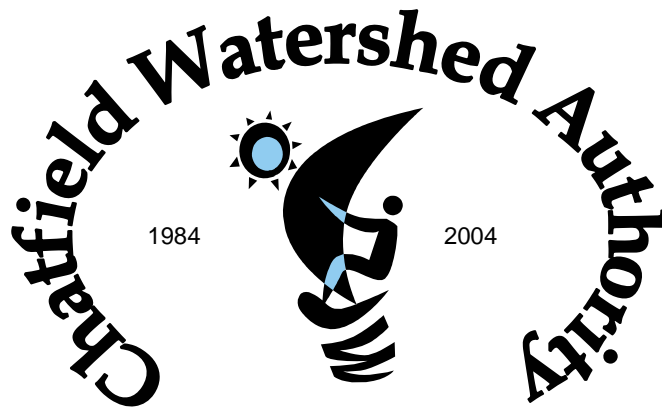


Chatfield Watershed Report 2003:

Annual Summary and Water Quality Fact Sheets

July 2004



Established 1984

Working for Water Quality

Watershed Management Agency

Chatfield Watershed Authority

Chatfield Watershed Report 2003: Water Quality Summary

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Introduction

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

Association Membership and Wastewater Treatment Plants

The Association includes:

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

The wastewater treatment facilities include Plum Creek Wastewater Authority, Roxborough Park Metropolitan District, Centennial Water & Sanitations District, Louviers Mutual Service Company, Perry Park Water and Sanitation District, Lockheed Martin Space Systems Company, Sacred Heart Retreat. The Ponderosa Retreat and Recreation Center is converting from a series of on-site disposal systems to a combination of a centralized treatment plant and a reduced number of on-site systems. The Jackson Creek Ranch Metropolitan District has an approved wastewater utility plan to construct a wastewater treatment plant after obtaining necessary Douglas County zoning approvals. Roxborough Park and Lockheed Martin are in the process of developing a joint pipeline project to transmit wastewater to the Littleton/Englewood treatment plant. The wastewater utility plan for the joint pipeline was approved by the Authority and accepted by the Denver Regional Council of Governments. The Plum Creek Wastewater Authority treatment plant is under construction for expansion to 4.9 million gallons per day with utility plan approval for a future expansion to 7.3 MGD.

Status of Total Maximum Annual Load (TMAL)

The Chatfield Reservoir Control Regulation (Regulation #73) incorporates the total maximum annual load that maintains wasteload allocations for point sources and the allowable nonpoint source load of 59,000 pounds of total phosphorus per year. This maximum phosphorus loading of 59,000 lbs/year is presumed upon a Q10 flow condition of 261,000 ac-ft/year. The point sources of phosphorus to the reservoir are limited to 7,358 lbs/yr with 51,642 lbs/yr allocated to nonpoint and background sources. Ongoing water quality modeling predicts the total phosphorus loading to Chatfield Reservoir that can be assimilated without exceeding the water quality standard of 0.027 mg/l total phosphorus.

The total maximum annual loads for total phosphorus by sources are based on the following formula:

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

The reservoir base-load represents the five-year rolling average total phosphorus load reaching Chatfield Reservoir. An implicit MOS is incorporated into the TMAL allocation of 59,000 pounds/year of phosphorus. The TMAL total phosphorus allocations are distributed among sources as follows:

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

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

Water Quality Monitoring

The Chatfield Watershed Authority maintains a water-quality monitoring program in the Chatfield Watershed. 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 has flexibility in determining the monitoring program elements in cooperation with the Colorado Water Quality Control Division (WQCD). Three critical questions answered by the monitoring program are:

- 1) *What is the annual and growing season limnological status of Chatfield Reservoir?*
- 2) *Are total phosphorus load controls working to prevent further eutrophication of the reservoir?*
- 3) Is the watershed in compliance with the control regulation?

The Chatfield water-quality monitoring program is consistent with recommendations made in the *Chatfield Reservoir Clean Lake Study* (DRCOG 1984) and referenced in the *Metro Vision 2020 Clean Water Plan* (DRCOG 1998). The Authority (Chatfield Watershed Authority 1997) completed a detailed evaluation of the historical data. The Authority 5-year nonpoint source management priorities for 1997-2003 (Chatfield Watershed Authority 1997) outline potential activities consistent with the adopted nonpoint source strategies (Chatfield Watershed Authority 1998).

Water-quality data are also used to characterize the trophic state of the reservoir, evaluate trends in the watershed and assess compliance with the adopted control regulation. The in-reservoir total phosphorus data are used by the Water Quality Control Division to determine compliance with the total phosphorus standard of 0.027 mg/L (27 ug/L). This total phosphorus standard is assumed to correspond to a Chlorophyll-a goal range of 15 to 25 ug/L.

The components of the monitoring program are designed to characterize inputs into the reservoir, the reservoir water column and outflow from the reservoir. The program provides time-trend monitoring of the South Platte River and Plum Creek; nonpoint source screening for each drainage system, and a measurement of alluvial groundwater quality. The in-reservoir parameters, trophic indicators, determine probable trophic state of the reservoir on an annual basis and predict shifts in the trophic state caused by external or internal inputs.

Quality Assurance Plan

The sampling and analysis plan [*2003-2005 Chatfield Watershed Authority: Quality Assurance Project Plan (QAPP), Sampling and Analysis Plan (SAP) and Standard Operating Procedures (SOP) Version 2.0, January 1, 2003*] describes the basic monitoring program for the Chatfield Watershed. The basic program is applicable for calendar years (CY) 2003-2005. The field-sampling portion of the monitoring program for the Chatfield Watershed for CY 2003-2005 generally matches previous monitoring efforts with the exception that sampling of alluvial groundwater wells has been discontinued. The Authority monitoring program maximizes the use of available financial resources, while providing the information necessary to meet water-quality program objectives.

Massy Draw Special Monitoring

A multi-organization project is being undertaken to stabilize streambanks and wetlands for a portion of Massey Draw that has experienced severe erosion. The Chatfield Watershed Authority has incorporated a limited water quality monitoring in Massey Draw from 2003 through

2005 into their standard monitoring program. This monitoring effort will compare pre-and post-construction trends within Massey Draw during each spring and summer runoff seasons. The three water quality parameters to be measured are: total nitrogen, total phosphorous, and total suspended sediment (turbidity). The Authority will take a single grab sample upgradient of the C-470 crossing during each of three dry weather events. During each of three stormwater events, the Authority will take grab samples at three points on the hydrograph. Flow measurements will be taken for each sample. The Authority may take additional samples depending on initial data results. This data will be used to calculate nitrogen, sediment and phosphorus loading from Massey Draw. All monitoring will adhere to the established quality assurance program of the Authority. Data results will be incorporated into the Authority database. The Massey Draw data will be used to determine the effectiveness of tributary restoration in reducing total phosphorus loading to Chatfield Reservoir.

Supplemental Metal Monitoring

In 2003 the Authority reviewed the metal data collection frequency and established additional sampling for metals beginning in the 2004 spring runoff season and extending through 2004. This additional metal sampling will evaluate the expected increase in metal loading from the Hayman fire. Results and requirements for additional supplemental metal monitoring will be evaluated in the 2004 monitoring program.

2003 Data Report and Data Record

The Authority produced and distributed the 2003 Water Quality Monitoring Annual Data Report, (Authority March 2004). 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.

Use and Standard Indicators

The reservoir trophic parameters determine overall water quality trends and compliance with designed uses and standards. The Authority applies two trophic models (TSI) that evaluate chemical and biological parameters and produce a growing season and annual estimate of water quality. The models and reservoir indicator parameters show a distinct improvement in water quality through 2003. However, 2003 water quality data is beginning to show a shift in water quality as a result of wildfire runoff. The pre-fire quality exceeds the water quality objective of the control regulation and meets the goal of the watershed management strategy. Over the period of data record, the trend in reservoir is balanced between a mesotrophic and a eutrophic state. The reservoir program evaluates seasonal as well as long-term changes in seven categories:

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

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

Board Retreat

The Authority Board held a retreat in November 2003 and developed a set of base program concepts and a five-year business plan format:

1. Collaboration and increased networking
2. Develop a new group image; increase outreach and education
3. Develop and maintain a list of funding opportunities/ projects
4. Re-evaluate role of Authority in nonpoint source and stormwater management
5. Seek opportunities for watershed planning grants
6. Develop a funding strategy.
7. The Authority should assume a leadership role in watershed
8. Identify issues and players.
9. The five Authority Agenda topics that must be included in all future agendas are:
 - a. Collaboration
 - b. Image, Education and Outreach
 - c. Monitoring and Watershed Opportunities
 - d. Funding Opportunities
 - e. Program Management and Administration

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

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

Stormwater Management

The Authority is concerned with the quality of dry-weather and stormwater runoff associated with significant development sites, which are generally related to urban development construction activities. The Authority is developing a project specific monitoring guidance report. However, 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 follows the watershed water quality management strategy using the best available management practices. The Authority reviews best management practices and makes recommendations as requested by local governments. Jefferson County and Douglas County have stormwater permitting programs. All CDPS Permit holders are required to have stormwater programs. Lockheed Martin's permit includes requirements for stormwater management.

Hayman Wildland Fire

The Hayman fire burned over 137,000 acres of Ponderosa Pine and Douglas Fir forest. This extremely hot fire vitrified soils and produced large tracts of impermeable surface with greatly increased runoff. The fire severely damaged 11 sixth level watersheds and threatens a major water supply for the Denver region. Over 188 miles of perennial streams and 182 miles of intermittent streams were impaired. The erosion potential from the runoff area is extreme. Downstream water quality data for 2003 show that concentrations for five water quality parameters (nutrients and metals) exceed historic data trends. Water quality data suggests that concentration of pollutants resulting from runoff could exceed numeric water quality standards. Consequently, water quality management programs currently in place to address other pollution problems are now jeopardized.

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

Duration of Recovery and Cooperative Efforts.

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

Fire Recovery Uncertainty

Fire recovery literature in Colorado and for other western states shows considerable variability in duration of recovery, magnitude of the problem and predictability of impacts from burn areas. A burn area the size of the Hayman burn will generate considerable amounts of erosion products even with best mitigation efforts until revegetation has stabilized the area. It is this long term erosional potential that generates uncertainty about sediment, nutrient and metal loading to downstream waterbodies. Preliminary Chatfield data and fire literature information shows a clear nutrient loading problem is associated with fire runoff. However, the data is variable and the magnitude of the loading is very difficult to predict. Already the downstream Chatfield Reservoir has exceeded the growing season total phosphorus standard with the drought impacted runoff remaining extremely low. A return of normal runoff in the South Platte River could a dramatic impact the reservoir quality. There is clearly a great deal of uncertainty on the magnitude of this impact. Yet preliminary water quality data would predict that there will be an impact. Since many parts of the burn area experienced such high burn temperatures, the soil was sterilized and recovery of vegetation and supporting biota will take much longer than a typical fire. Some scientific experts estimate the recovery in the Hayman burn area to take many decades, while others have speculated that recovery of non-forest habitat is more variable:

"If recovery means going back to trees that were 600 years old, than the answer is kind of obvious. It'll be 600 years or more. If it means recovering, will it now become a meadow and will life come back in there, and will animals come back in there and start utilizing it, and the water quality improve, etc..., we're talking a few years. We're talking 4 or 5 or 6 years, 7 years -- we're not talking a very long time." (Bob Brobst, environmental engineer in Colorado)

There is no good indication that the South Platte River runoff will return to the same quality as pre-fire conditions in a near-term. On the contrary, literature information suggests the water quality will be altered for the long-term. The critical question facing the Chatfield Authority is whether it is best to simply continue monitoring in hopes that the problem will repair itself in the shorter term and the degree of impact will be less than predicted, or to more proactively evaluate what changes needed to protect the underlying reservoir uses. This uncertainty has triggered a water quality management process to evaluate what the new underlying standard for growing season total phosphorus should be in the reservoir based on long-term fire runoff impacts. The fire runoff and increased loading from the South Platte River could alter the total maximum annual load distributions as identified in the control regulation.

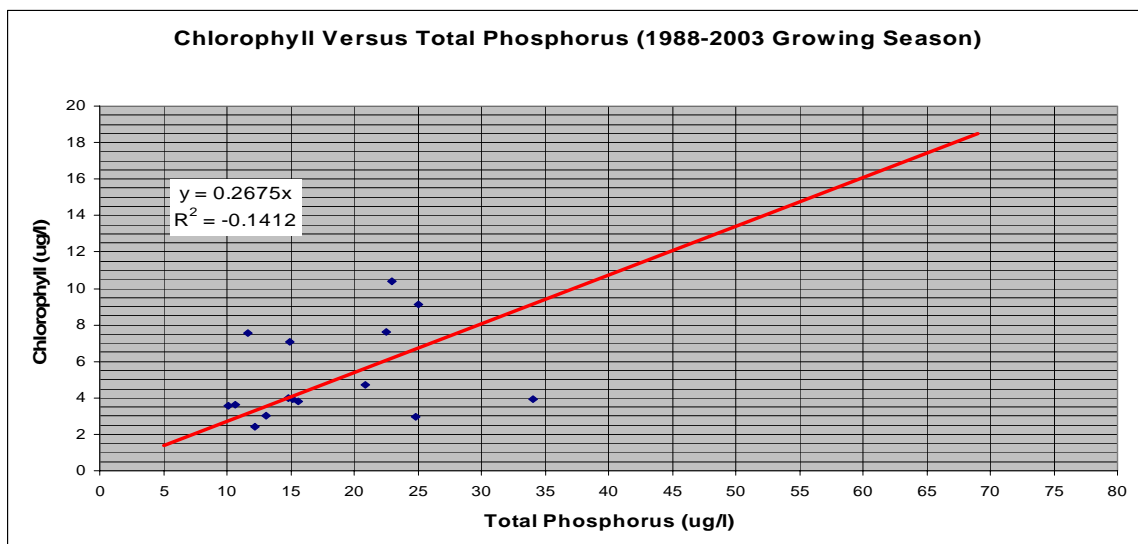
The wasteload allocation assigns 17,930 pounds of total phosphorus to the Upper South Platte Watershed with 6,000 pounds as the base-load reaching the reservoir after upstream water diversions. The South Platte River inflow into Chatfield Reservoir as estimated by the Chatfield Authority was 31,000 acre-feet, which is about 12% of the "normal" condition identified in the control regulation. Consequently, the load allocations are reduced to match the flow conditions. At a flow of 49,000 acre-feet (South Platte River plus Plum Creek, see fact sheet --), the expected total phosphorus load to the reservoir is 11,100 pounds. The South Platte River base load allocation would be 1,125 pounds of total phosphorus and the total Upper South Platte Watershed allocation is 3,370 pounds. The measured load from the South Platte River in 2003 was 3,800 pounds total phosphorus, slightly over the assigned allocation. The base loading from the South Platte River, under lower flow conditions at 1,270 was also over the assigned

allocation. The 2003 total phosphorus load to the reservoir was 8,430 pound of total phosphorus, which is slightly below the TMAL limit. Although 2003 inflow into Chatfield Reservoir was substantial below normal, the flow-based loading was significantly increased as a direct result of runoff from the Upper South Platte Watershed.

The Hayman burn area has experienced some minor runoff events, but not the typical stormwater events. As more normal runoff events occur, it s anticipated that the concentrations of nutrients will increase. Based on conservative 2003 total phosphorus data with normal or near normal runoff, the Upper South Platte Watershed can generate over 33,000 pound of phosphorus per year. This doubling of the phosphorus load into Chatfield Reservoir will have a dramatic impact on the trophic sate of the reservoir. Additionally, this increased load in combination with load allocation from he Plum Creek drainage would cause the TMAL to be exceeded on a regular basis. The Chatfield Authority believes it is essential to ask the question, “How will this increased total phosphorus affect the reservoir uses?”

Re-evaluation Of The Correlation Between Phosphorus and Chlorophyll

The following figure predicts the relationship between chlorophyll and total phosphorus as a linear regression using Authority data records. The target for chlorophyll in the reservoir during the growing season is 17 ug/l, which is the maximum allowable level that will still protect all of the reservoir’s assigned beneficial uses (e.g., aquatic life and water supply). The Chatfield Authority asserts that the chlorophyll- target of 17 ug/l is appropriate and reasonable for the reservoir. Consequently, total phosphorus loading needs to be managed in order to not exceed the chlorophyll target. Based on this assumption and existing data record, a total phosphorus average in the growing season should not exceed 65 ug/l (0.065 mg/l), while the current growing season standard is 0.027 mg/l. A growing season total phosphorus standard of 65 ug/l would still protect the reservoir uses.



Plans For Obtaining Data And Improving Water Quality

The Chatfield Authority encourages the following activities within the existing monitoring program:

- 1) Characterize burn area water quality runoff impacts on Chatfield Reservoir through the routine Authority monitoring program;
- 2) Document how changes to water quality impact standards, beneficial uses and implementation of the total phosphorus TMDL;
- 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.

The Chatfield Authority is seeking funding support to develop a special monitoring program and obtain supplemental water quality data. The project would monitor problems based on selected indicator parameters and augment the water quality data record with missing information after review of data record. The supplemental monitoring program will collect and analyze necessary water quality data applying the currently approved quality assurance and quality control program and the adopted standard Sample Analyze Plan. The Authority anticipates that a limited, focused data and cost effective collection effort can fill in the data gaps. If funding becomes available, the Authority plans to develop a supplemental data characterization report and informational fact sheets on fire related indicator parameters (Information transfer), water quality impacts on stream and reservoir quality, and monitoring plan to characterize fire water quality impacts on downstream waterbodies. The report and fact sheets are designed for general distribution and specific posting on the existing Chatfield Watershed Authority Web page (www.chatfieldwatershed.org). Based on fire related water quality indicator parameters and associated reports, the Authority will document how standards, uses and implementation of the total phosphorus TMDL are altered or affected in segments 6a and 6b of the South Platte River with the ability to transfer this information to other fire impacted waterbodies in Colorado.

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Fact Sheet Series

This series of fact sheets describe the water quality-monitoring program and analytical results from the 2003 Chatfield Watershed Authority water quality monitoring program. Fact sheets are individually available from the Authority manager and can be used in other publications with notification to the Authority.



The Chatfield State Parks is responsible for recreational activities at the state park. The State Parks Department does not financially or actively support or participate in Authority programs. The U.S. Army Corps of Engineers manages release of water from Chatfield Reservoir (below). The Corps is an active and valuable member of the Authority.

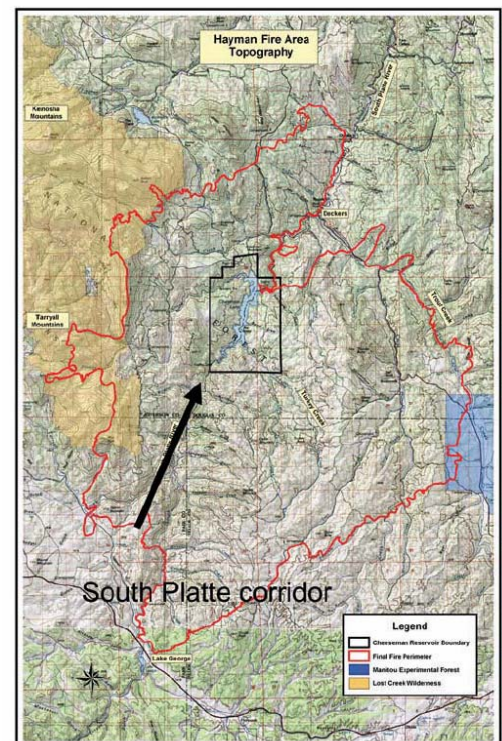


Fact Sheet # 1. Hayman Fire Runoff Affects 2003 Downstream Water Quality

The Hayman fire burned over 137,000 acres of Ponderosa Pine and Douglas Fir forest. This extremely hot fire vitrified soils and produced large tracts of impermeable surface with greatly increased runoff. The fire severely damaged 11 sixth level watersheds and threatens a major water supply for the Denver region. Over 188 miles of perennial streams and 182 miles of intermittent streams were impaired. Forest Service estimates suggest 10-25 years before recovery of low lying vegetation and forest recovery is decades away. The erosional potential from the runoff area is extreme and 2003 downstream water quality data shows five water quality parameters (nutrients and metals) that exceed historic data trends. Water quality data predict fire quality runoff and erosion runoff from the 2002 Hayman Wildland Fire could exceed numeric water quality standards for decades. The 2003 growing season standard for total phosphorus was 38 ug/l with the standard set at 27 ug/l. This standard exceedence is of great concern to the Authority. Consequently, water quality management programs currently in place to address other pollution problems are now jeopardized. The Authority monitors both inflow and outflow water quality within Chatfield Reservoir in the hope that the effects will be attenuated and not as long lasting.

2003 Growing Season				
	South Platte Inflow	South Platte Outflow	Plum Creek	Reservoir Average
Nitrate/Nitrite as N, dissolve (mg/l)				Total Nitrogen (mg/l)
2-Jul	0.229	0.035	0.534	0.536
16-Jul	0.341	0.032	Dry	0.449
6-Aug	0.295	0.005	Dry	0.331
20-Aug	0.214	0.005	Dry	0.410
3-Sep	0.357	0*	0.675	0.467
17-Sep	0.772	0	0	0.541
Phosphorus, ortho total (mg/l)				
2-Jul	0.009	0.003	0.027	0.01
16-Jul	0.014	0.033	Dry	0.039
6-Aug	0.021	0.004	Dry	0.003
20-Aug	0.005	0.044	Dry	0.038
3-Sep	0	0.018	0.032	0
17-Sep	0.021	0	0.008	0
Phosphorus, total (mg/l)				
2-Jul	0.034	0.044	0.062	0.024
16-Jul	0.012	0.088	Dry	0.039
6-Aug	0.058	0.033	Dry	0.036
20-Aug	0.033	0	Dry	0.038
3-Sep	0.192	0.043	0.087	0.041
17-Sep	0.049	0.043	0.03	0.043
2003 Season	0.063	0.042	0.051	0.037
2002 Season	0.025	0.023	0.038	0.023

Cheeseman Reservoir



Fact Sheet # 2. Control Regulation #38 Statement of Basis and Purpose Related to Hayman Fire Runoff Impact To Chatfield Reservoir

Hayman Fire



The Chatfield Watershed Authority submitted two alternative proposals for a temporary modification of water quality standards for total phosphorus and selected metals in Segments a and 6b of the South Platte River basin. The temporary modifications were requested 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. The Authority, in cooperation and coordination

with the Division and other interested parties has committed to the development and implementation of a monitoring plan. 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.



Cheeseman Reservoir and Burn Area

Hayman Burn Area and Erosion



The point source and stormwater discharge permit holders in the 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 to the reservoir. Point source discharge permit holders and 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 Water Quality Control 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 practices, which could be implemented on a voluntary basis prior to any such adjustment if warranted by monitoring conditions in the watershed.

Fact Sheet # 3. Chatfield Reservoir and State Park Serves Many Uses

Chatfield Reservoir



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

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

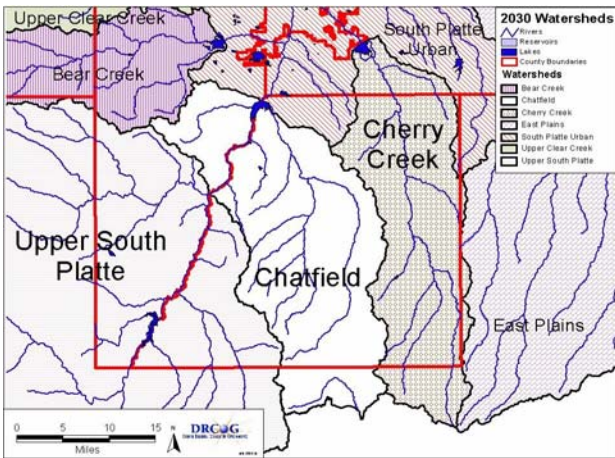
Spring and fall trout fishing is excellent. Bass, channel catfish, yellow perch and crappie are also taken in summer. Ice fishing occurs in the winter. Fishing and boating are major recreational uses.



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

Fact Sheet # 4. Chatfield Watershed and Active Participants

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

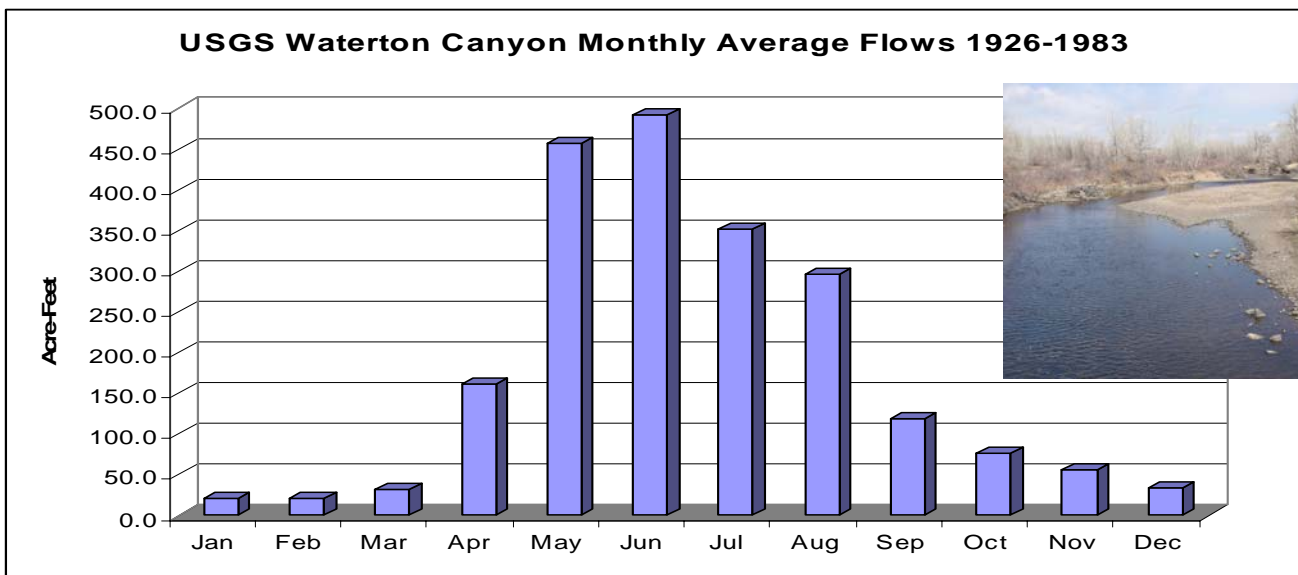
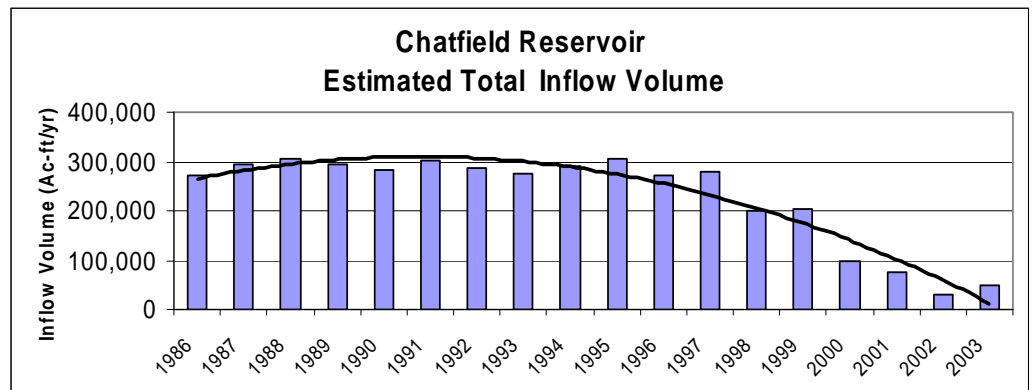


Towns & Communities	Counties	Special Districts	Industry & Agencies	Church Camps
City of Littleton	Jefferson	Plum Creek Wastewater Authority	Lockheed Martin Space Systems Company	Ponderosa Retreat & Recreation Center
Town of Castle Rock	Douglas	Castle Pines Metro District Centennial Water & Sanitation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

Fact Sheet # 5. Chatfield Reservoir 2003 Storage Trends

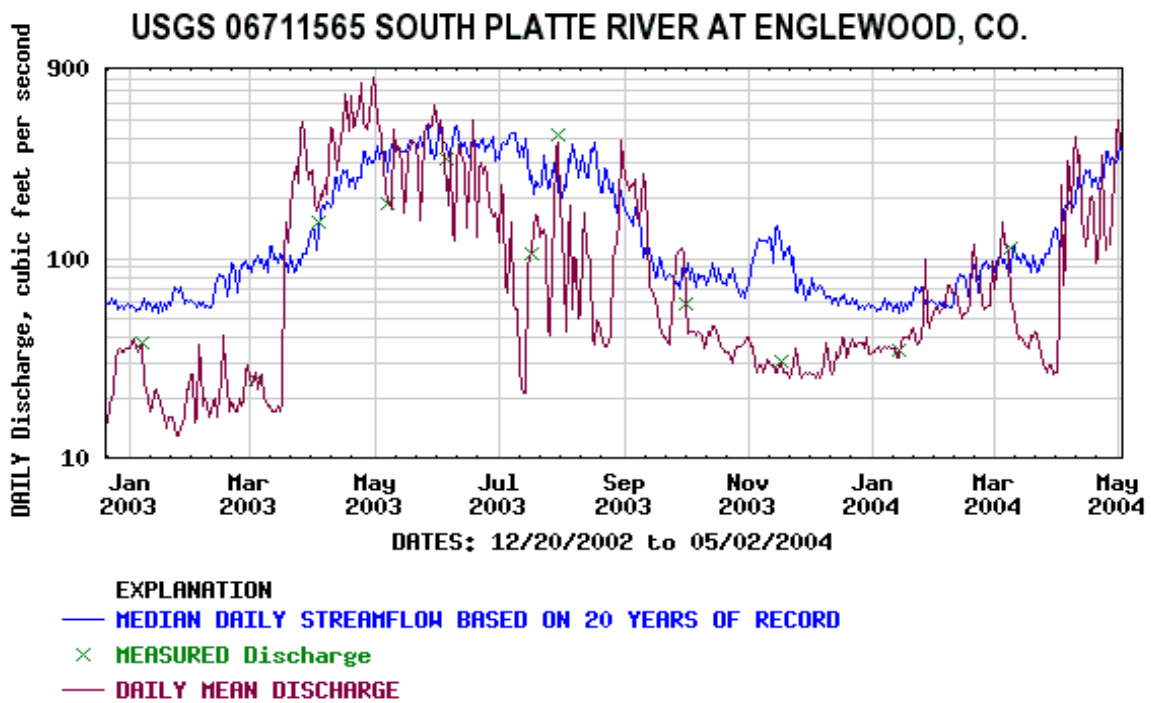
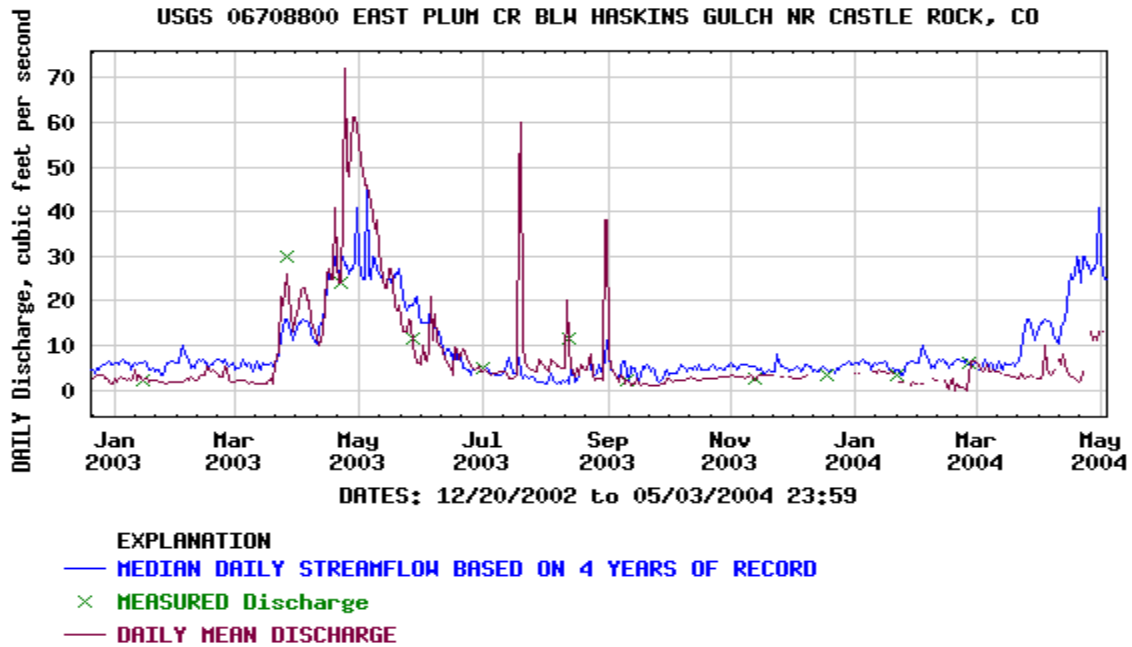
Chatfield Dam was the second of three dams built to protect the Denver region from floods. Construction of the dam began in 1967 and was completed in 1975. The dam measures approximately 13,136 feet in length with a maximum height of 147 feet from the streambed to the top of the dam. Chatfield Reservoir 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 2003 at about 48,800 acre-feet. U.S. Army Corp of Engineers records shows the average flow into Chatfield Reservoir from 1986 through mid 2003 as 239,200 acre-feet per year. The Authority estimate is 80% lower than the monitored average and the second lowest monitored flow for the reservoir on record. The U.S. Army Corp of Engineers estimated an outflow from the reservoir in 2003 of about 50,000 acre-feet. The multi-purpose pool storage capacity in 2003 was generally below normal pool size. The 2003 total inflow was associated with continued drought conditions.



Fact Sheet # 6. USGS 2003 Flow Trends at Gauged Sites

The 2003 flows (red line) in Plum Creek and the South Platte River were near or below the median daily streamflow (blue line). Flows in the South Platte River remain below normal.



Provisional Data Subject to Revision

Fact Sheet # 7. Chatfield Reservoir Total Maximum Annual Load (TMAL) & Total Phosphorus Distributions

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

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

$$\text{TMAL} = \text{Chatfield Watershed (reservoir base-load + background + wasteload allocation)} + \text{Upper South Platte River Watershed (reservoir base-load + background + wasteload allocation)} + \text{Margin of Safety}$$

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

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

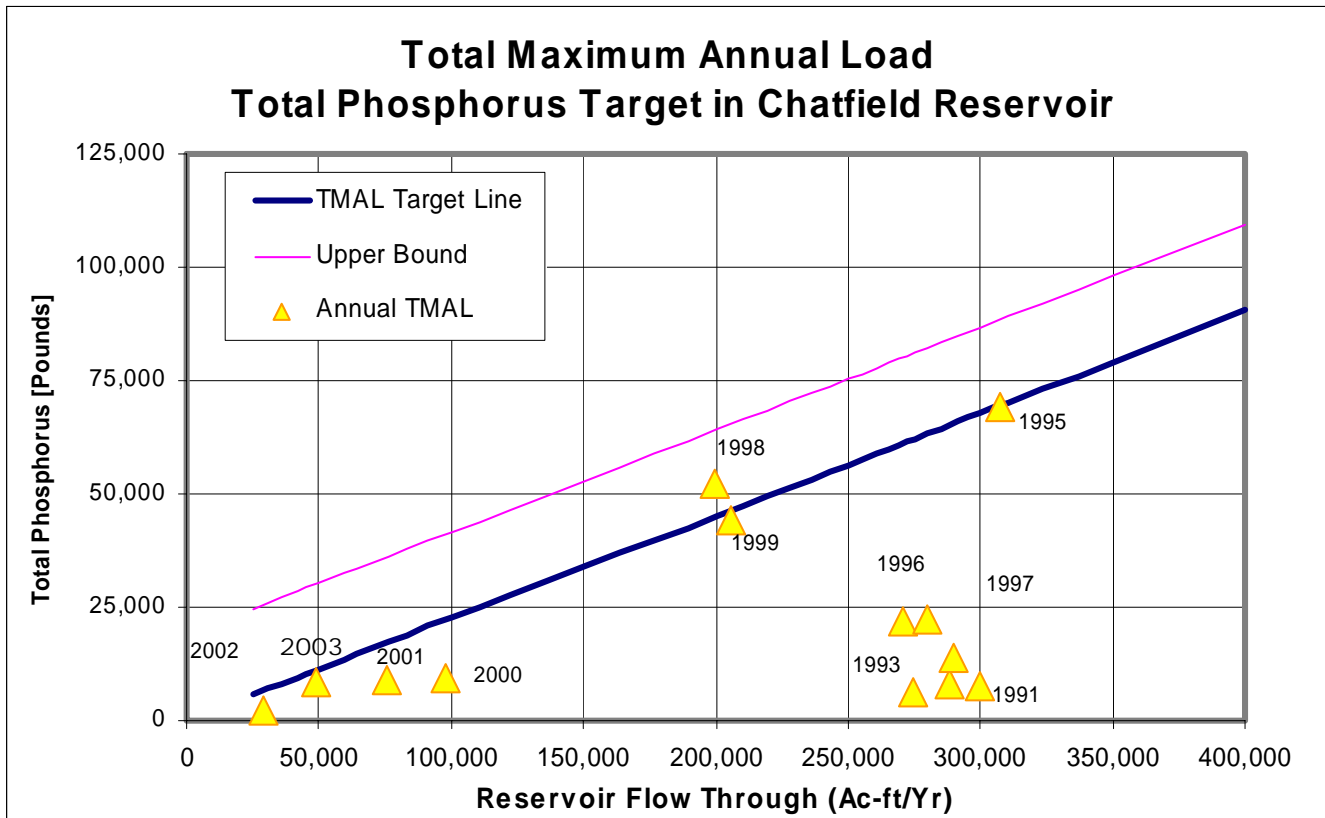
Allocation Distribution	Total Phosphorus Pounds/Year
Total Maximum Annual Load (TMAL)	59,000 @ 261,000 ac-ft/year
Chatfield Watershed	41,070
Reservoir Base-Load	13,400
Background	20,312
Wasteload Allocation (point sources)	7,358
Upper South Platte River Watershed	17,930
Reservoir Base-Load	6,000
Background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

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

Fact Sheet # 8. Total Maximum Annual Load Compliance in Chatfield Reservoir

The total maximum phosphorus load to the reservoir is limited in the Chatfield Reservoir Control Regulation as a flow dependent function where 59,000 pounds of total input can occur at 261,000 acre-feet total inflow without causing a standard exceedence. On the graphic, the total maximum annual load (TMAL) target shows allowable total phosphorus load given different reservoir inflows. In low flow years the total load that can be assimilated in the reservoir decreases substantially. The upper bound line on the graph reflects the margin of safety that protects the 17 ug/l chlorophyll goal. This chlorophyll goal has never been exceeded.

In 2003, the TMAL value of 8,379 total phosphorus pounds was below the compliance range based on an inflow of 48,800 acre-feet of water. There isn't a good linear relationship between the Total Phosphorus TMAL and reservoir inflow as predicted from the original Clean Lakes Study. The Authority will continue monitoring the TMAL and investigating the relationships and assumptions as part of the annual monitoring program.



Reservoir Meets Standards and Goals

1. *Chlorophyll a* goal met 100% of monitored years
2. Annual Total Phosphorus load met 92% of monitored years

Fact Sheet # 9. Plum Creek Wastewater Authority Plant Expansion

Existing Treatment Plant



Beginning late summer of 2002, the Plum Creek Wastewater Authority started construction on a \$30 million expansion of their advanced wastewater treatment facility with a phased wastewater discharge capacity of 4.9 million gallons per day (MGD) and 7.3 MGD.



New Treatment Plant Under Construction



The new wastewater facility includes preliminary treatment additions and modifications consisting of two influent flumes, two screw pumps, two bar screens, and an upgraded grit collection system. The secondary treatment process has been completely reconfigured through the construction of three oxidation ditches and three clarifiers to accommodate biological removal of both nitrogen and phosphorus. The facility is switching from ferric chloride to alum for the chemical removal of phosphorus. Tertiary treatment has been upgraded to include cloth disk filters and UV



disinfection. For improved solids handling, the existing plant will be converted into sludge digesters and an additional centrifuge (for a total of two) will be installed.



In May 2004, the project is approximately 86% complete, with two of the oxidation ditch/clarifier trains expected to come on-line by the end of June 2004. PCWA is excited about the benefits of an improved wastewater treatment process and capacity expansion expected to be fully operational by February 2005.



Fact Sheet # 10. 2003 Wastewater Management Activities

Treatment Plants

- Update to Perry Park Water & Sanitation District utility plan
 - ✓ Amend wastewater utility plan
 - ✓ Sage Port Treatment Plant upgrade
- Update to Plum Creek Metropolitan District utility plan
 - ✓ Amend wastewater utility plan
 - ✓ Plum Creek Treatment Plant expansion
- Louviers Mutual Service Company Treatment Plant options review
- Highlands Ranch Law Enforcement Training Foundation (In Progress)

Perry Park Wauconda Plant



Plum Creek Authority Plant



Lift Stations

- Eastern Water Treatment Plant (EWTP) Lift Station
- Meadow Filing 15 Lift Station
- Sellar Gulch Lift Station

Perry Park Wauconda Plant



Review Process and Policies

- Wastewater Service Needs for Titan Road area
- Adjustments Castle Rock Wastewater Service Area
- Roxborough Park and Lockheed Martin wastewater management strategies (See Fact Sheet #29)
- Wastewater Utility Plan Review Team and Submittal Requirements For Chatfield Technical Review Committee and Authority Board Actions



Plum Creek Authority Detention Basin



- Wastewater review policies
- The Chatfield Watershed Authority strongly supports the beneficial use of reclaimed water for irrigation applications within the Chatfield Watershed

Plum Creek



Fact Sheet # 11. Total Phosphorus Effluent Limitations, Point Source Wasteload Allocations & 2003 Total Phosphorus Pounds Discharged From Treatment Plants in Chatfield Watershed

The allowed annual wasteload of point source phosphorus (among all permitted dischargers) in the Chatfield Watershed is limited to 7,358 lbs/year. In 2003, recorded total phosphorus discharges were 4,655 pounds/year or about 63% of the allowable total discharge poundage.

Facility	Wasteload Allocation Pounds Per Year	2003 Point-Source Total Pounds
Plum Creek Wastewater Authority	4,256	3,421
Lockheed Martin Space Systems Company	1,005	180
Roxborough Park Metro District	1,168	936
Perry Park Water & San. District-Waucondah	365	115
Perry Park Water & San. District-Sageport	73	0 ¹
Town of Larkspur	231	0 ¹
Louviers Mutual Service Company	122	2.5 ²
Sacred Heart Retreat	(15) ³	ND ⁴
Ponderosa Center	- ⁵	ND
Jackson Creek Metropolitan District	50 ⁵	ND
Reserve/Emergency Pool	73	Not Used
Total Point Source Phosphorus Wasteload	7,358	4,654.5

1 Dry Monitoring Lysimeters, Assume Land Application at Agronomic Rates

2 May only discharge from wastewater lagoons

3 The Authority & Water Quality Control Division Recommend a Temporary Five-Year Phosphorus Allocation of 15 pounds for Inclusion in Discharge Permit; Obtained from the Reserve/Emergency Pool

4 ND - No Data, Monitoring Program Not Established in Permit

5 Authority has recommended inclusion of plant in management plan and a wasteload allocation. Jackson Creek has a transfer of 50 pounds from Roxborough Park. Ponderosa total phosphorus trade credit of 124 pounds based on nonpoint source to point source trading provisions.

Point Sources limited to wastewater treatment plants sited within the Chatfield Watershed. Treatment plants in the upper portion of the South Platte River are not covered by the Chatfield Control Regulation.

Fact Sheet # 12. Chatfield Watershed Authority 5-Year Funding Plan

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

The 2003 annual dues collected from members and contributing participants with interest payments are about \$112,000. The decision by any member not to participate will create a revenue shortfall and limit activities. The Authority has attempted to keep funding levels constant, so annual spending does not to exceed \$118,500 by 2008. The Authority membership does recognize that this funding level is not sufficient to accomplish all of the monitoring and management work elements that could be done within the watershed.

Massey Draw



Beginning in 2003, the Authority devoted financial resources for development and construction of water quality improvement projects. Funding limits will be placed on the water quality monitoring and administrative programs in future years.

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

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

Fact Sheet # 13. Cost of Monitoring Chatfield Reservoir

Chatfield Authority Started = 1984

Continuous Monitoring Record = 1982-2003

Sampling Sites

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

Algal Growth in South Platte River



Sample Frequency

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

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

Plum Creek Above Reservoir

Other Associated Costs

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



Cost Assumptions:

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

Fuel Operations At Reservoir

Minimum Annual Program Cost Estimates:

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

Total Costs	\$ 110,000



Fact Sheet # 14. Chatfield Watershed Authority 2003 Management Activities

Plum Creek At Titan Road



The Chatfield Watershed Authority implements a water quality planning and implementation program for Chatfield Watershed. The 2003 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 is derived from the South Platte River and the South Platte River Watershed.



Reservoir At Low Pool Volume

The 2003 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 for Plum Creek Wastewater Authority, Town of Castle Rock, City of Littleton, Centennial Water and Sanitation District, Lockheed Martin, Roxborough Park, Perry Park and Louviers;
- 3) Wastewater planning for Louviers Mutual Service and proposed Highland Ranch Law Enforcement training facility new treatment plant;

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

Fact Sheet # 15. Chatfield Watershed Authority Trading Program

TRANSFERS

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

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

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

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

DISCHARGE PERMIT

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

Trade Credit Regulations

TRADE RATIO

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

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

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

Fact Sheet # 16. Nonpoint Source Control 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 # 17. Nonpoint Source Projects & Activities

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

Lockheed Martin - During the period 1999-2003 Lockheed Martin completed a number of erosion control/sediment reduction projects. The projects have reduced non-point phosphorus loadings by at least 340 lbs/year. Additional non-point phosphorus reductions are anticipated as additional projects are completed in the near future.

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

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

Massey Draw



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

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

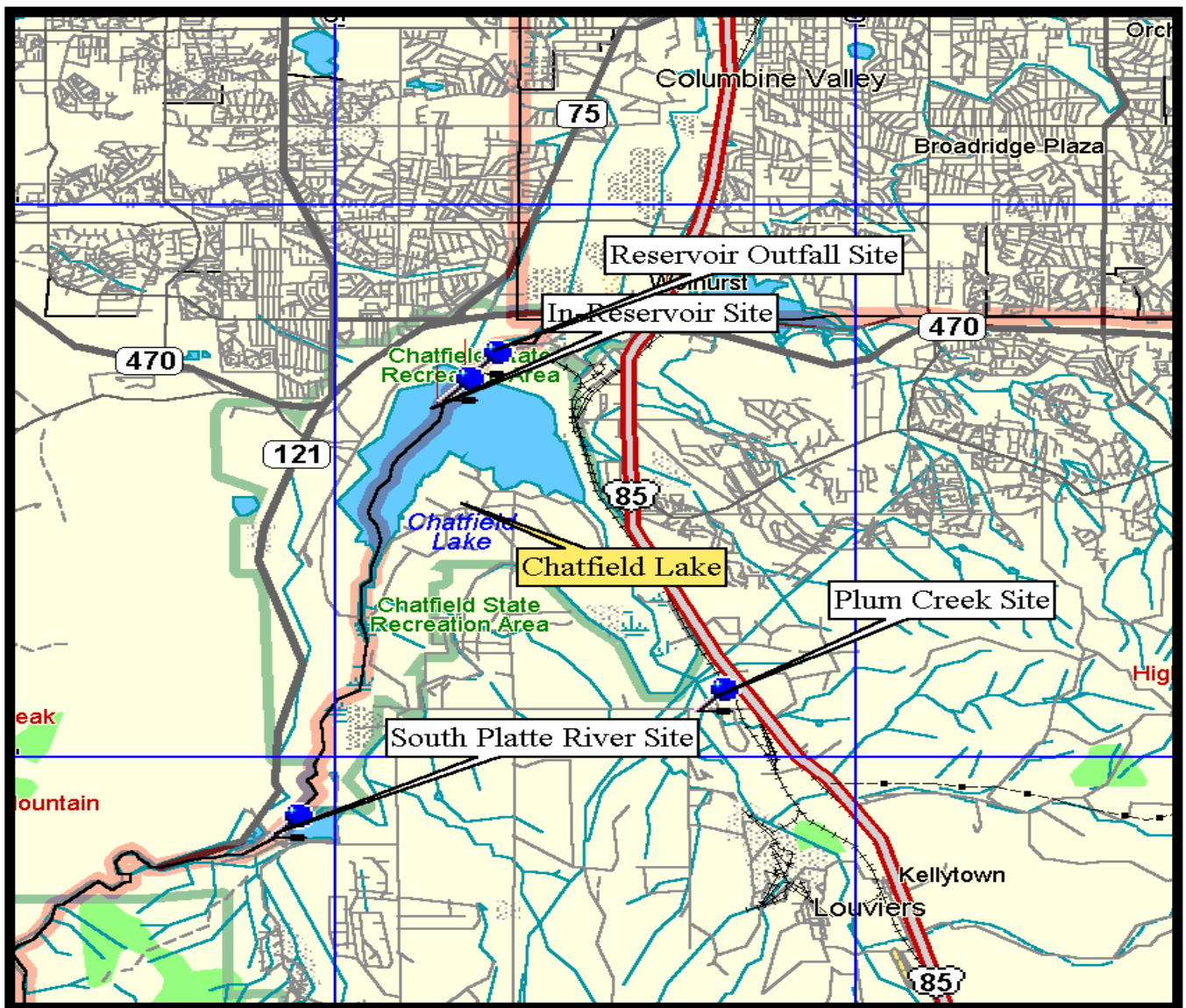
Douglas County - Douglas County maintains an erosion control program. The county is updating their Erosion Control Manual and Drainage Criteria Manual to provide greater emphasis on water quality. While the county has not determined the total phosphorus poundage reduction from the county erosion control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

City of Littleton - The City of Littleton project in the watershed is within the Chatfield Green development, marketed as the Trailmark Subdivision. Several detention ponds and wetland areas were constructed over the past 10 years. The goal of these systems is to reduce the total phosphorus load in runoff by 45-50%. The estimated stormwater detention system reduction of nonpoint phosphorus load was over 400 pounds in 2003.

Fact Sheet # 18. Chatfield Watershed Monitoring Sites & Sampling Parameters

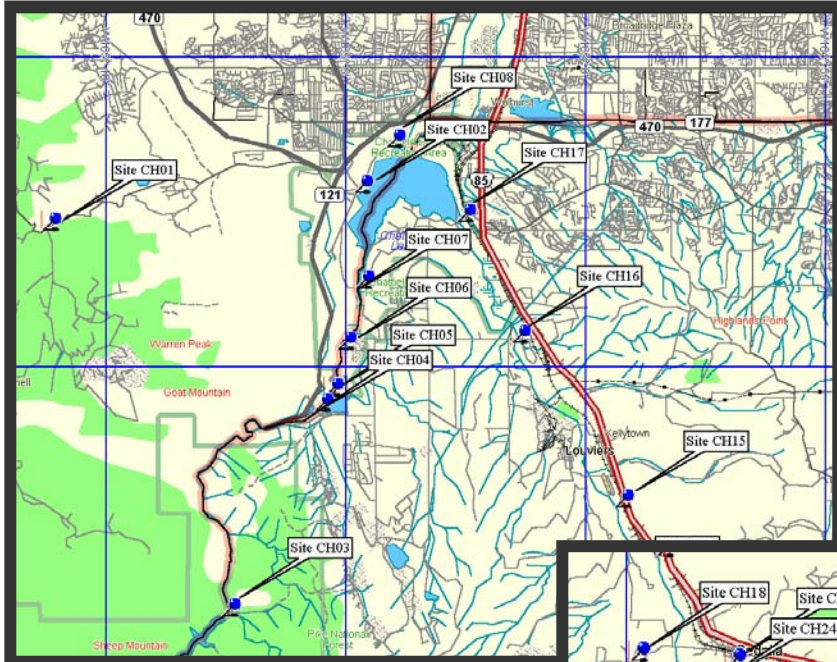
The water quality-monitoring program samples selected parameters at reservoir inflow (South Platte River and Plum Creek) and reservoir output (South Platte River) stations and within Chatfield Reservoir.

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 # 19. Chatfield Watershed Authority Nutrient Screening Survey Helps Identify Potential Future Projects

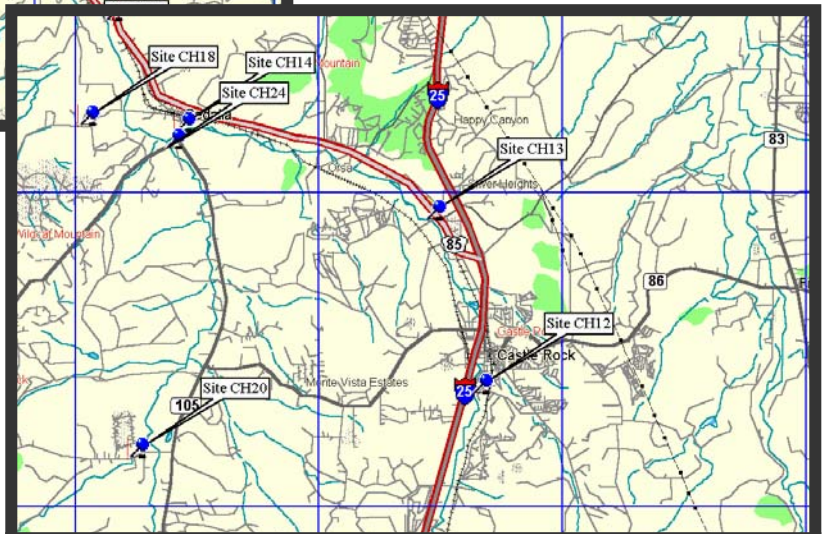
Selected field nutrient screening surveys of small tributaries and drainages were previously performed at 24 locations in the watershed to establish a watershed baseline. Nitrate and phosphorous were target parameters. These surveys indicate substantial background levels of nutrients are measurable in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



Nutrient load potential

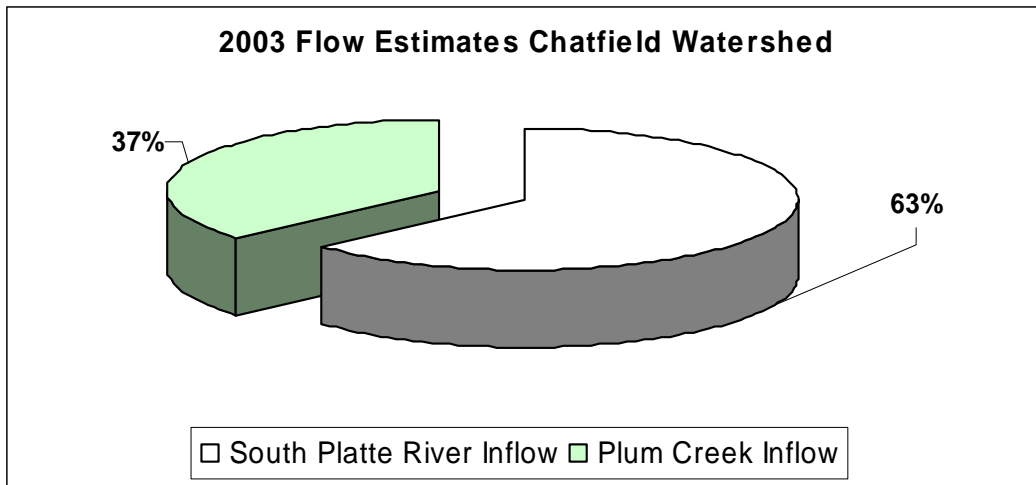
- Elevated concentrations of nitrogen and phosphorus at many upstream sites and tributaries
- Maximum nitrate-nitrogen 5 mg/l
- Maximum phosphorus 4.3 mg/l
- Elevated nutrient loading associated with runoff events
- Tributary nutrients are higher than mainstem concentrations
- Erosion control practices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

Stormwater Runoff Near Sedalia



Fact Sheet # 20. 2003 South Platte River and Plum Creek Flows with Water Balance for Chatfield Reservoir

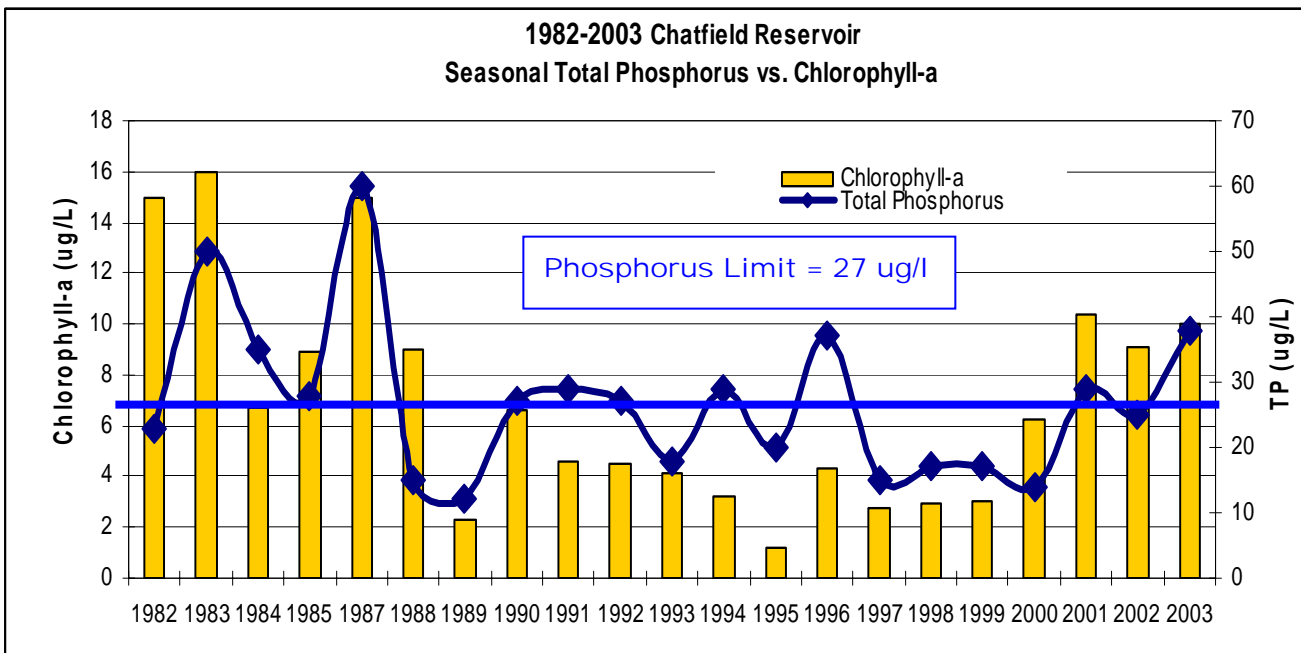
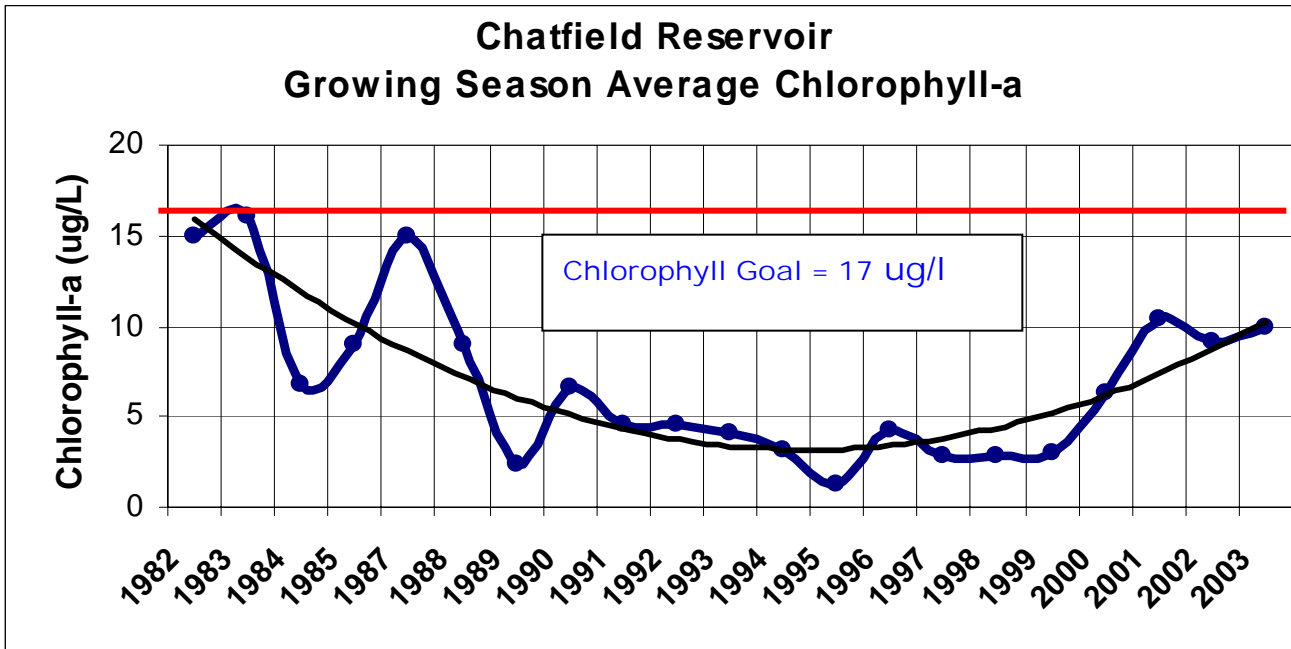
The monitoring program estimates flow from the South Platte River and Plum Creek as inflow into Chatfield Reservoir. The flow data is used to calculate water quality loading. The loading compliance formulas are flow-dependent. Total flow through the reservoir in 2003 was 48,800 acre-feet based on data from the Authority monitoring program. The U.S. Army Corp of Engineers measured average flow in the last decade was 239,300 acre-feet. The 2003 total inflow was well below normal for the combined Chatfield and Upper South Platte Watersheds and is associated with a current drought.



2003	South Platte River Inflow	Plum Creek Inflow	Total Inflow	Reservoir Outflow	Reservoir Retention
	ac-ft/mo				
Jan	1,094	1,177	2,271	1,222	1,049
Feb	1,177	1,222	2,399	1,444	955
Mar	1,449	615	2,064	13,155	-11,091
Apr	3,376	1,755	5,131	11,720	-6,589
May	3,738	10,819	14,557	891	13,665
Jun	4,378	952	5,330	15,348	-10,018
Jul	3,827	430	4,257	9,058	-4,801
Aug	2,812	0	2,812	2,699	114
Sep	5,072	129	5,201	5,476	-275
Oct	1,475	33	1,509	55	1,454
Nov	1,933	286	2,219	53	2,166
Dec	547	510	1,057	292	765
Annual	30,878	17,928	48,807	61,412	-12,606
% of Flow	63.27%	36.73%			

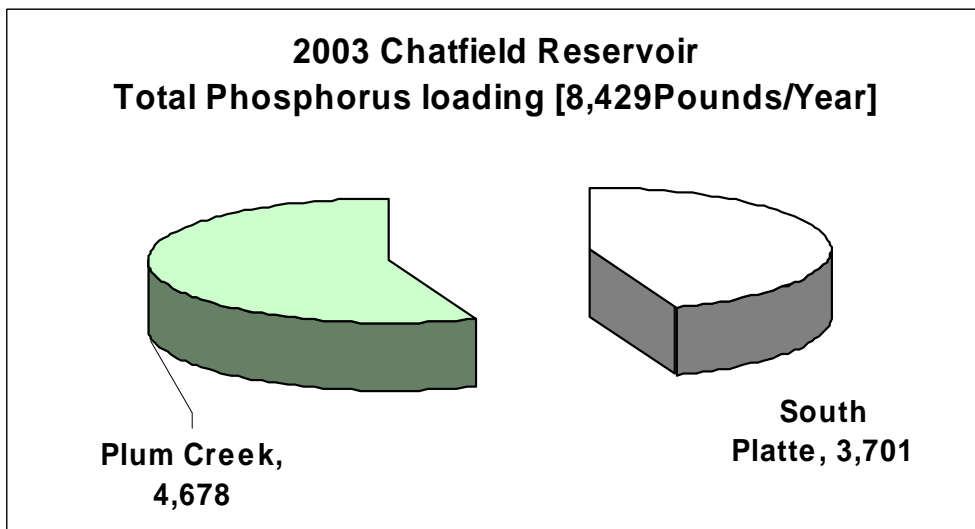
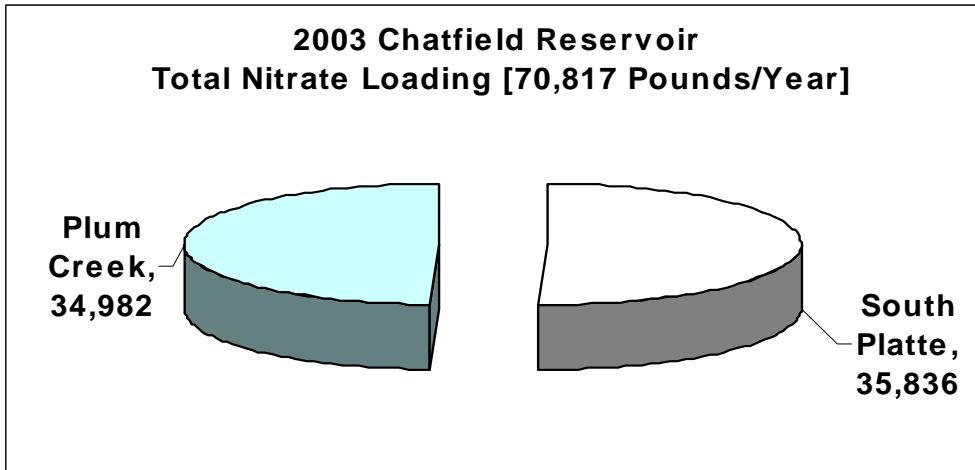
Fact Sheet # 21. Chatfield Reservoir Chlorophyll-a & Total Phosphorus Growing Season Trends

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



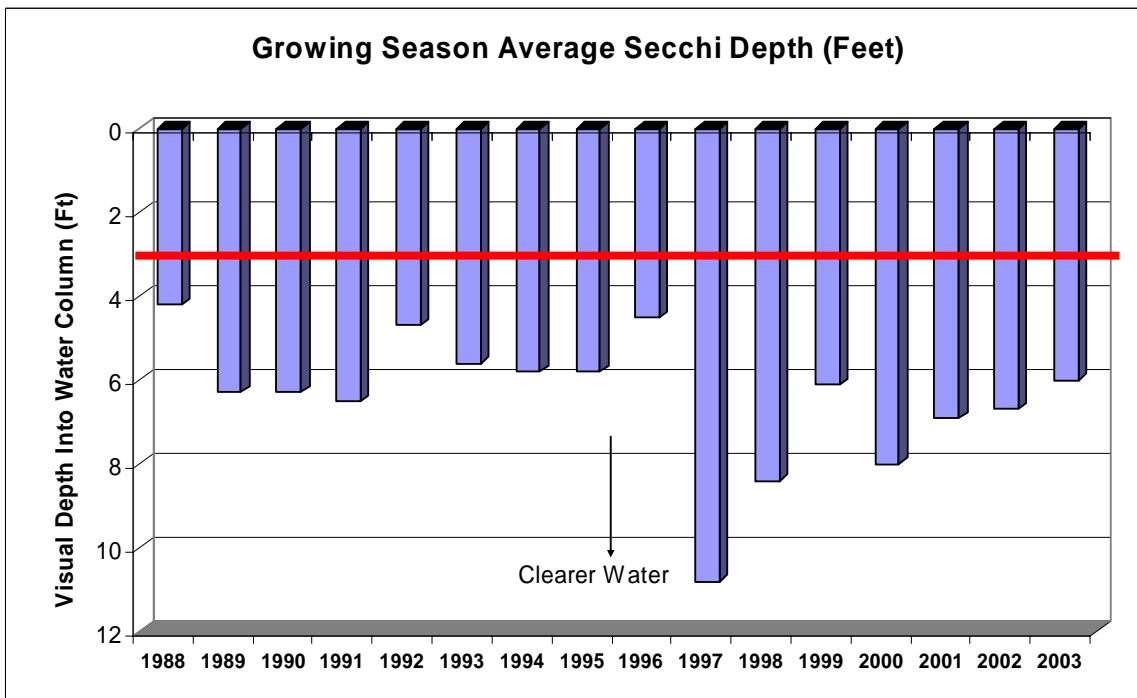
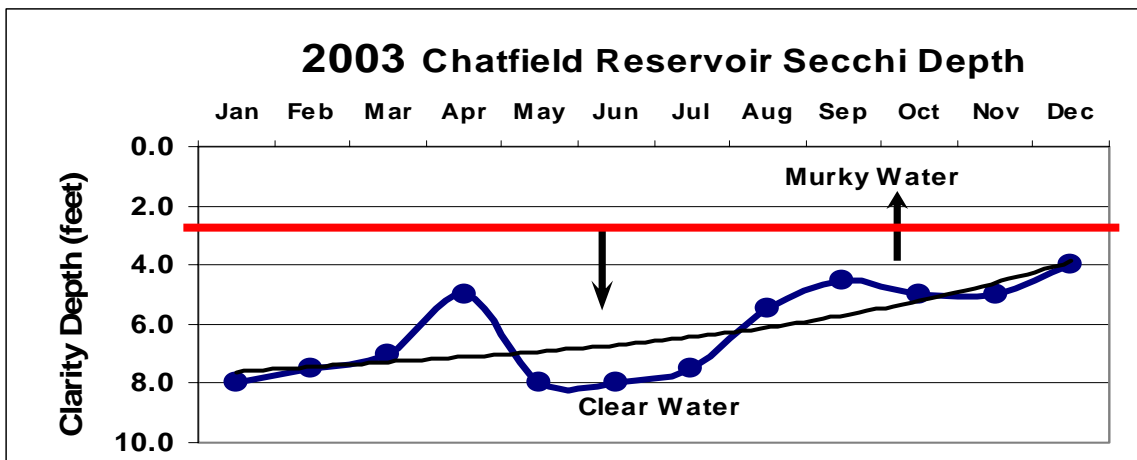
Fact Sheet # 22. 2003 Nitrate & Total Phosphorus (Nutrient) Loading into Chatfield Reservoir

The monitoring program measures chemical loading into Chatfield Reservoir from the South Platte River and Plum Creek. The total phosphorus load is derived from wastewater treatment plants within the Plum Creek drainage and as nonpoint source load from both the Chatfield Watershed and the Upper South Platte River Watershed. The 2003 drought had a significant impact on nutrient loading into the reservoir in 2003. Extremely low load of both phosphorus and nitrogen reached the reservoir. The total phosphorus load in 2003 from all sources was 8,430 pounds at a total inflow of 48,800 acre-feet. This is the second lowest total phosphorus loading recorded for the reservoir by the Authority. The nitrate loading was also well below historic conditions with only 70,820 pounds derived from all sources. However, greater proportion of nitrogen s now derived from the South Platte River drainage compared with historical trends. There was no significant nutrient-loading problem associated with Chatfield Reservoir in 2003.



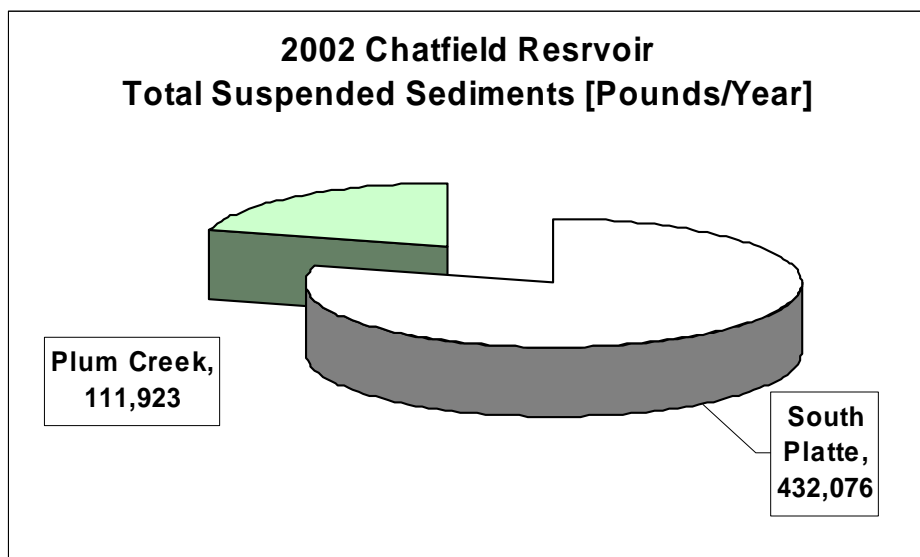
Fact Sheet # 23. 2003 Water Clarity (Secchi) in Chatfield Reservoir

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 is equated to declining or improving water quality based many lake and reservoir studies. The Secchi depth is also a factor used to estimate the trophic status (overall water quality) of a waterbody. Deeper Secchi readings indicate clearer water. Secchi measurements of about 3 feet (one-meter) or less characterize very turbid or sediment laden water or an algal bloom (Red Line on Graph). The reduced Secchi depth in the fall was associated with minor runoff events from the Hayman burn area. The long-term trend in the reservoir has been toward less murky or clearer water; however, this trend is expected to change as runoff increases from the Hayman burn area.



Fact Sheet # 24. 2003 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. Also 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 2003 TSS loading to the reservoir is 80% below normal. The Plum Creek 2003 loading is much less than average due to drought conditions and far fewer storm events. The table shows most of the instream sediment load is captured and retained within Chatfield Reservoir.



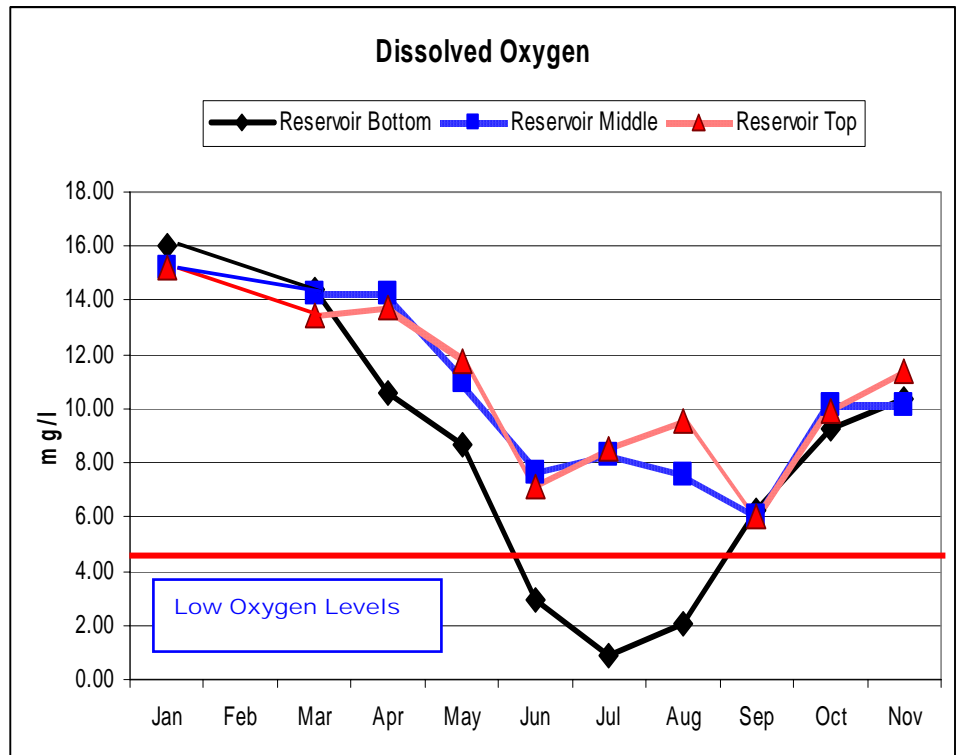
TSS	South Platte	Plum Creek	Total	Reservoir	Outflow	Retention
	Pounds/Mo	Pounds/Mo	Input	Pounds/Mo	Pounds/Mo	Pounds/Mo
Jan	35,448	1,003	36,451	36,324	1,058	35,393
Feb	30,960	30,809	61,769	43,846	30,390	31,380
Mar	28,425	12,540	40,966	92,684	92,601	-51,635
Apr	27,508	14,240	41,748	51,027	1,620	40,128
May	43,340	20,065	63,405	81,385	1,925	61,480
Jun	40,372	9,709	50,081	42,847	1,620	48,461
Jul	93,903	18,058	111,962	49,012	3,817	108,145
Aug	28,592	0	28,592	28,624	1,707	26,885
Sep	36,812	0	36,812	26,324	1,507	35,306
Oct	27,171	0	27,171	32,641	1,523	25,648
Nov	20,583	3,074	23,657	24,299	1,814	21,843
Dec	18,961	2,424	21,386	18,246	1,088	20,298
Total	432,076	111,923	544,000	527,258	140,669	403,330

Fact Sheet # 25. 2003 Chatfield Reservoir Dissolved Oxygen

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

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

Monthly Minimum Dissolved Oxygen Profile	
	mg/l
Jan	15.20
Feb	-
Mar	13.45
Apr	13.76
May	8.64
Jun	2.97
Jul	1.74
Aug	0.55
Sep	6.00
Oct	10.38
Nov	13.77
Dec	-

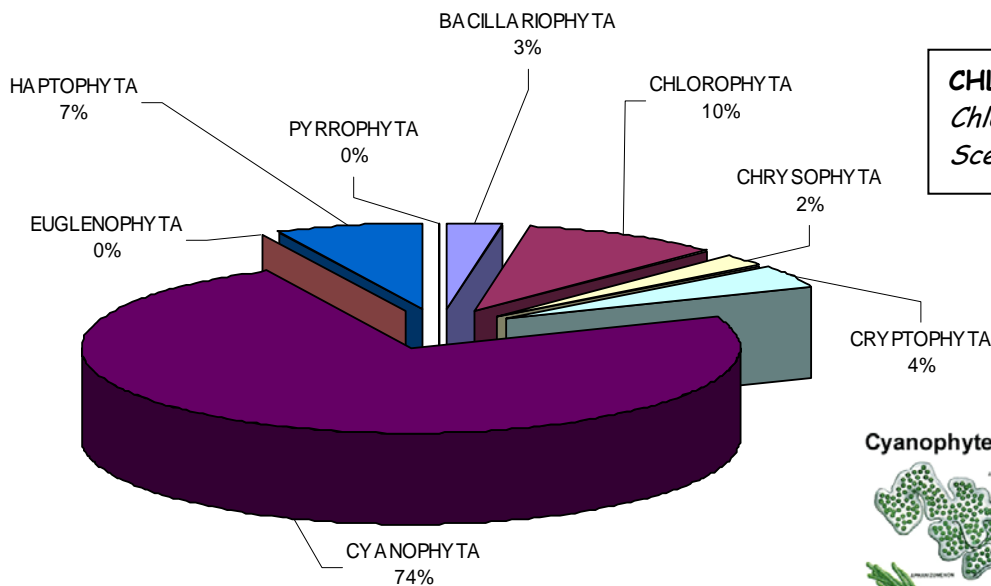


The Basic Standards and Methodologies for Surface Water (5 CCR 1002-31, Regulation #31) -The dissolved oxygen criterion is intended to apply to the epilimnion and metalimnion strata of lakes and reservoirs. Dissolved oxygen in the hypolimnion may, due to the natural conditions, be less than the table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

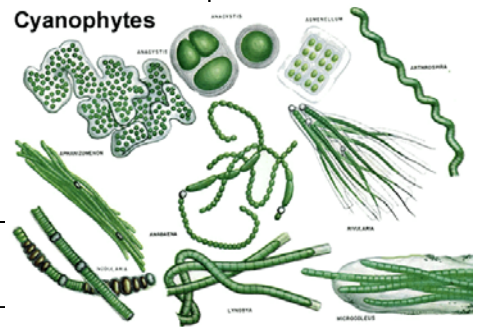
Fact Sheet # 26. 2003 Phytoplankton & Zooplankton Species Distributions in Chatfield Reservoir

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 2003, the blue-green again dominated the species mix at 74%. The increased nutrient conditions are more favorable to blue-green algae compared to greens. The 9-zooplankton species from three functional groups are typical of front-range reservoirs.

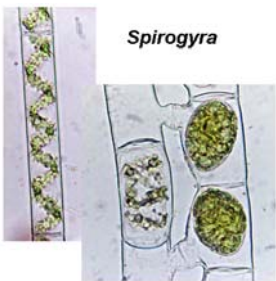
2003 Average Phytoplankton Distribution



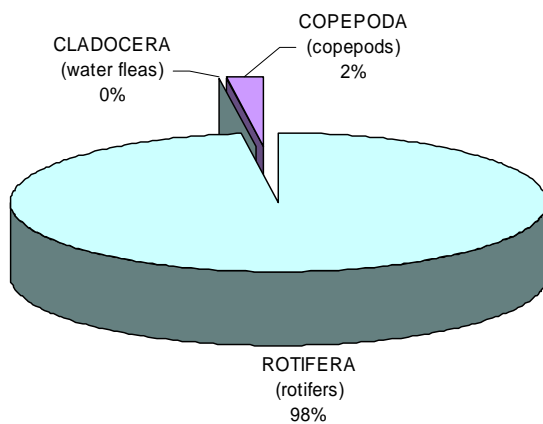
CHLOROPHYTA (Greens)
Chlorella minutissima
Scenedesmus intermedius



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



2003 Zooplankton Distribution

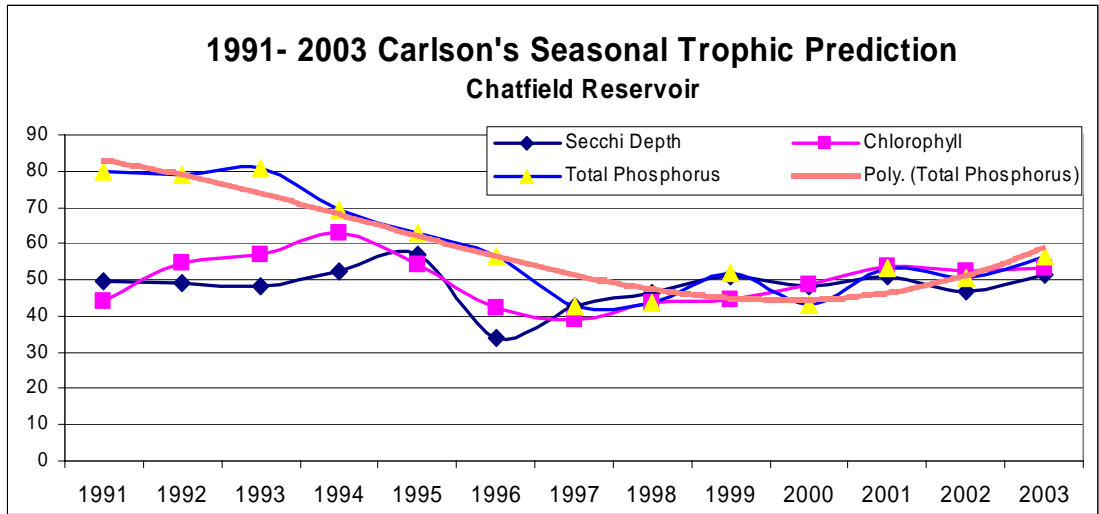


Keratella cochlearis (Gosse)
Lecane sp.
Polyarthra vulgaris
Trichocerca sp.
Bosmina longirostris
Chydorus sp.
Diacyclops thomasi (S.A. Forbes)
Mesocyclops edax (Forbes)
 Nauplii

Fact Sheet # 27. Long-Term Walker and Carlson Trophic State Indexes (TSI) for Chatfield Reservoir

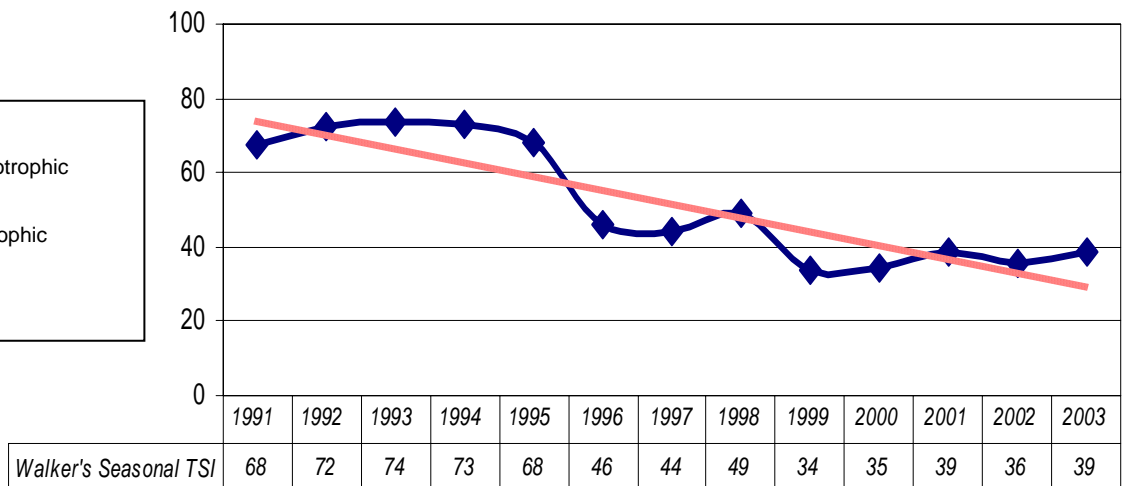
The ongoing trend-monitoring program characterizes Chatfield Reservoir chemical and biological quality, along with South Platte River and Plum Creek inputs and outflow from the reservoir. The reservoir trophic status evaluation determines overall water quality trends. The two trophic models (TSI) look 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.

**1991- 2003 Carlson's Seasonal Trophic Prediction
Chatfield Reservoir**



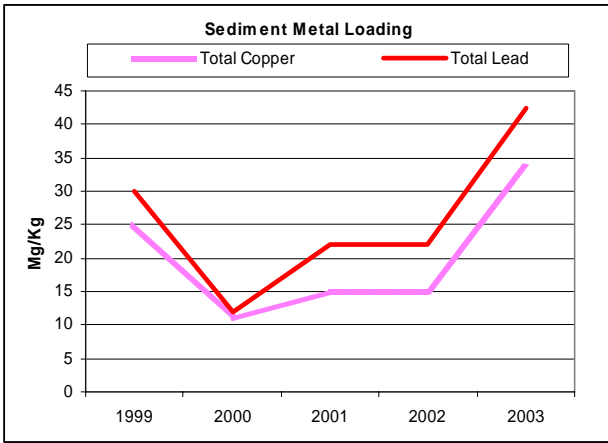
0-25	Oligotrophic
25-30	Oligotrophic-Mesotrophic
30-45	Mesotrophic
45-50	Mesotrophic-Eutrophic
50-65	Eutrophic
65+	Hypereutrophic

1991-2003 Walker's Seasonal Trophic Prediction



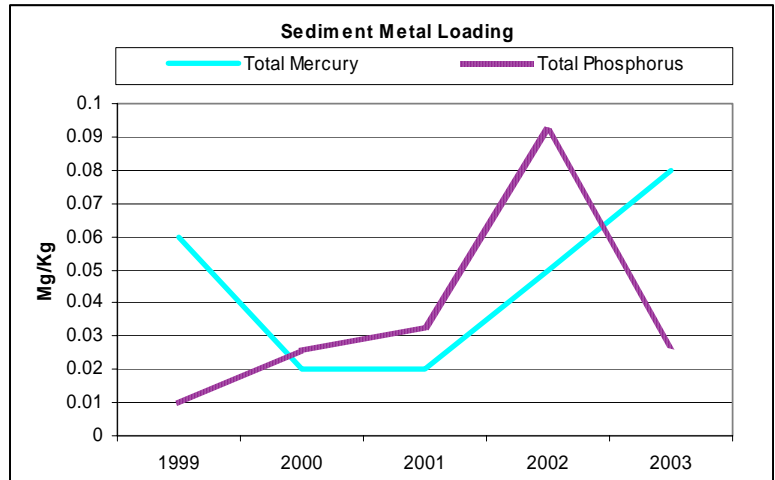
0-25	oligotrophic
25-30	oligotrophic-mesotrophic
30-45	mesotrophic
45-50	mesotrophic-eutrophic
50-65	eutrophic
65+	hypereutrophic

Fact Sheet # 28. Chatfield Reservoir Sediment Base Line Data



A single sediment box core sample of surface sediments is obtained at the profile monitoring station. The sediment analyses include five indicator metals, total organic carbon, percent silts and clays, and total phosphorus. Bed sediments in the Chatfield Reservoir come from a variety of sources. They wash off surrounding land surface and are transported by the South Platte River during rainstorms. Sediment also comes from direct deposition of airborne dust and particles. Over time, these sediments accumulate and form a layer on the reservoir bottom. The chemical composition of the deposited sediments changes

over time and can reflect the historical activity in the watershed. The Chatfield Authority is collecting sediment data to form a base line for future analysis and trend characterization. Bottom sediments range from a silty-clay to a silty sand. In 2003 positive detection were measured in bottom sediments for all monitored metals. The total copper and lead values were higher than previously monitored. However, these data points are not a water quality problem. The concentration of total organic carbon was elevated and reflects the accumulation of organic matter in the reservoir sediments. Total phosphorus concentrations declined in 2003. The bottom sediments in the reservoir aren't homogenous with a wide variation in the sand/clay ration between monitoring periods. This variation in sand/clay mix can greatly affect the concentration of metals, phosphorus and organic matter in the sediments. The data record is not large enough to detect any trends on an annual basis. The Authority will continue bottom sediment analysis and develop a longer-term trend data set.



Total Metal Analysis of Reservoir Sediments												
Date Sampled	Total Arsenic	Total Cadmium	Total Copper	Total Lead	Total Mercury	Total Phosphorus	Total Selenium	Carbon TOC	Texture by Hydrometer			
	Mg/Kg	Mg/Kg	Mg/Kg	Mg/Kg	Mg/Kg	Mg/Kg	Mg/Kg	Mg/Kg	% Silt	% Clay	% Sand	
20 Aug 2003	8.95	0.82	33.6	42.4	0.08	0.027	2.25	2.4	31.3	65	3.8	
14-Aug-2002	79	1	14.9	22	0.05	0.0916	3.1	2.14	2.5	70	22.7	
15-Aug-2001	2.0	0.5	14.9	22	0.02	0.0328	0.77	0.86	7.5	18	74.5	
16-Aug- 2000		0.25	11	12	0.02	0.026	0.8	0.78	12.5	27.5	40	
18-Aug-1999		0.5	25	30	0.06	0.01	2	2.02	30	60	10	

Fact Sheet # 29. 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). This regional project will close two wastewater treatment plants which are due for upgrades. This action would remove wastewater effluent from discharge into the South Platte River above Chatfield Reservoir.



Chatfield Reservoir With Outlet Structure



The reduction in phosphorus discharges to the Chatfield Reservoir provides further water quality benefits. 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.

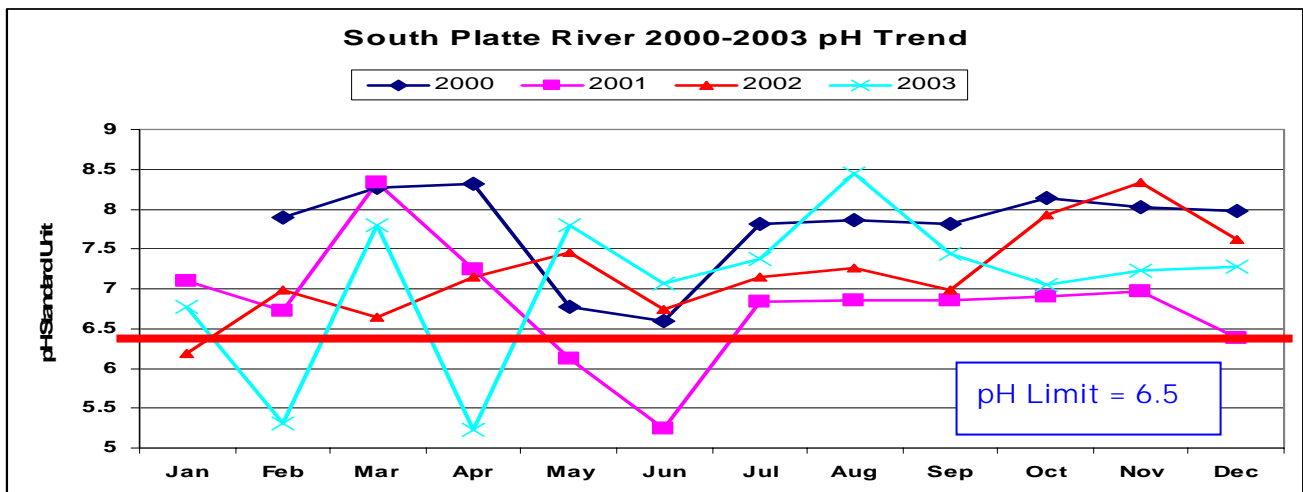
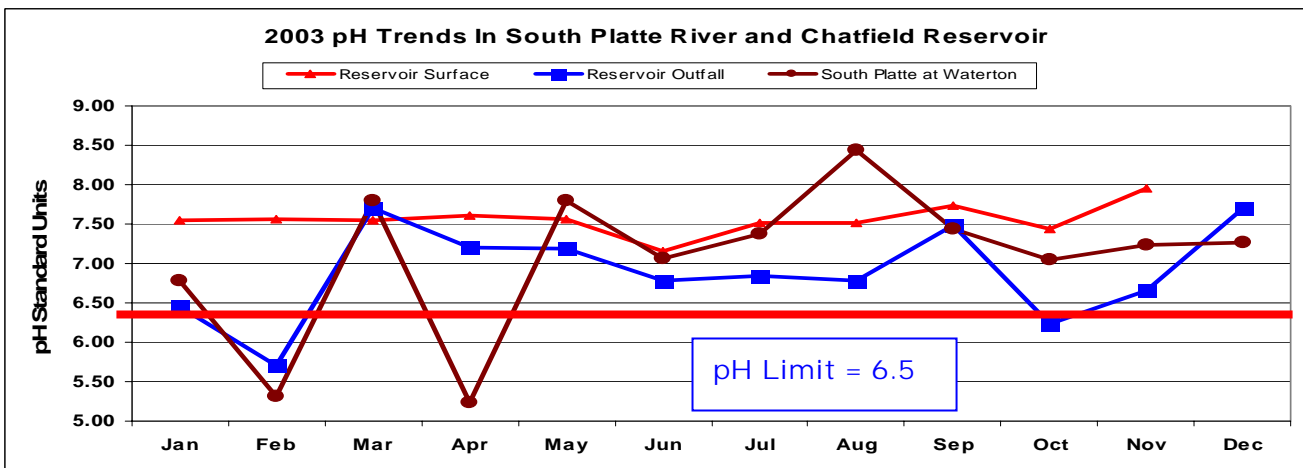
The Authority continues to track plans by Roxborough and Lockheed regarding their intent to combine wastewater flows for treatment at the Littleton Englewood wastewater plant. The Littleton Englewood wastewater treatment plant has included the proposed pipeline in their wastewater utility plan. The Authority is confident that a regional solution is possible in the near-term. After completion of the pipeline project, both treatment plants will be decommissioned. Lockheed will still retain treatment of groundwater.



The Authority is concerned about Lockheed’s discharge permit renewal process and compliance schedule that could force unnecessary and costly upgrades to their treatment plant when the Authority is encouraging regionalization and decommissioning of the treatment plant. The Authority strongly encourages the pipeline regionalization and keeping flexibility in the Lockheed and Roxborough discharge permits, which will allow for this consolidation.

Fact Sheet # 30. 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 0 on the scale] and hydroxyl ions predominate in very alkaline solutions [measured as 14 on the scale]. At around pH 7 the numbers of both species present are equal and the water is said to be neutral. The pH scale is a logarithmic measurement of the concentration of hydrogen ions, which means that each one unit change in the scale equals a ten-fold increase or decrease. Plant photosynthesis is the main cause of high pH and diurnal pH fluctuations. High alkalinity water [pH > 9.0] 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 2000 pH South Platte River reservoir inflow trend shown in the lower graph is more typical of historic trend for the river with values ranging from 6.5 to 8.5. The drought conditions beginning in 2001 through 2003 and subsequent fire runoff impacts have caused the river pH to fluctuate with a range of 5.3 to 8.6. The low river pH values could stress resident trout populations. The reservoir generally maintains pH values within the standard range.



Fact Sheet # 31. Stormwater Management In Trailmark Subdivision

The City of Littleton has required a comprehensive stormwater management system for the Trailmark Subdivision west of Chatfield Reservoir. This stormwater management system was designed to protect the Chatfield Nature Preserve operated by the Denver Botanical Gardens south of the project. These stormwater structures help reduce over 400 pounds of total phosphorus from reaching the Chatfield Reservoir.

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



Fact Sheet # 32. Jefferson and Douglas County Stormwater Permit Programs



Jefferson County stormwater permit activities

- Applied for and received coverage under the General Permit for Stormwater Discharges Associated with Municipal Separate Storm Sewer Systems
 - Prepared a storm sewer outfall map to trace sources of potential illicit discharges and illegal dumping
 - Added stormwater information to the County's web page
 - Revised County's standard for storm sewer inlets, requires "No Dumping" insignia on inlets
- Jefferson County provides opportunities for residents and visitors to learn and be involved in environmental stewardship.



Douglas County Stormwater management

East Plum Creek Near Castle Rock



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



- Douglas County Floodplain Management Department issues floodplain development permits.

Fact Sheet # 33. Reduction in Phosphorus Loading Through Erosion Controls at the Lockheed Martin Waterton Facility

Lockheed Martin Site

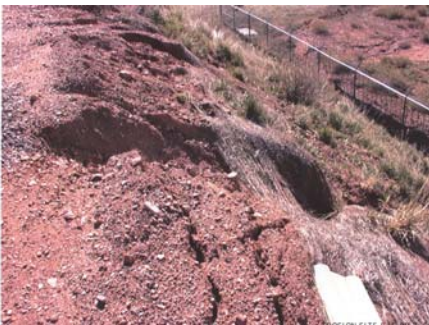


Erosion is a continuing concern at the Lockheed Martin Space Systems Company Waterton Facility because of the topography, erosive soils, and impervious roadways and parking areas. Erosion is a potential source of phosphorus and sediment loading to waterways that are tributary to the Chatfield Reservoir. 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

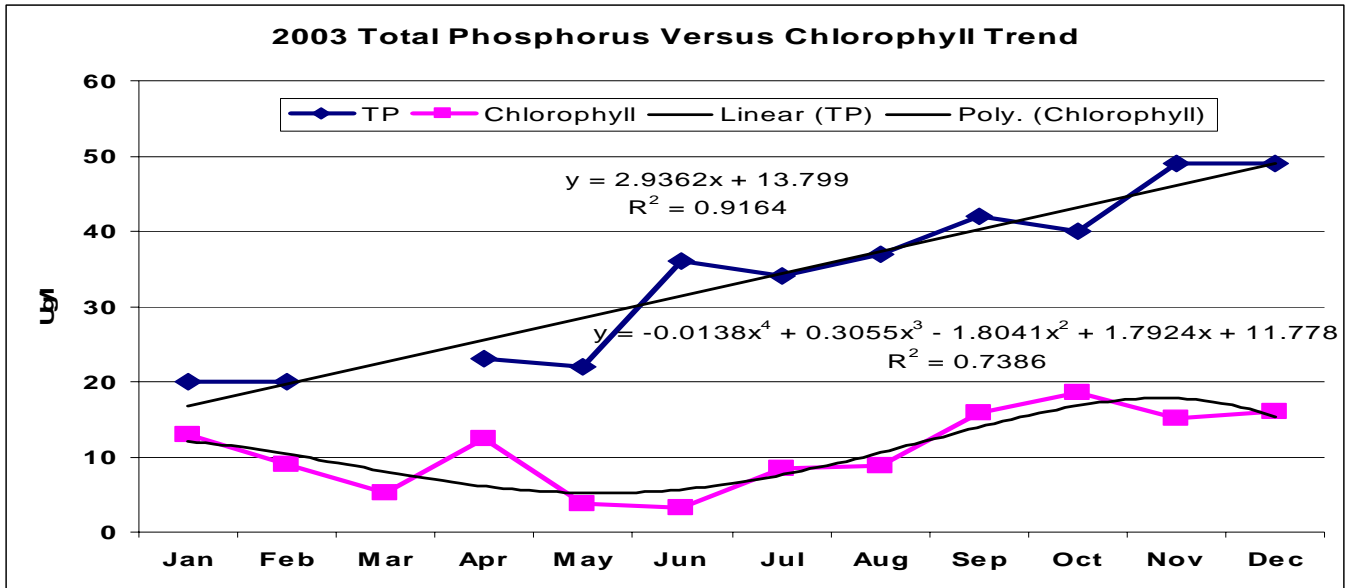


- Engineering solutions to remediate areas and prevent further erosion

As a result of implementation of erosion controls, Lockheed Martin has reduced potential annual phosphorus loading by more than 340 lbs/year.



Fact Sheet # 34. 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.

