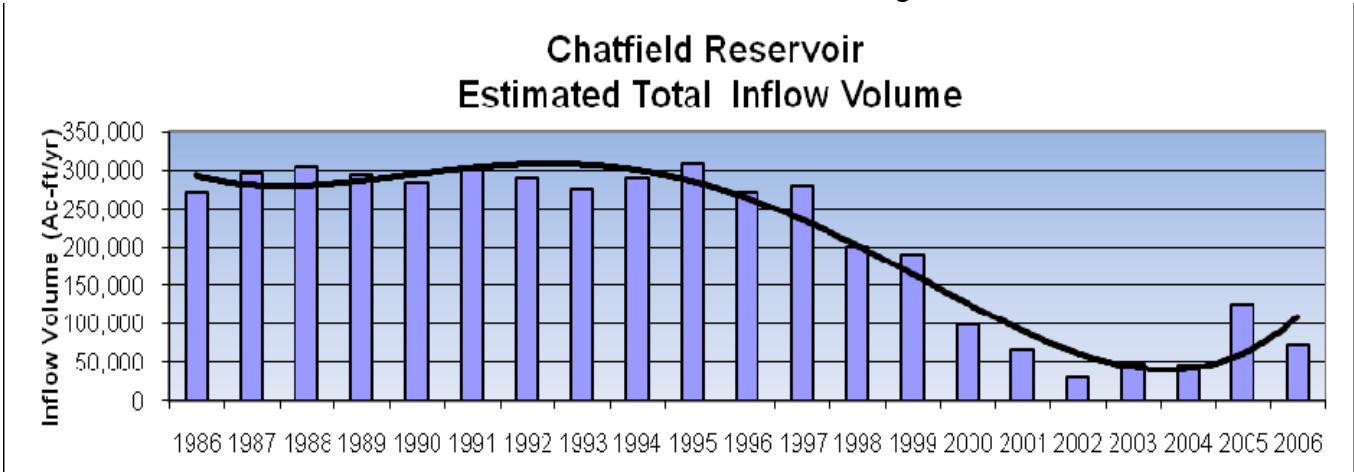


Fact Sheet # 27. Watershed Hydraulics: Chatfield Reservoir 2006 Storage Trends

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.

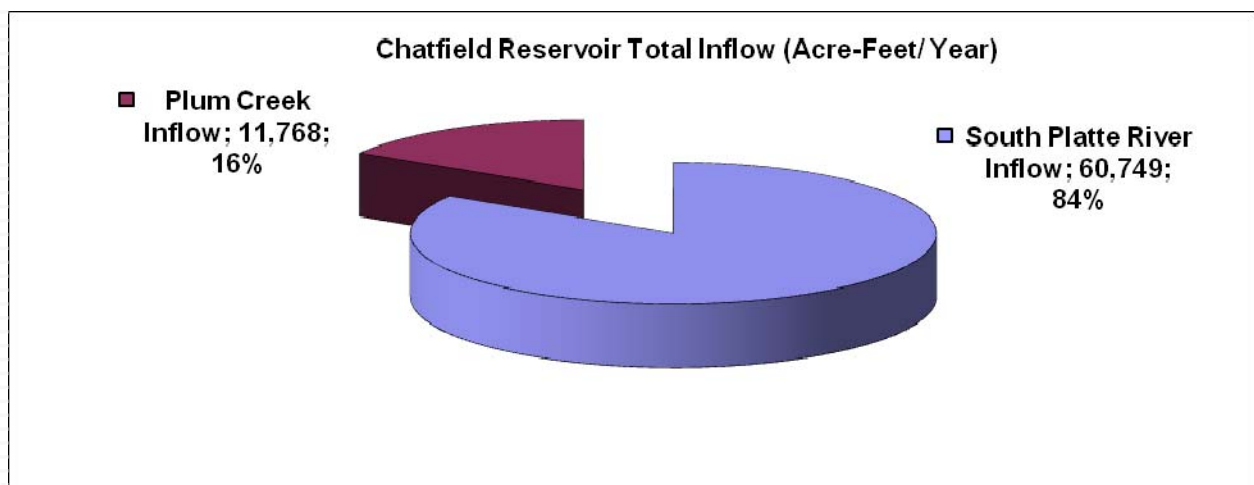


The Authority monitoring program estimated flow through the reservoir in 2006 at about 75,500 acre-feet. U.S. Army Corp of Engineers records shows the average flow into Chatfield Reservoir from 1986 through mid 2004 as 239,000 acre-feet per year. The Authority estimate is 68% lower than the monitored average. The reservoir shows increased inflow volume since the drought, but not full recovery. The multi-purpose pool storage capacity in 2006 was generally normal pool size. The 2006 total inflow was associated with continued drought conditions.



Fact Sheet # 28. Watershed Hydraulics: 2006 South Platte River and Plum Creek Flows with Water Balance for Chatfield Reservoir Chatfield Reservoir

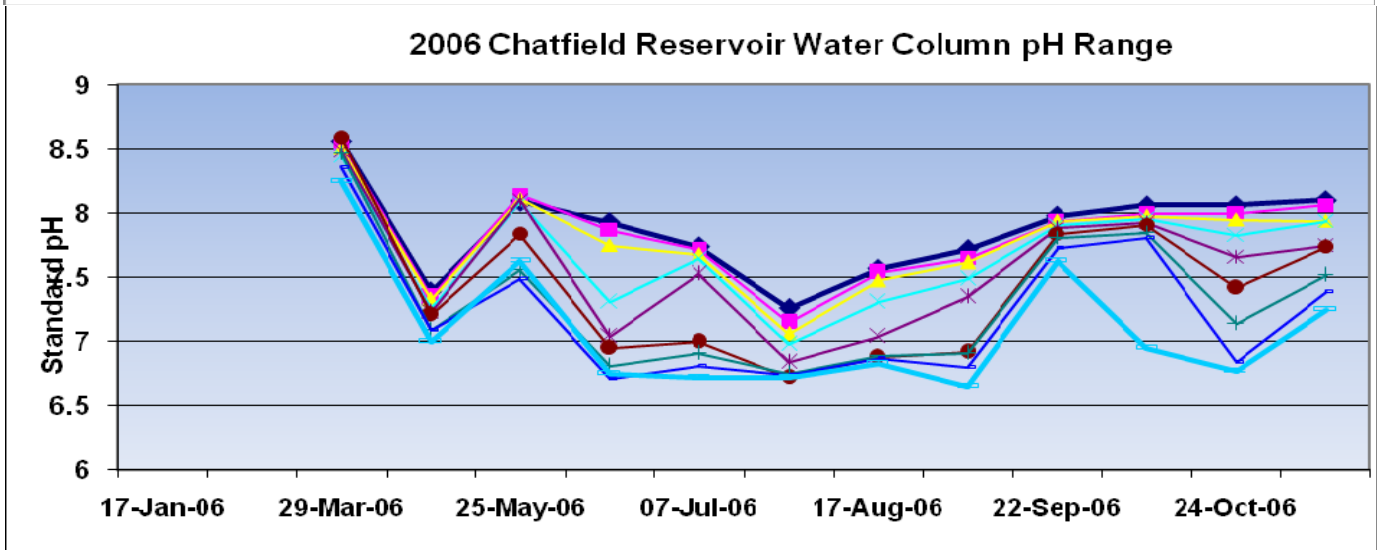
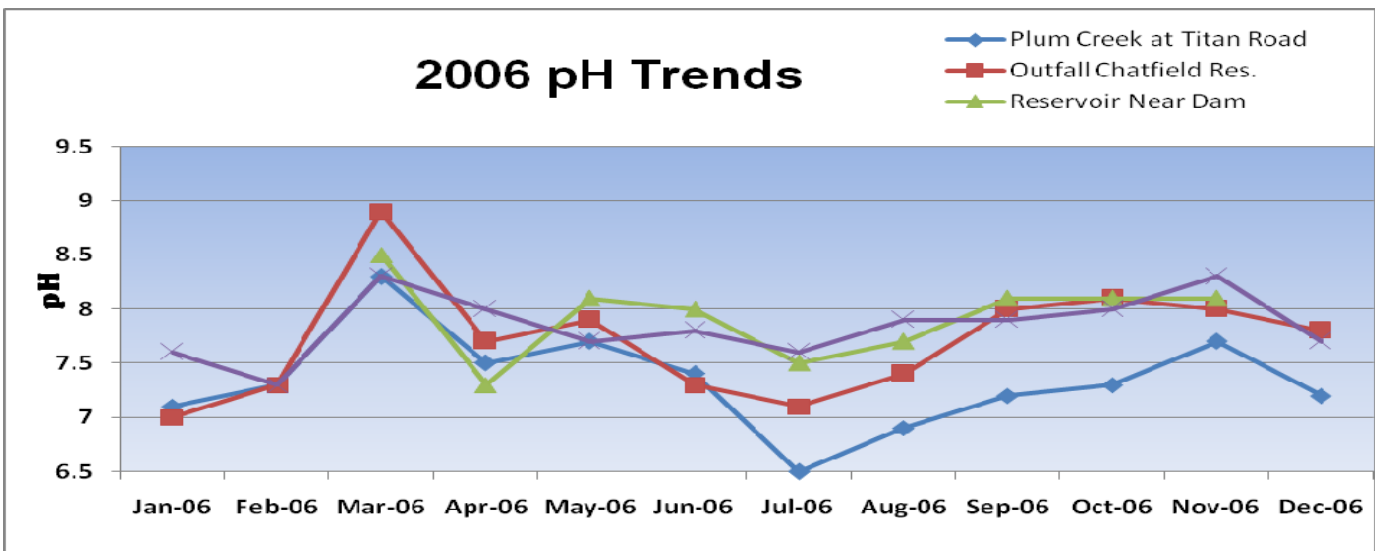
The monitoring program estimates flow from the South Platte River and Plum Creek as inflow into Chatfield Reservoir. The Authority flow data crosschecked against monthly average and cumulative gaging data from the USGS Titan Road station on Plum Creek and the Denver Water Department Waterton Canyon station 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 2006 was 75,500 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 2006 total inflow was below normal for the combined Chatfield and Upper South Platte Watersheds and is associated with a current drought.



2006	South Platte River Inflow	Plum Creek Inflow	Total Inflow	Reservoir Outflow	Reservoir Retention
	ac-ft/mo				
Jan	1,604	4,119	5,723	37	5,686
Feb	1,805	1,222	3,026	1,222	1,805
Mar	1,088	1,229	2,318	1,986	332
Apr	1,838	464	2,302	405	1,898
May	5,336	498	5,834	10,389	-4,555
Jun	7,500	393	7,893	6,639	1,254
Jul	16,092	571	16,663	11,987	4,676
Aug	14,600	348	14,948	7,795	7,153
Sep	1,648	247	1,895	7,377	-5,482
Oct	5,705	595	6,300	5,878	422
Nov	2,225	892	3,117	1,606	1,511
Dec	1,309	1,190	2,499	595	1,904
Annual	60,749	11,768	72,518	55,914	16,603
% of Flow	83.77%	16.23%			

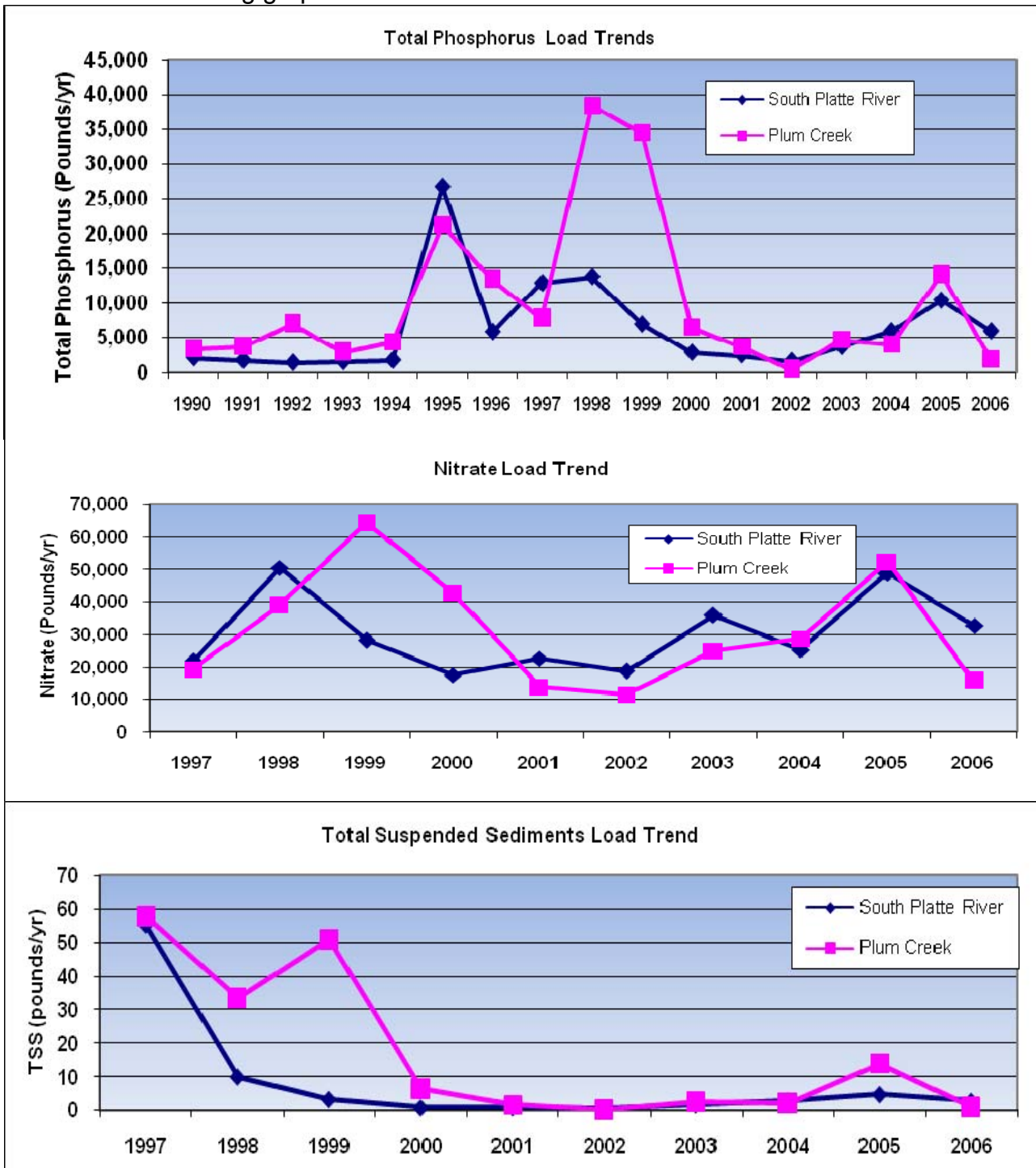
Fact Sheet # 29. Watershed Trends: Changing pH Trends In South Platte River and Chatfield Reservoir

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 2006 and subsequent fire runoff impacts have caused the river and reservoir pH to fluctuate within a range of 6.5 to 9.0. The reservoir generally maintains pH values within the standard range.



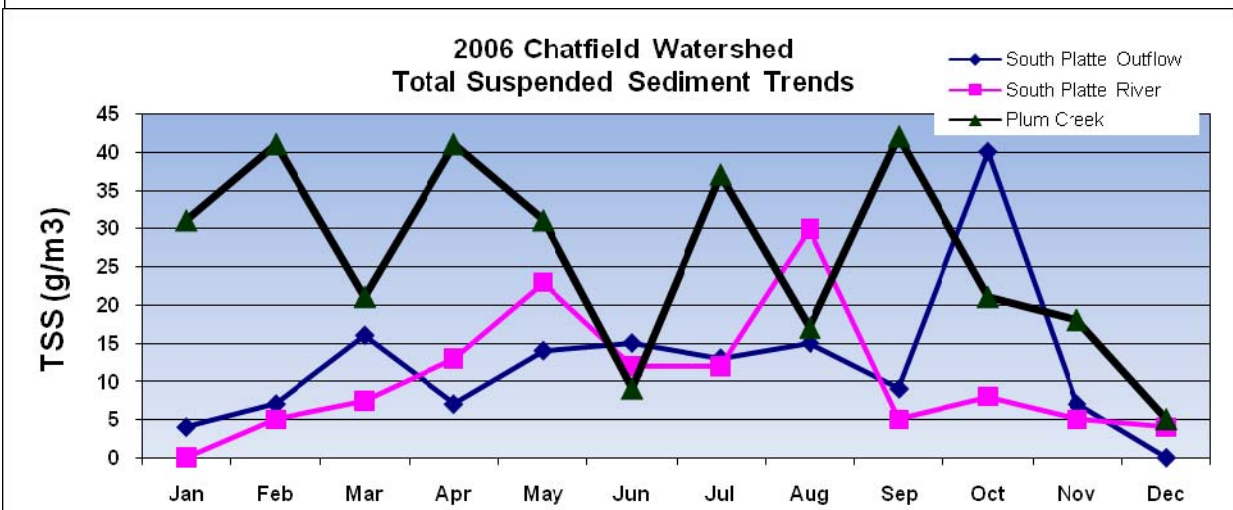
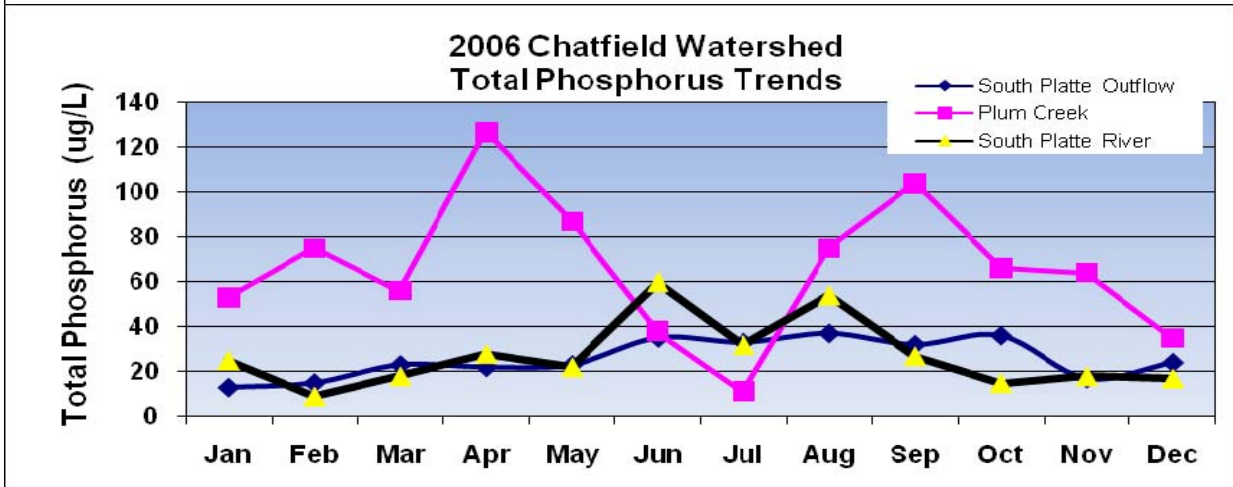
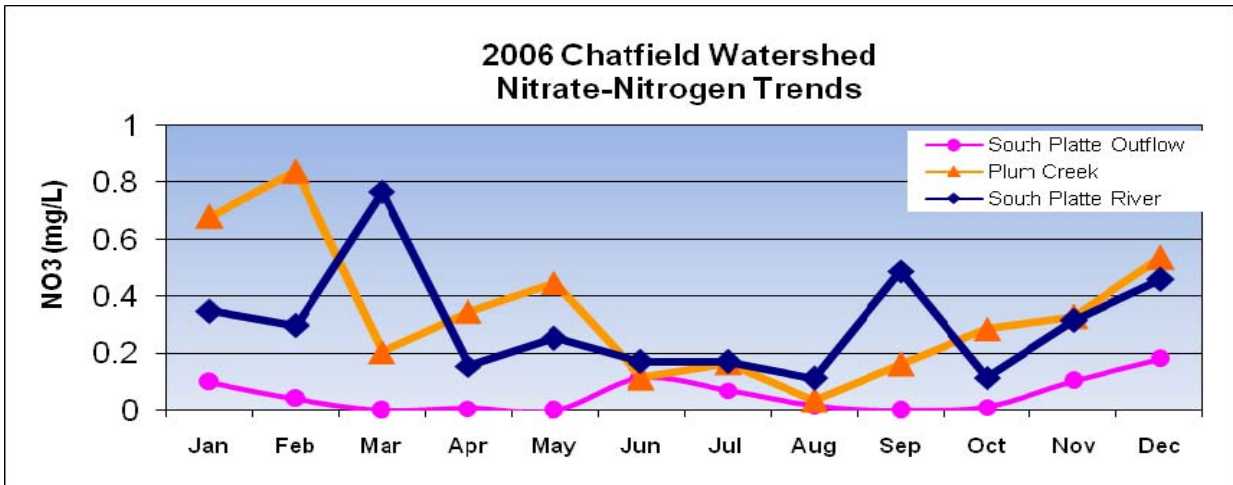
Fact Sheet # 30. Watershed Trends: Long-Term Nutrients & Suspended Sediments

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 # 31. Watershed Trends: 2006 Nutrients & Suspended Sediments

The 2006 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.



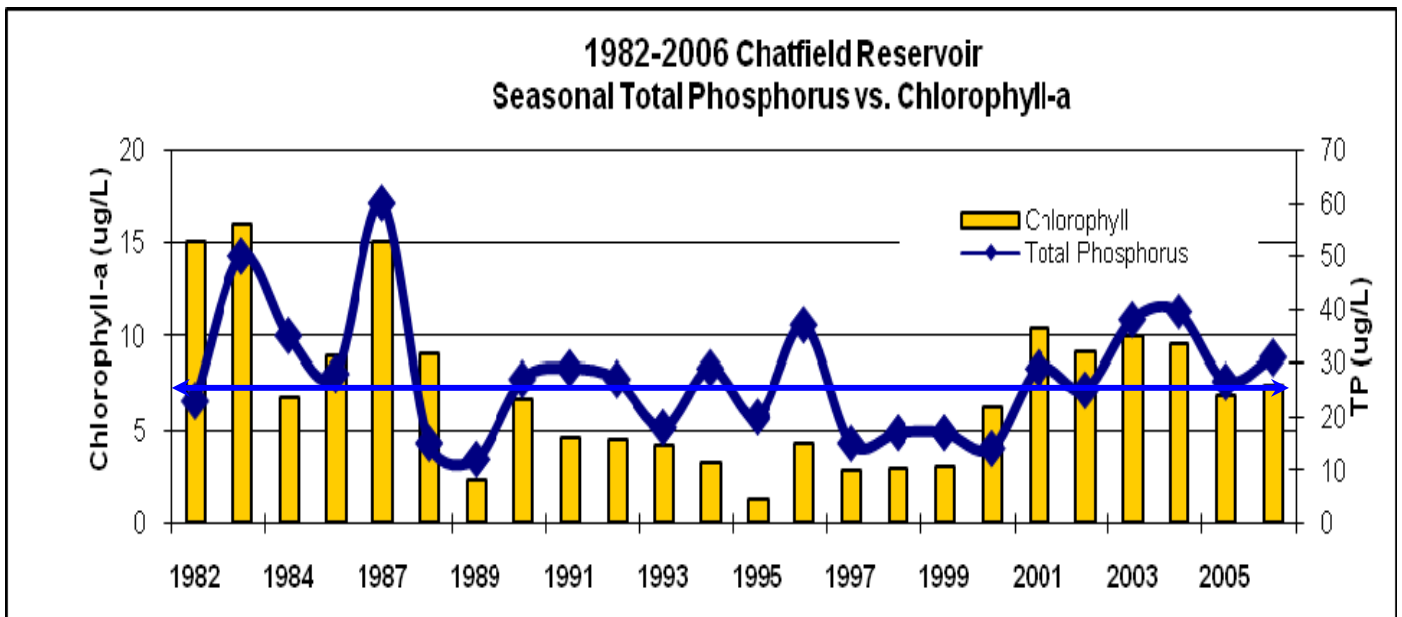
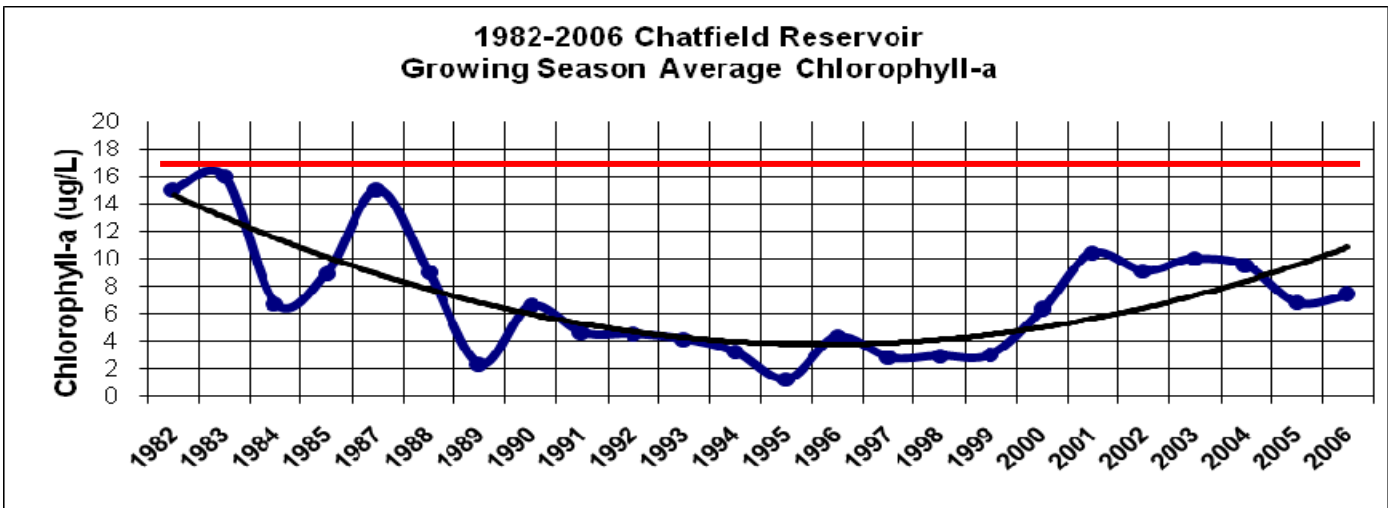
Fact Sheet # 32. Chatfield Reservoir: 2006 Trophic Status Summary

The following table summarizes selected trophic state categories from the 2006 data set.

Chatfield Reservoir 2006 - Selected Trophic Indicators	
Trophic Indicator	Reservoir
Chlorophyll	
Average Growing Season Chlorophyll-a [ug/l]	7.4
Peak Chlorophyll-a [ug/l]	20.0
Phosphorus	
Average Annual Total Phosphorus [ug/l]	29
Seasonal Annual Total Phosphorus [ug/l]	31
Peak Annual Total Phosphorus [ug/l]	51
Average Annual Ortho Phosphorus ug/l]	4.3
Seasonal Average Ortho Phosphorus [ug/l]	4.6
Peak Annual Ortho Phosphorus [ug/l]	16
Total Nitrogen	
Average Annual Total Nitrogen [ug/l]	466
Seasonal Average Total Nitrogen [ug/l]	525
Peak Annual Total Nitrogen [ug/l]	748
Clarity	
Average Annual Secchi Depth [meters/feet]	2.13 (7.0)
Seasonal Average Secchi Depth [meters/feet]	1.9 (5.9)
Total Suspended Sediments	
Annual Average Total Suspended Sediments [mg/l]	11.0
Seasonal Average Total Suspended Sediments [mg/l]	10.0
Peak Total Suspended Sediments [mg/l]	31.8
Trophic State Index	
Walker Index - Annual	57 (Eutrophic)
Walker Index - Seasonal (July-September)	59 (Eutrophic)
Carlson Index - Annual	50 (Mesotrophic-Eutrophic)
Carlson Index - Seasonal (July-September)	52 (Eutrophic)
Phytoplankton Species	
Peak Phytoplankton Density	245,000 cell/ml
Average Phytoplankton Density	7,150 cells/ml
Major Phyla	Species
CYANOPHYTA	<i>Synechococcus nidulans</i>
	<i>Aphanothece clathrata</i>
	<i>Pseudanabaena limnetica</i>
CHLOROPHYTA	<i>Chlorella minutissima</i>
CRYPTOPHYTA	<i>Plagioselmis nannoplanctica</i>

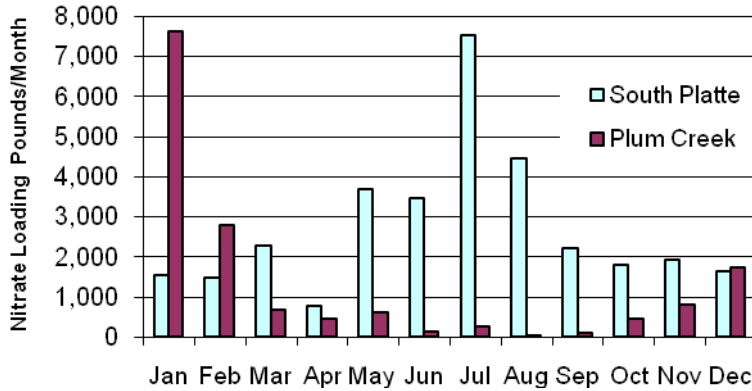
Fact Sheet # 33. Chatfield Reservoir: Chlorophyll & Phosphorus Growing Season Trends

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 (red line in upper graphic). 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 showed increased trends associated with low flow conditions. The growing season (July-September) total phosphorus standard as listed in Regulation #38 is 27 ug/l as measured throughout the water column (blue line in lower graphic). The reservoir compliance with this total phosphorus standard is only 54% of the time with exceedance occurring in 4 out of the last six growing seasons. The WQCD and Authority are concerned about the number of exceedances of the growing season total phosphorus standard as shown in the lower graph.



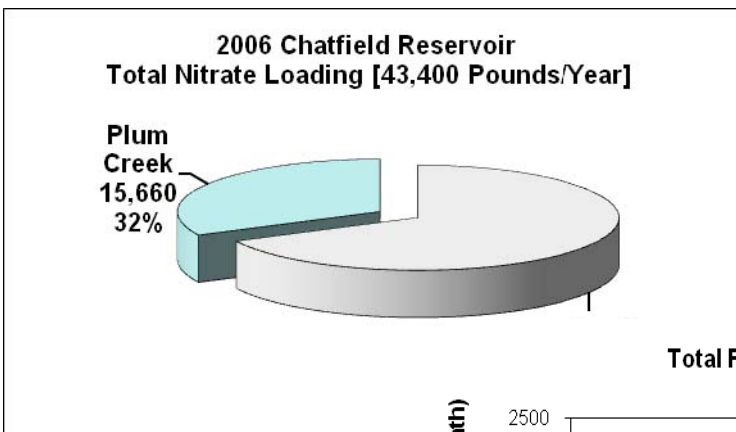
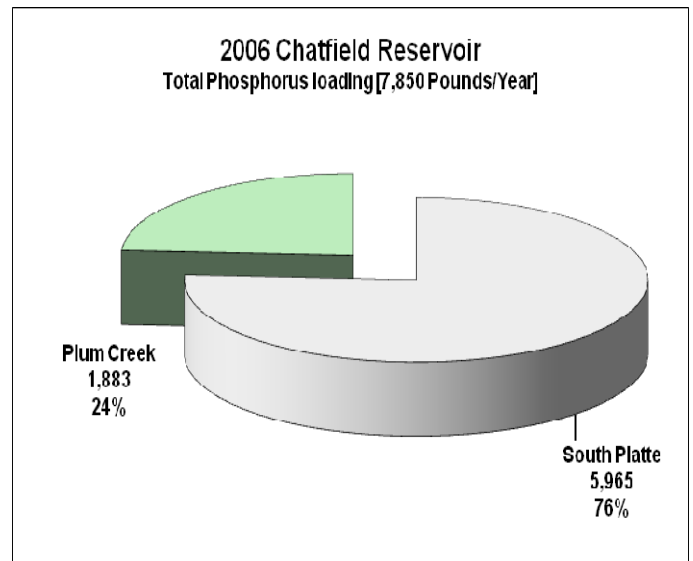
Fact Sheet # 34. Chatfield Reservoir: 2006 Nitrate & Phosphorus (Nutrient) Loading

**2006 Chatfield Reservoir
Total Nitrate Loading**

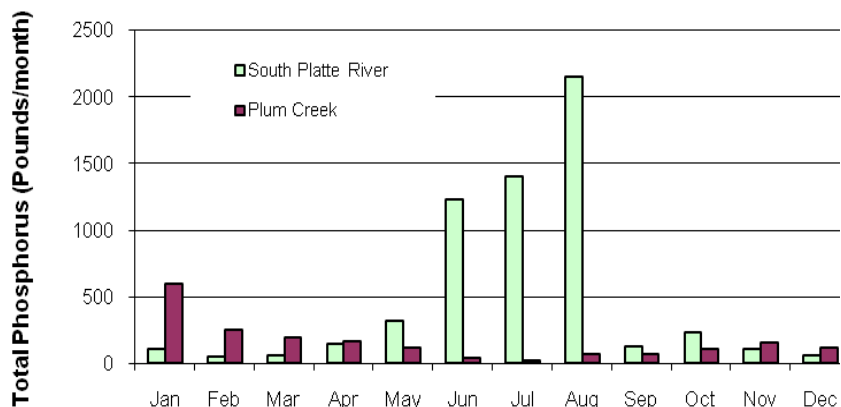


The monitoring program measures nutrient loading into Chatfield Reservoir from the South Platte River and Plum Creek. The total phosphorus load is derived from wastewater treatment plants within the Plum Creek drainage and as nonpoint source load from both the Chatfield Watershed and the Upper South Platte River Watershed. The 2002 drought had a significant impact on nutrient loading into the reservoir continuing into 2006. Low load of

both phosphorus and nitrogen reached the reservoir. The total phosphorus load in 2006 from all sources was 7,850 pounds at a total inflow of 75,500 acre-feet. The nitrate loading was also well below historic conditions with only 43,400 pounds derived from all sources. However, a greater proportion of nitrogen comes from the South Platte River drainage compared with historical nutrient loading trends. There was no significant nutrient-loading problem associated with Chatfield Reservoir in 2006.

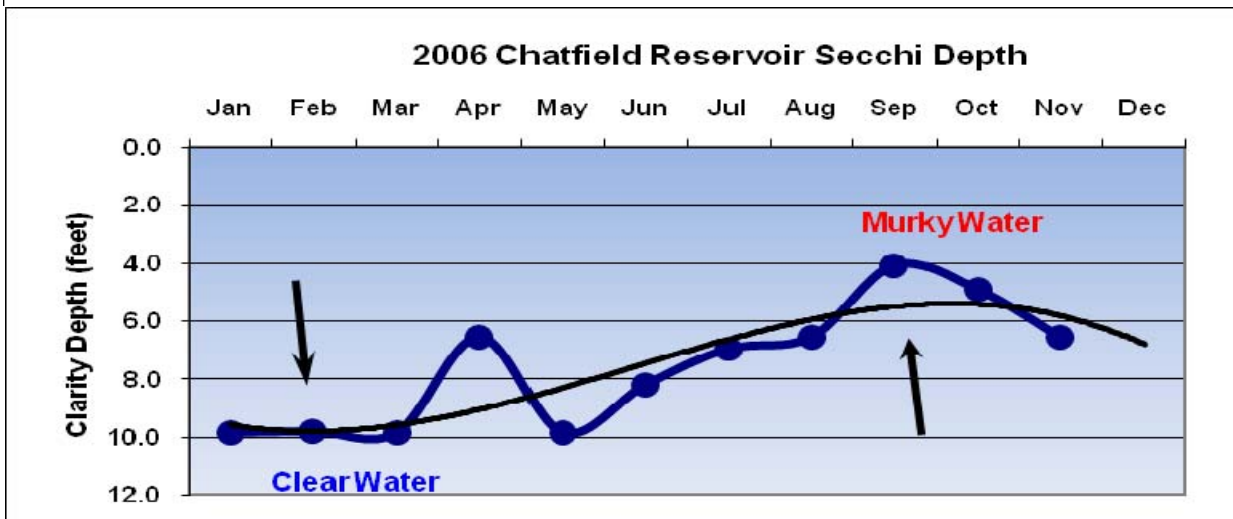
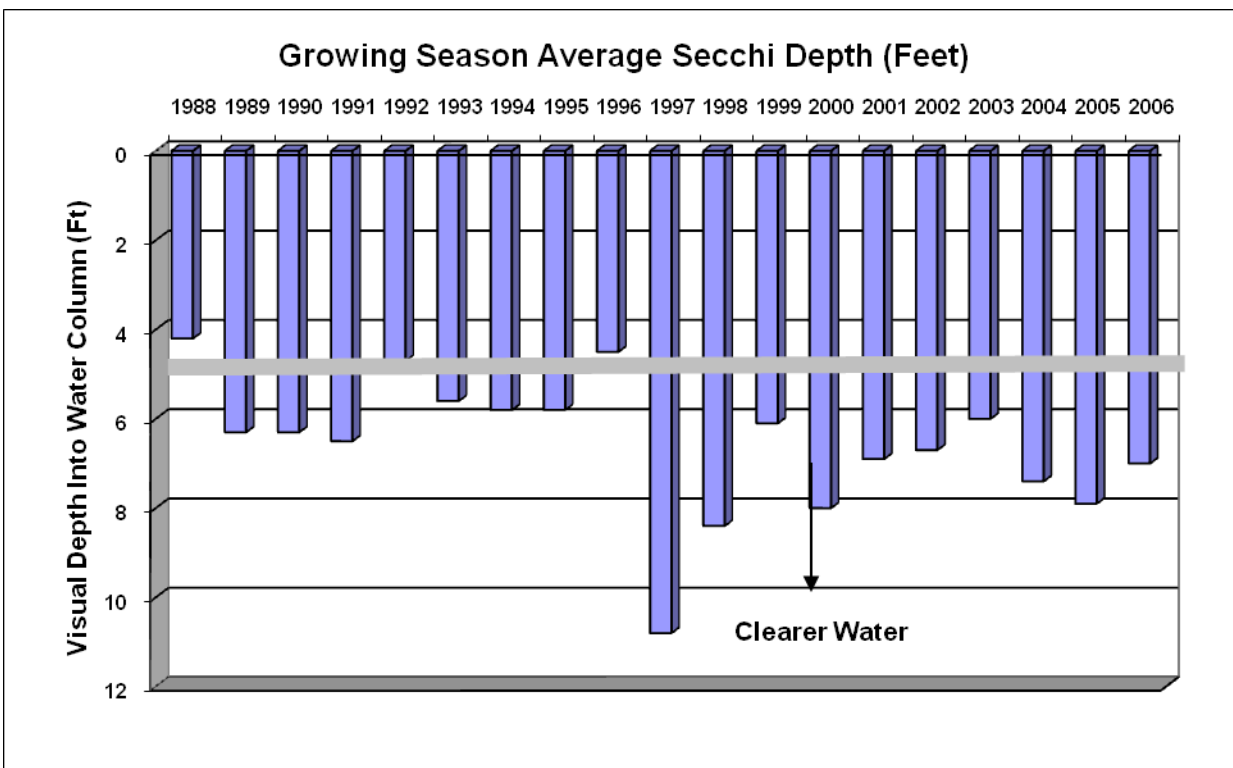


**2006 Chatfield Reservoir
Total Phosphorus Loading [Pounds/Month]**



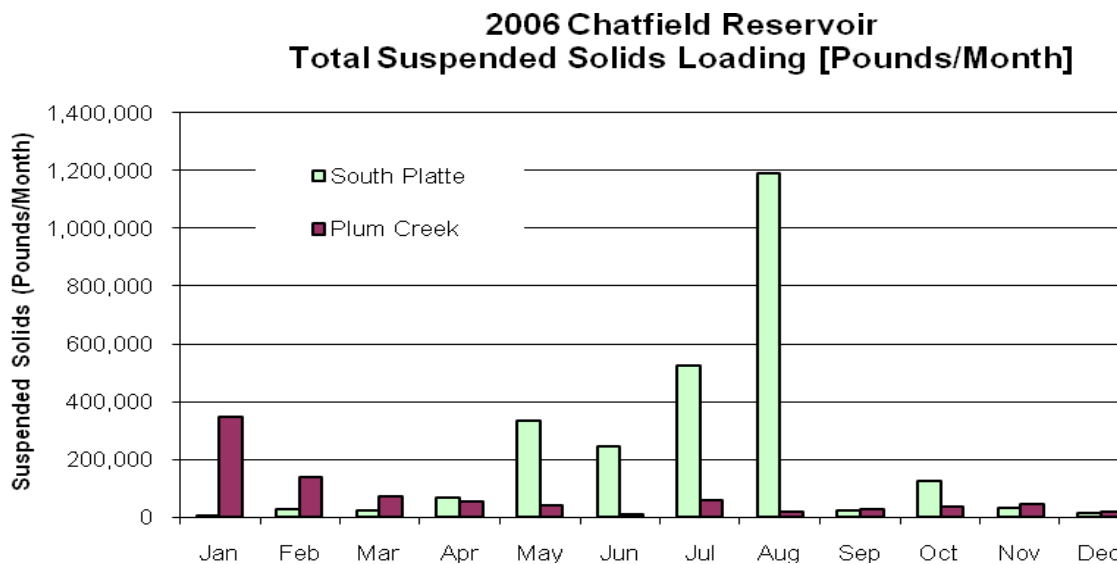
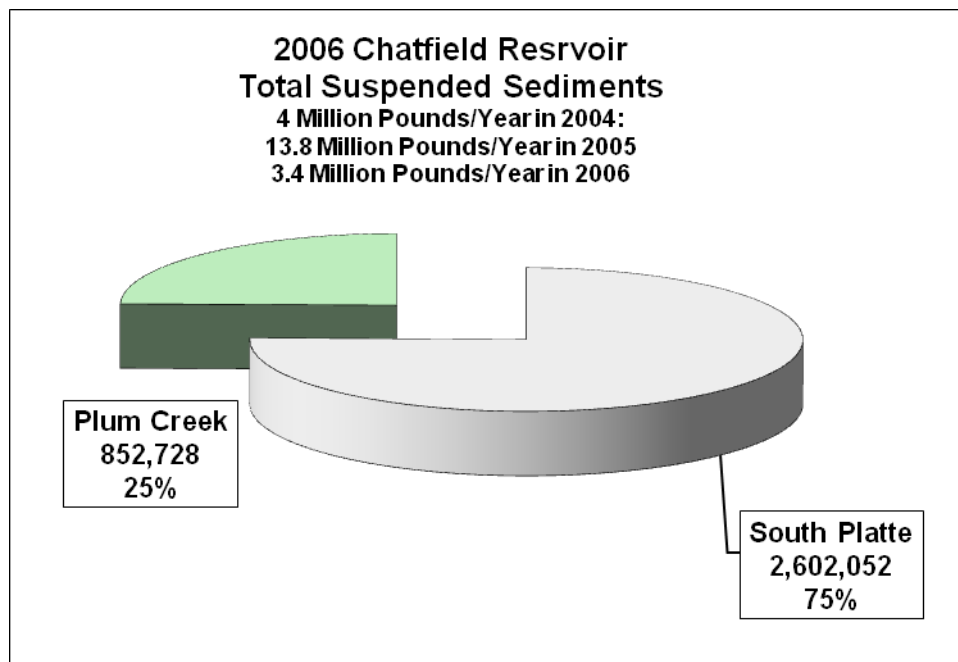
Fact Sheet # 35. Chatfield Reservoir: 2006 Water Clarity (Secchi)

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. 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.



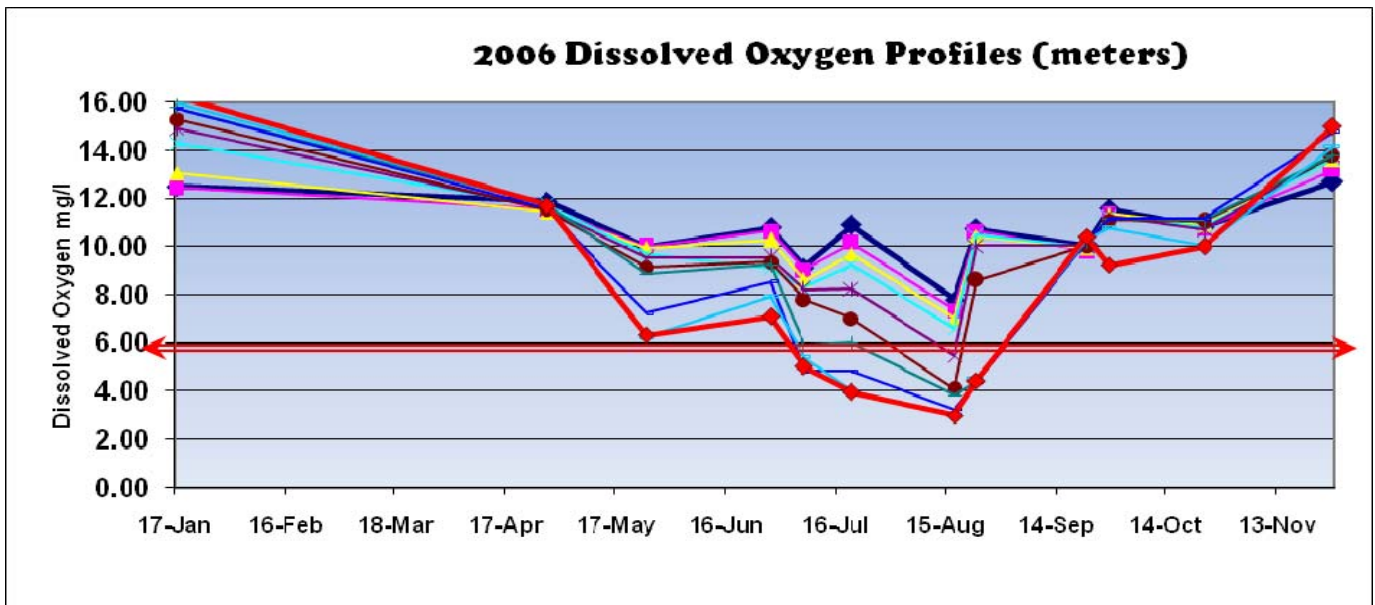
Fact Sheet # 36. Chatfield Reservoir: 2006 Total Suspended Sediment Loading

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 2006 TSS loading to the reservoir decreased about 76% from 2005 loading conditions. The Plum Creek 2006 loading is less than average due to drought conditions and far fewer storm events. Most of the instream sediment load is captured and retained within Chatfield Reservoir.



Fact Sheet # 37. Chatfield Reservoir: 2006 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.



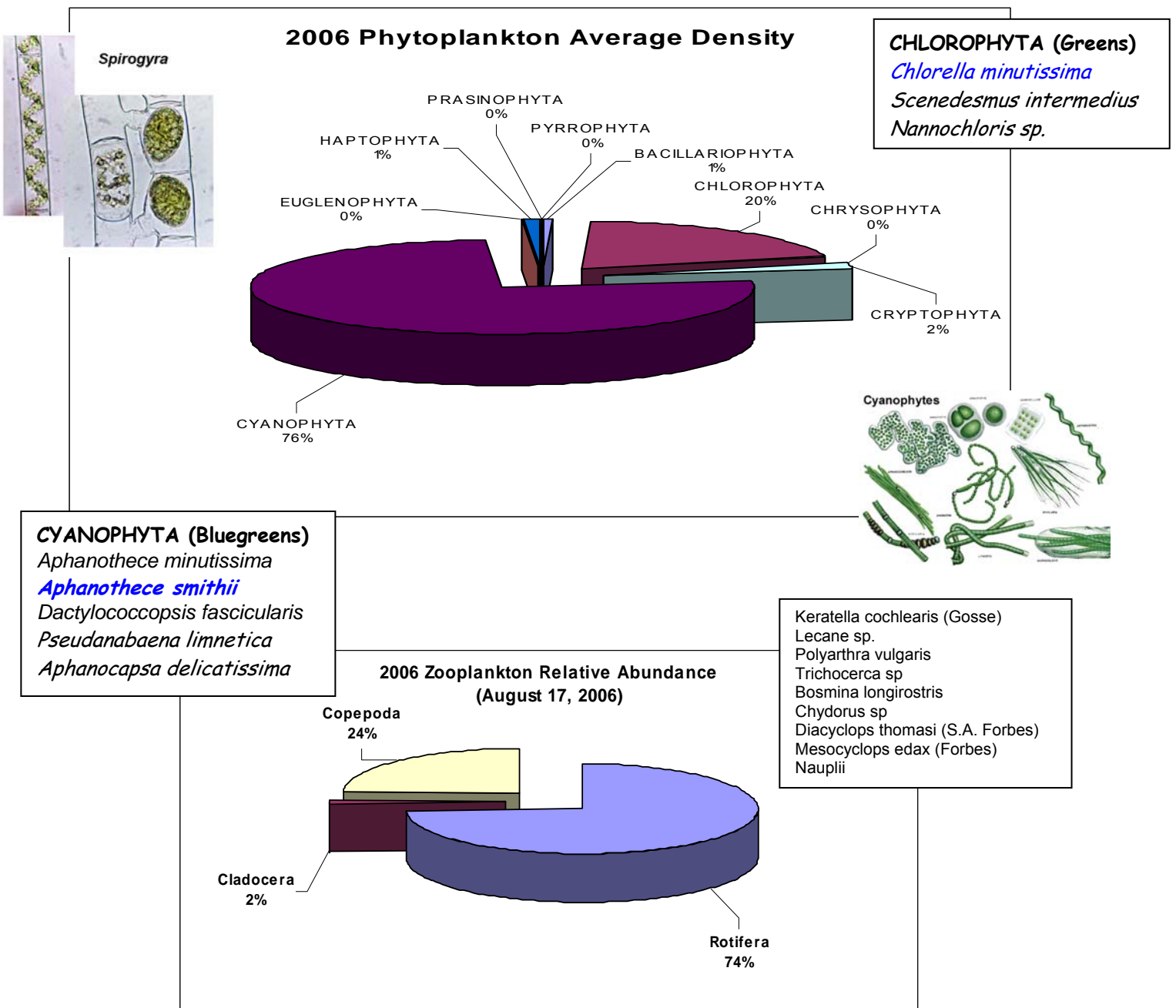
Low dissolved oxygen concentrations occur below 7 meters (about 23 feet) during summer months of June through August. Dissolved oxygen concentrations were in expected ranges for the remainder of the year. However, this lower summer oxygen data doesn't represent a regulatory problem since compliance monitoring 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.

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: 2006 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% with the greens dominate in 2005. Bluegreen became dominate in 2006. 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.

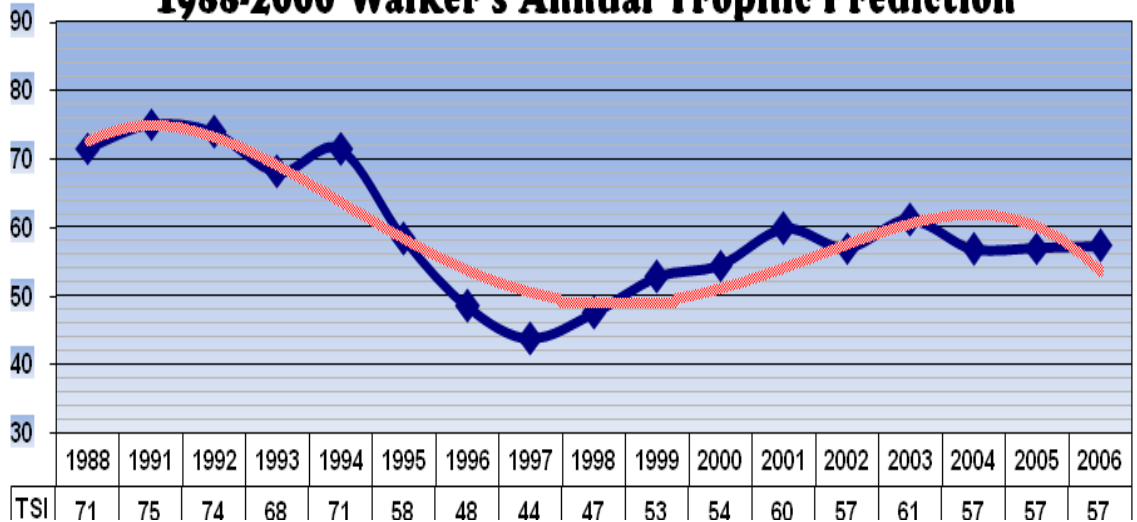


Fact Sheet # 39. Chatfield Reservoir: Walker & Carlson Trophic State Indexes (TSI)

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.

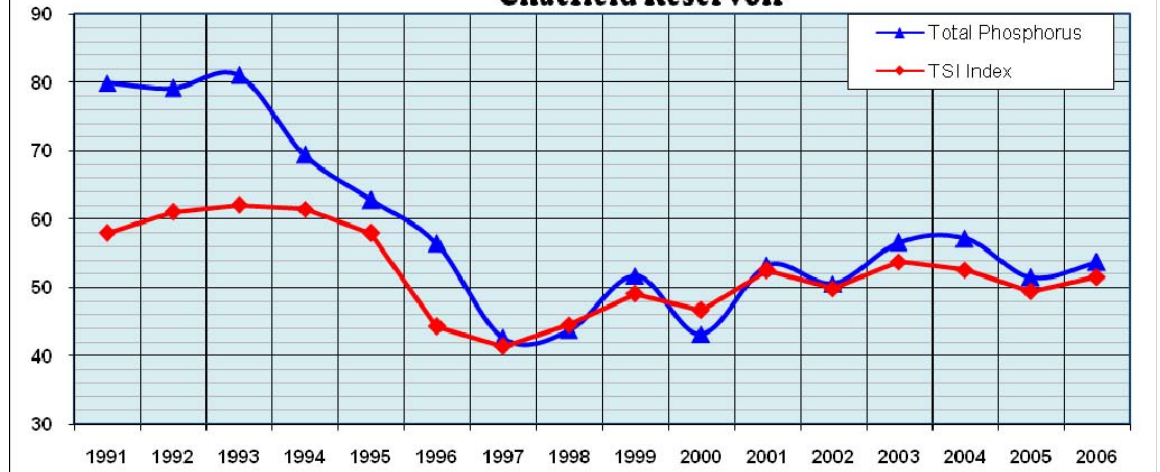
1988-2006 Walker's Annual Trophic Prediction

- 0-25 Oligotrophic
- 25-30 Oligotrophic-Mesotrophic
- 30-45 Mesotrophic
- 45-50 Mesotrophic-Eutrophic
- 50-65 Eutrophic
- 65+ Hypereutrophic

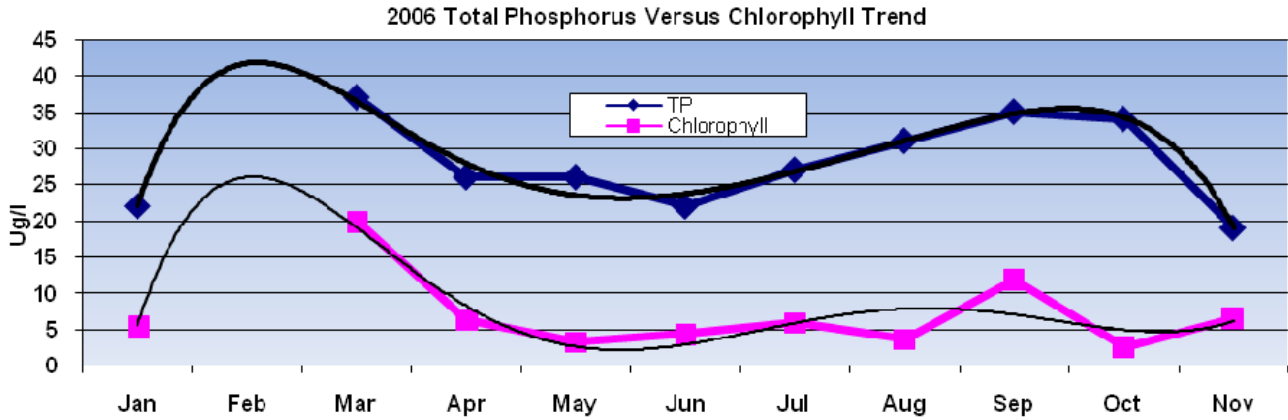


- 0-25 oligotrophic
- 25-30 oligotrophic-mesotrophic
- 30-45 mesotrophic
- 45-50 mesotrophic-eutrophic
- 50-65 eutrophic
- 65+ hypereutrophic

1991-2006 Carlson's Seasonal Trophic Prediction Chatfield Reservoir



Fact Sheet # 40. 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.

