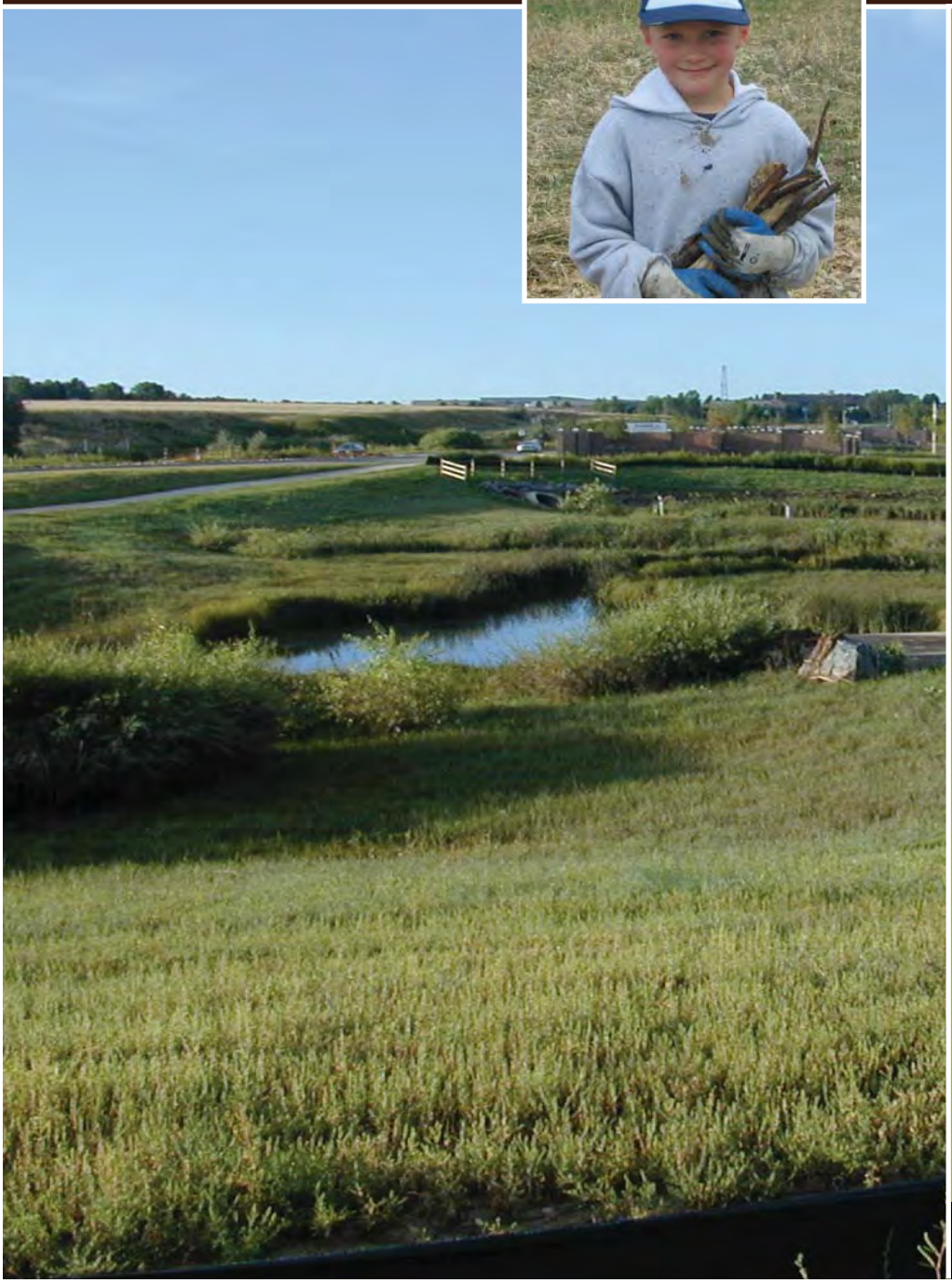
CHERRY CREEK BASIN WATER QUALITY AUTHORITY

March 31, 2009

2008 ANNUAL REPORT ON ACTIVITIES



BROWN AND CALDWELL

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ANNUAL REPORT
ON ACTIVITIES

CHERRY CREEK BASIN
WATER QUALITY AUTHORITY

March 31, 2009

Prepared for

CHERRY CREEK BASIN
WATER QUALITY AUTHORITY

Chuck Reid, Manager
R.S Wells LLC
8390 E. Crescent Parkway, Suite 500
Greenwood Village, CO 80111-2814

P: 303.779.4525
F: 303.773.2050

http://www.cherrycreekbasin.org/cc_home.asp

Prepared by

BROWN AND CALDWELL
1697 Cole Boulevard, Suite 200
Golden, Colorado 80401
303.239.5400

Contributions from:

GEI CONSULTANTS
5575 South Sycamore Street, Suite 101
Littleton, Colorado 80120-1141

JOHN C. HALEPASKA AND ASSOCIATES, INC.
26 West Dry Creek Circle, Suite 640
Littleton, Colorado 80120

LAND USE AGENCIES AND UTILITIES
Within the Cherry Creek Basin

CHEERY CREEK STEWARDSHIP PARTNERS
http://www.cherry-creek.org

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CONTROL REGULATION 72 REPORTING REQUIREMENTS

REG 72 REPORTING

Look for this symbol in the margin of the 2008 Annual Report to see sections that correlate to the reporting requirements, listed in Section 72.9, Reporting, of Regulation No. 72 – Cherry Creek Reservoir Control Regulation.

Control Regulation Section Number and Reporting Requirement	Section of Annual Report
Section 72.9 - Reporting	
72.9(1) Annual Report Submittal	Cover Letter
72.9(1)(a) Wastewater Facility Controls	
Monthly and annual loads	4.1.1
Permit violations	4.2
Approved site location approval applications	4.3
Effectiveness in reducing nutrient loads	4.1, 4.2
72.9(1)(b) Nonpoint Source Controls	
Sediment and erosion control permit, inspection, and enforcement actions	5.1
Construction BMPs inspection and enforcement actions	5.1
Permanent BMPs construction, inspection, and maintenance actions	5.1
Flood control facilities retrofitting, inspection, and maintenance actions	5.1
Effectiveness in reducing nutrient loads	9.5
Funding of nonpoint source control projects	5.6
Monitoring of nonpoint source control projects	9.5
Public information and education actions	7.1-7.5
72.9(1)(c) Riparian and Wetlands Protection	
Protection, enhancement and restoration actions	5.7
72.9(1)(d) Wasteload Allocation	
Temporary transfers, reserve pool allocations, and semi-urban area transfers	4.1, 6.2
72.9(1)(e) Trading Program	
Point and nonpoint source actions, including reporting TMAL reductions from Trading Program	6.1
72.9(2) Provide data and information on the following:	
Water quality monitoring	9
Point and nonpoint source loadings	4.1, 9.4
Status of compliance with discharge permit limits and conditions	4.2
Recommendations on new or proposed expansion of treatment facilities	4.3
Recommendations for improving water quality	5.6, 10
Annual report format shall provide comparability among previous years	n/a
72.9(3) Include evidence or agreements for the following:	
Financing of nonpoint source projects	5.6
Implementation of stormwater permit requirements	5.1,5.3
Adoption and implementation of BMPs by local governments	5.1
Demonstrate reasonable progress towards control of point and nonpoint sources of phosphorus	4.4, 5.8

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CONTROL REGULATION 72 TASK REQUIREMENTS

Look for this symbol in the margin of the 2008 Annual Report to see how the Authority is taking steps to meet the task requirements outlined in Regulation No. 72 – Cherry Creek Reservoir Control Regulation.

Control Regulation Section Number and Task Requirement	Section of Annual Report
Section 72.3 Phase I Total Maximum Annual Phosphorus Load Allocations	
72.3 (4) Future Activities to attain TMAL	
72.3 (4)(1) Construct nonpoint source control projects	5.6
72.3 (4)(2) Conduct Reservoir nutrient studies	8
72.3 (4)(3) Develop event mean concentrations for stormwater flows	8
72.3 (4)(4) Quantify soil and groundwater background phosphorous levels	8
72.3 (4)(5) Identify industrial process wastewater sources and associated phosphorous loading	8
72.3 (4)(6) Evaluate phosphorus removal effectiveness of nonpoint source control structures	8
72.3 (4)(7) Monitor shallow alluvial ground water loading in tributaries	8
72.3 (4)(8) Quantify individual sewage disposal system phosphorus loading	8
72.3 (4)(9) Implement lower phosphorus effluent limits	4.2
72.3 (4)(10) Characterize Watershed hydrology to establish reference condition for evaluation of phosphorus loading	8
72.3 (4)(11) Conduct depth profiling of nutrient content for ground water	8
72.3 (4)(12) Revise calculations of background sources, industrial processes, wastewater sources, and individual sewage disposal systems sources of phosphorus contributions	8
72.3 (4)(13) Revise control regulation TMAL for next triennial review	8
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LIST OF ACRONYMS

ac-ft	acre feet
ACWWA	Arapahoe County Water and Wastewater Authority
Annual Report	Cherry Creek Basin Water Quality Authority 2008 Annual Report on Activities
Authority	Cherry Creek Basin Water Quality Authority
BMP	Best Management Practice
CDOT	Colorado Department of Transportation
CDPHE	Colorado Department of Public Health and Environment
CIP	Capital Improvement Projects
COE	U.S. Army Corp of Engineers
Commission	Colorado Water Quality Control Commission
Control Regulation 72	Regulation No. 72 – Cherry Creek Reservoir Control Regulation
DESC	Drainage, Erosion and Sediment Control
Division	Colorado Water Quality Control Division
DMR	Discharge Monitoring Report
DRCOG	Denver Regional Council of Governments
Education Initiative	Cherry Creek Basin Water Stewardship and Education Initiative
EMC	event mean concentration
GESC	Grading, Erosion and Sediment Control
gpd	gallons per day
IGA	Intergovernmental Agreement
ISDS	Individual Sewage Disposal System
lbs	pounds
LID	low-impact development
mg/L	milligrams per liter
MS4	Municipal Separate Storm Sewer Systems
NPDES	National Pollutant Discharge Elimination System
O&M	Operations and Maintenance
ORP	oxidation-reduction-potential
Park	Cherry Creek State Park
Partners	Cherry Creek Stewardship Partners
PRF	Pollutant Reduction Facility
Requirements	Cherry Creek Reservoir Watershed Stormwater Quality Requirements
SEMSWA	Southeast Metro Stormwater Authority
SRP	Soluble Reactive Phosphorus
TABOR	Tax Payers' Bill of Rights
TAC	Authority's Technical Advisory Committee
TMAL	Total Maximum Annual Load
UDFCD	Urban Drainage and Flood Control District
µg/L	micrograms per liter

WET	whole effluent toxicity
WQCV	water quality capture volume
WWTP	Wastewater Treatment Plant
yr	year
2008 Annual Monitoring Report	2008 Annual Aquatic Biological-Nutrient Monitoring Study and Cottonwood Creek Phosphorus Reduction Facility Monitoring

EXECUTIVE SUMMARY

The purpose of the 2008 Annual Report on Activities (2008 Annual Report) is to provide a status report on Cherry Creek Reservoir water quality and review progress made by the Cherry Creek Basin Water Quality Authority (Authority) towards achieving water quality standards in 2008. The following objectives guide the development of the Annual Report.

- Document the steps taken in 2008 to perform required tasks.
- Meet Regulation No. 72 – Cherry Creek Reservoir Control Regulation (Control Regulation 72) reporting requirements.
- Present the results of monitoring activities.
- Review the effectiveness of watershed management strategies.
- Provide an Executive Summary that can act as a stand-alone abbreviated report of 2008 activities and progress.

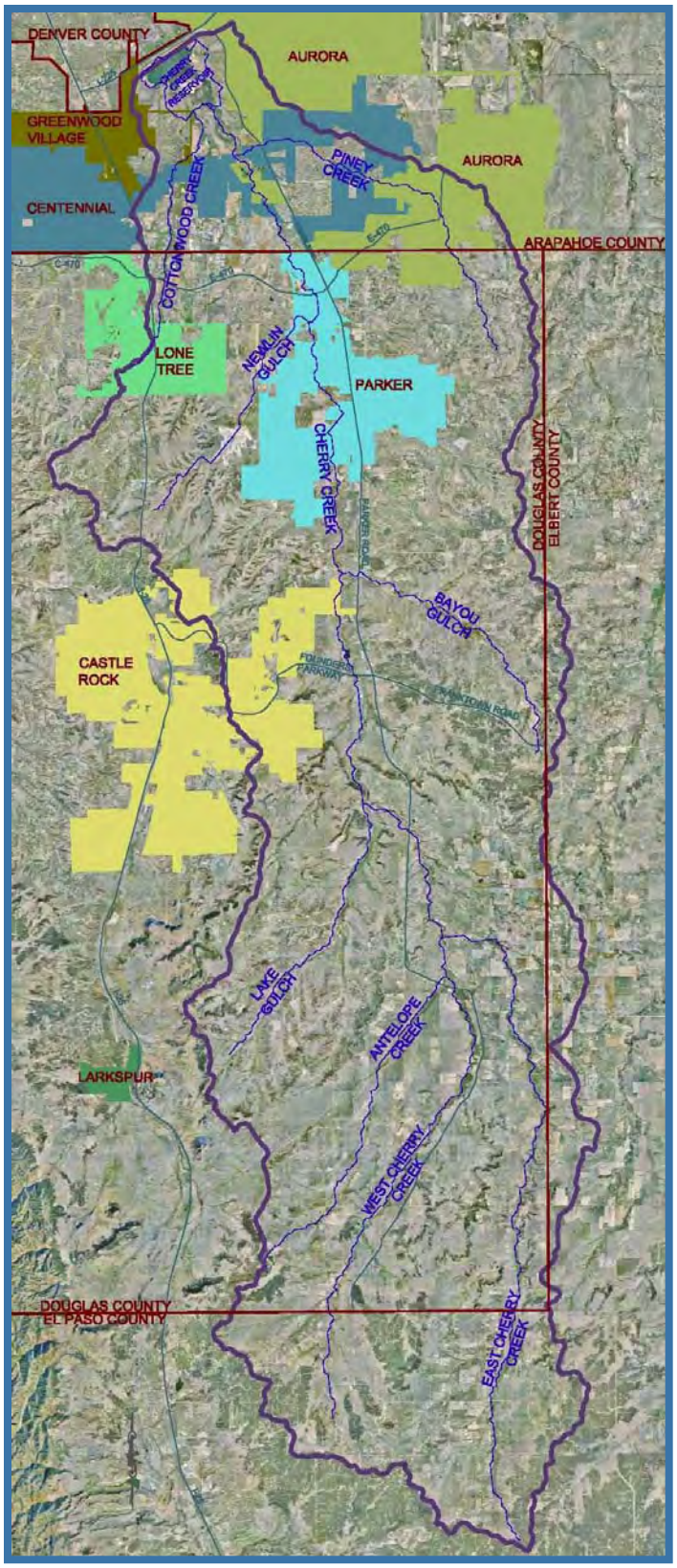
The mission of the Authority is to "maintain beneficial uses in the Cherry Creek Reservoir by preserving its water quality." Beneficial uses are those uses for which the Cherry Creek Reservoir has been assigned to protect and include: (1) aquatic life; (2) primary recreation; (3) water supply; and (4) agriculture. Authority activities discussed in the Annual Report are components of a plan directed toward meeting water quality standards, enhancing environmental health in the Cherry Creek Reservoir Watershed (Figure ES-1), and implementing the phased Total Maximum Annual Load (TMAL) for phosphorus entering Cherry Creek Reservoir. These activities include monitoring water quality, measuring phosphorus loads to Cherry Creek Reservoir, implementing point, nonpoint, and regulated stormwater source controls and programs, conducting special study efforts required by Control Regulation 72 to update the TMAL, and discussing additional strategies for meeting Reservoir water quality standards and goals in the foreseeable future. The Annual Report reviews the Authority's activities to ensure the strategies employed to meet the water quality standards and goals are appropriate and effective in the short and long term.

Status of Water Quality

In 2008, the Authority continued to implement the routine annual water quality monitoring program in the Cherry Creek Reservoir and the Cherry Creek Watershed. The program monitors Reservoir water quality, Reservoir inflow and loading, Reservoir outflow, surface and groundwater quality in the Watershed, and the effectiveness of Authority pollutant reduction facilities (PRFs). Figure ES-1 presents the Cherry Creek Watershed.

In addition to the routine monitoring, 2008 was the second year of a three to five-year special monitoring program within the Cherry Creek Reservoir to measure changes due to the new destratification project.

Figure ES-1. Cherry Creek Reservoir Watershed Map



2008 Water Quality Summary

- Seasonal mean chlorophyll *a* of 16.6 μg/L was greater than the 15 μg/L Reservoir standard.
- Seasonal mean total phosphorus of 118 μg/L exceeded the Reservoir goal of 40 μg/L.
- Total phosphorus load of 9,144 pounds to the Reservoir was less than the TMAL of 14,270 lbs/year.
- Cottonwood-Peoria Pond PRF demonstrated phosphorus load reduction effectiveness of 37 percent. The PRF load reductions at the Cottonwood Peoria Pond were a slight improvement over 2007 (34 percent).
- The Cottonwood Creek Perimeter Pond PRF saw a 17 percent increase in phosphorus loads from 2007 to 2008 due to greater sediment and phosphorus loads during and post construction of the Cottonwood Phase II reclamation. This is a short-term negative effect on the PRF, and, once the new channel stabilizes, the PRF is expected to return to previously documented functionality.

Historical sampling of the PRFs on Shop Creek and Quincy Drainage indicate an average annual phosphorus reduction of 63 percent or 173 pounds (1990 to 2000) and 99 percent or 138 pounds (1996 to 1999), respectively.

Long-term Water Quality Summary

The Cherry Creek Reservoir chlorophyll *a* standard of 15 μg/L has only been met three times in the past 17 years, and the phosphorus goal of 40 μg/L has not been achieved in the past 17 years. The phosphorus loads have been lower than the TMAL of 14,270 pounds in 15 of the past 17 years (Table ES-1).

Figure ES-2 provides a picture of water quality concentrations, phosphorus loads, and inflow to the Reservoir since 1992. This figure demonstrates how phosphorus loads track closely with inflows to the Reservoir and that chlorophyll *a* and in-lake phosphorus concentrations do not necessarily have an immediate or significant response to changes in phosphorus loads. For example, load reductions that coincided with the recent drought years (2000 to 2002) did not result in a similar continuous decrease in phosphorus and chlorophyll *a* concentrations.

The Authority's Watershed management strategies focus on reducing nutrient loading, both through structural and non-structural management strategies. The Authority PRF monitoring typically shows the PRFs are effective in reducing phosphorus, but the Reservoir monitoring does not demonstrate immediate improvements in Reservoir water quality related to Watershed management strategies. However, after many years of not meeting the chlorophyll *a* standard, the standard was met in 2006 and 2007, although not in 2008. The Reservoir has an overabundance of phosphorus and is often limited by nitrogen during the summer growing season. The Authority's work to redevelop the Reservoir model with data collected over the past six years indicates that the in-lake phosphorus to chlorophyll *a* relationship is weak, particularly during the summer growing season, but that the chlorophyll *a* relationship with flow-weighted external phosphorus concentration is better correlated. The relationship with external phosphorus concentration was the basis for the Authority's proposal to change the chlorophyll *a* standard and TMAL.

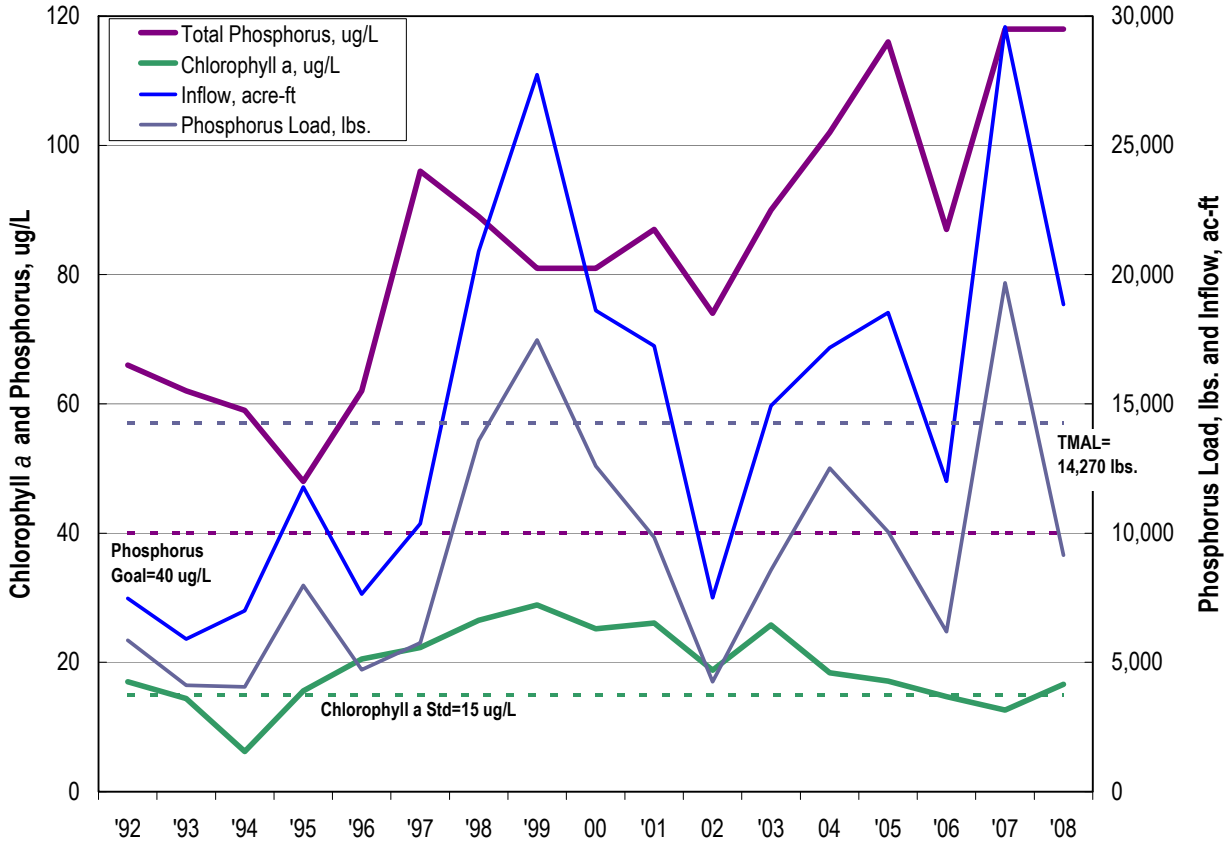
In 2008 the Authority began operation of the Reservoir destratification system to artificially mix Cherry Creek Reservoir with the intent to decrease the tendency for algal blooms. Initial monitoring results suggest that the period of stratification may have been reduced in frequency and duration, based in comparison to previous years' data for potential periods of stratification. The monitoring data also suggest that the average water temperature in the Reservoir may have dropped slightly (see Section 9 Water Quality Monitoring).

Table ES-1. Water Quality (July–September Average Concentration) and Total Phosphorus Load Data for Cherry Creek Reservoir, 1992 – 2008

Year	Chlorophyll *a* (µg/L)	Total Phosphorus (µg/L)	Total Nitrogen (µg/L)	Annual Phosphorus Load (lbs/yr)[1]	Annual Inflow (ac-ft)[1]	Flow-weighted Phosphorus Concentration (µg/L)	Net Phosphorus Load (lbs/yr)[2]
1992	17.4	66	970	**5,364**	9,210	214	3,921
1993	**14.4**	62	826	**3,114**	5,581	196	2,186
1994	15.4	59	1,144	**3,784**	6,998	199	2,729
1995	15.6	48	913	**5,736**	11,788	179	4,302
1996	18.1	62	944	**4,425**	7,654	213	3,102
1997	22.3	96	1,120	**5,675**	10,391	200	4,076
1998	26.5	89	880	**13,222**	20,902	234	9,311
1999	28.9	81	753	17,672	27,604	235	10,913
2000	25.2	81	802	**13,788**	18,611	272	9,362
2001	26.1	87	757	**9,099**	17,246	194	4,402
2002	18.8	74	858	**3,525**	7,511	173	1,681
2003	25.8	90	1,121	**9,390**	14,953	231	4,717
2004	18.4	102	977	**8,974**	17,203	192	5,553
2005	17.1	116	990	**10,725**	18,534	213	7,080
2006	**14.7**	87	914	**6,492**	12,799	187	3,206
2007	**12.6**	118	716	19,772	29,586	246	11,730
2008	16.6	118	800	**9,144**	18,841	178	4,316
Mean	19.6	84	911	8,824	15,040	209	5,445
Median	18.2	87	913	8,974	14,953	200	4,316

Notes:
1 This represents the total load and inflow to Cherry Creek Reservoir from stream, alluvium, and precipitation.
2 The net phosphorus load is the total load to the Reservoir minus the Reservoir outflow load.
Bold indicates value meets the respective standard, goal, or TMAL value.

Figure ES-2. Cherry Creek Reservoir Water Quality, Load, and Inflow, 1992-2008



Background

Control Regulation 72 is established by the Commission and sets forth actions and requirements that the Authority must meet. The Commission revised Control Regulation 72 in November 2004, which became effective on December 30, 2004.

- Emphasis is placed on implementation of watershed measures to control the water quality in Cherry Creek Reservoir.
- The Cherry Creek Reservoir has a chlorophyll *a* water quality standard of 15 µg/L mean July-September concentration to be met 9 out of 10 years.
- The Cherry Creek Reservoir has a phosphorus concentration goal of 40 µg/L.

Overview of Progress Made

Although the Cherry Creek Reservoir did not meet the chlorophyll *a* water quality standard for the reservoir in 2008, the Authority continues to take initiative towards meeting standards through key planning, implementation, and evaluation actions.

- Planning – Recommendations of the Watershed Plan 2003 continue to guide the Authority's Work Plan. During the budgeting process, the Authority set aside funds for stream corridor preservation, partnering opportunities for long-term PRF operations, and maintenance of existing Authority PRFs.

- PRF Implementation – The Authority continued to make progress in the design, construction, and maintenance of PRFs.
- Phased TMAL Progress - The Authority completed the special studies and modeling necessary to support future Watershed management goals and objectives.
- Facilitation and Coordination – The Authority has continued to work closely with land use agencies and the Division. This resulted in a proposal to update stormwater permit requirements in the Cherry Creek basin and the development of a draft guidance document to address specific requirements for land disturbances related to rural road construction and maintenance, large lot development, and trail construction.
- Education – The Authority coordinated with the Cherry Creek Stewardship Partners (Partners) to implement more avenues for education and public outreach (e.g., training, volunteer workdays, and conference).
- Monitoring – The Authority continued to monitor water quality, loads, and PRF performance to provide a means of measuring effectiveness of Watershed management strategies. In addition, 2008 was the second year of comprehensive monitoring of Reservoir water quality to assess the progress of the Reservoir destratification system. This information feeds back into the dynamic planning process.

Progress Made in Specific Management Programs

Listed below are specific Watershed management programs that the Authority implemented in 2008 to improve Watershed health and water quality, along with the associated progress made through each program.

Wastewater Facility Controls

- Wastewater facility discharges did not exceed annual permitted wasteload allocations or effluent phosphorus concentrations, with the exception of Stonegate Village Metropolitan District.
- The total annual phosphorus pounds discharged in the basin from the wastewater discharges was less than the total annual wasteload allocation.
- The Authority solicited feedback on its Site Location Approval process.

Nonpoint and Regulated Stormwater Source Controls

The Authority has made progress in meeting the requirements of Control Regulation 72 for control of nonpoint and regulated stormwater source pollution in the following ways.

- The Authority coordinated and assisted local land use agencies in implementing Phase II stormwater permit requirements consistent with Control Regulation 72.
- The Authority has seen improvement in the incorporation of stormwater quality into development plans over the years due to raised awareness and proactive efforts of the land use agencies. The Authority reviewed 184 land use and development applications for nonpoint and regulated stormwater pollutant source impacts. Of the 184 applications it reviewed, the Authority took no exception for 75 percent of the applications. This percentage has increased since the stormwater quality requirements were developed.
- The Authority began operation of the Reservoir Destratification system for in-lake management, completed construction of Cottonwood Creek Reclamation Phase II, completed preliminary design of additional Reservoir shoreline stabilization measures, and began repairs to existing PRFs along the east shoreline of the Reservoir.
- The Authority continued its process to update the Stormwater Quality Requirements in the form of a guidance document that represents the collective experience of the Authority and the land use agencies for implementing Phase II stormwater regulations and other measures to protect the water quality of the Cherry Creek Reservoir Watershed.

Trading Program

- No new trade projects were proposed in 2008.

Public Education Actions and Partnerships

The Authority made progress in meeting the requirements of Control Regulation 72 for implementing public information and education programs in the following ways.

- The Cherry Creek Stewardship Partners facilitated broad community involvement and benefited long-term environmental stewardship through outreach efforts, reaching an estimated 2,074 people.
- The Authority leveraged resources by supporting the Partners and coordinating with other entities to implement the Education Initiative, a comprehensive and coordinated education strategy and action plan.
- The Authority continued the use of its website through cooperation with the Partners to facilitate the dissemination of information to parties interested in Authority activities.
- The Authority collaborated on information and education efforts with other entities with common interests and goals for the watershed.

Phased TMAL Implementation

The Authority has continued to develop and implement point, nonpoint, and regulated stormwater source controls and has worked with the Colorado Water Quality Control Division (Division) to complete one more, and make progress on the final, required investigations for the phased TMAL.

- The Authority completed the updates to the watershed and Reservoir models to provide guidance and direction on the ability of existing and future watershed management programs to protect Reservoir water quality. The special study report evaluating phosphorus infiltration within BMPs was published in March 2008.
- PRF Implementation – The Authority started operations of the Reservoir Destratification system on April 4, 2008. Cottonwood Creek Reclamation Phase II was substantially complete in June 2008. The contract to repair existing PRFs of Tower Loop, Dixon Grove, East Shade Shelter, East Boat Ramp, and Shop Creek was issued in December 2008 with construction scheduled to begin in January 2009. Preliminary design of shoreline stabilization measures at Mountain and Lake Loop Trails was completed in December 2008. Design of restoration measures for Cottonwood Creek Wetlands (aka perimeter road pond) began in December 2008.
- The Authority and Division jointly proposed a revised rulemaking hearing schedule and milestones to prepare for the hearing in March 2009.

Water Quality Monitoring

The Authority completed annual water quality monitoring and analysis for the Reservoir, Watershed, alluvium, and selected PRFs in accordance with the Sampling, Analysis, and Quality Assurance Work Plan.

- The Cottonwood Creek-Peoria Pond PRF showed improvement in removing total phosphorus from the stream flows in 2008, removing 37 percent of the phosphorus load.
- The Cottonwood Creek Perimeter Pond PRF showed a 17 percent increase in the phosphorus load downstream of the system. This is anticipated to improve after maintenance of the facility.
- Despite the provisional nature of the annual load data, the projected total phosphorus load to the Reservoir is expected to be less than the TMAL.
- There has been a statistically significant decrease in seasonal whole reservoir chlorophyll *a* concentrations since 1999, with the 2008 seasonal mean concentration of 16.6 μg/L.

- Initial monitoring results suggest that stratification of the Reservoir may have been reduced in frequency and duration in comparison to previous years data for the same period. The monitoring data also suggest that the average water temperature in the Reservoir may have dropped slightly (see Section 9 Water Quality Monitoring).

Results and Conclusions

The Authority recognizes the challenge of meeting water quality standards, and continues to plan, gather information, implement strategies, monitor, and reevaluate approaches to meet the challenge. The Authority has undertaken actions through a variety of programs to "maintain beneficial uses in the Cherry Creek Reservoir by preserving its water quality." These actions are components of a plan directed toward meeting water quality standards and enhancing environmental health in the Cherry Creek basin.

The 2008 Reservoir data, as well as the long-term monitoring, indicate the relationship between chlorophyll *a* and phosphorus concentrations in the Reservoir (or between in-lake phosphorus concentration and load) is not as strong as originally believed when the Reservoir standard was set. With data collected from 2000-2006, the Authority redeveloped the Reservoir model to evaluate these relationships in the Reservoir and refine the TMAL. Results of the Reservoir and Watershed modeling and special studies culminated in the Authority stakeholders proposing to the Commission a change in the chlorophyll *a* standard and a change in the phosphorus TMAL from a load to a flow-weighted concentration-based TMAL.

The Authority's management strategies have strong focus on the Watershed, including the construction of PRFs that have shown to be effective in reducing phosphorus loads. The Authority believes watershed management strategies may take years before a measurable improvement to Reservoir water quality is seen, but these strategies are beneficial over the long term. The Authority began operation of the Reservoir Destratification system, an in-lake management strategy, for more short-term improvements to Reservoir water quality, specifically focused on reducing algal blooms. With implementation of Authority-backed controls, future development will be accompanied by reductions in phosphorus concentrations in the long-term. As a result, the Authority focuses on continued reduction of nutrient loads and concentrations from the Watershed through watershed management strategies.

1. PURPOSE OF THE ANNUAL REPORT

The purpose of the 2008 Annual Report is to summarize activities conducted by the Authority in 2008. Authority activities are directed towards:

- Meeting water quality standards.
- Protecting beneficial uses, which include aquatic life, primary recreation, water supply, and agriculture.
- Enhancing environmental health in the Cherry Creek Reservoir Watershed.
- Implementing the phased TMAL.

Activities discussed in the Annual Report are components of a plan for protecting the health of the Watershed, and include the following:

- Monitoring water quality.
- Measuring loads to the Cherry Creek Reservoir.
- Implementing point and nonpoint source controls and programs.
- Completing special studies to update the TMAL.
- Evaluating additional strategies for meeting water quality standards and goals in the Cherry Creek Reservoir.

The following objectives guide the development of the Annual Report.

Objective 1 – Document the Steps Taken in 2008 to Perform Required Tasks

The Authority's actions are primarily governed by Control Regulation 72, as developed by the Commission. Control Regulation 72 establishes various task requirements for the purpose of meeting water quality standards and the phased TMAL. Throughout the Annual Report, the "Steps" icon in the left margin indicates steps the Authority is taking towards completing Control Regulation 72 tasks, which are listed in the Table of Contents.

Objective 2 – Meet Control Regulation 72 Reporting Requirements

Control Regulation 72 requires that the Authority complete an Annual Report in accordance with specific reporting requirements. The Authority submits the Annual Report to the Commission for review on March 31. The Authority's activities and the Annual Report include more than what Control Regulation 72 requires for reporting. The "Reg 72 Reporting" icon indicates reporting requirements, which are listed in the Table of Contents.

Objective 3 – Present the Results of Monitoring Activities

The Authority continually monitors water quality to evaluate compliance with water quality standards, establish reservoir and watershed water quality conditions, and document changes in water quality. These monitoring efforts also provide the basis for measuring phosphorus loadings to the Reservoir and evaluating the effectiveness of PRFs. The data are also utilized by the Division, Colorado State Parks Department, the U.S. Army Corp of Engineers (COE), and other interested parties.

Objective 4 – Provide a Framework for a Review of Strategies

Each section in the Annual Report concludes with a "Progress Made" section, which identifies outcomes of activities, where measurable, and reports if those activities are meeting target goals. Section 8 provides the outcomes of special studies that provide additional options for water quality improvements and Section 10 provides recommendations for directing future water quality efforts. This information provides a framework for determining if strategies employed to meet Control Regulation 72 requirements are appropriate and effective in the near and long term.

Objective 5 – Provide an Abbreviated Report of 2008 Activities and Progress Made

The Executive Summary of the Annual Report serves as a stand-alone document providing a brief summary of the Authority's activities in 2008 and progress made towards the phased TMAL. The Executive Summary can be distributed to interested agencies and individuals, and also used to supplement other reports or grant applications developed by the Authority.

2. THE AUTHORITY

The mission of the Authority is to "maintain beneficial uses in the Cherry Creek Reservoir by preserving its water quality" and, as such, is designated as a 208 Management Agency. From this mission, the Authority has developed water quality management strategies to minimize point and nonpoint pollutant sources by implementing specific programs and monitoring water quality to evaluate progress. These strategies create an effective water quality management approach, as shown on Figure 2-1.

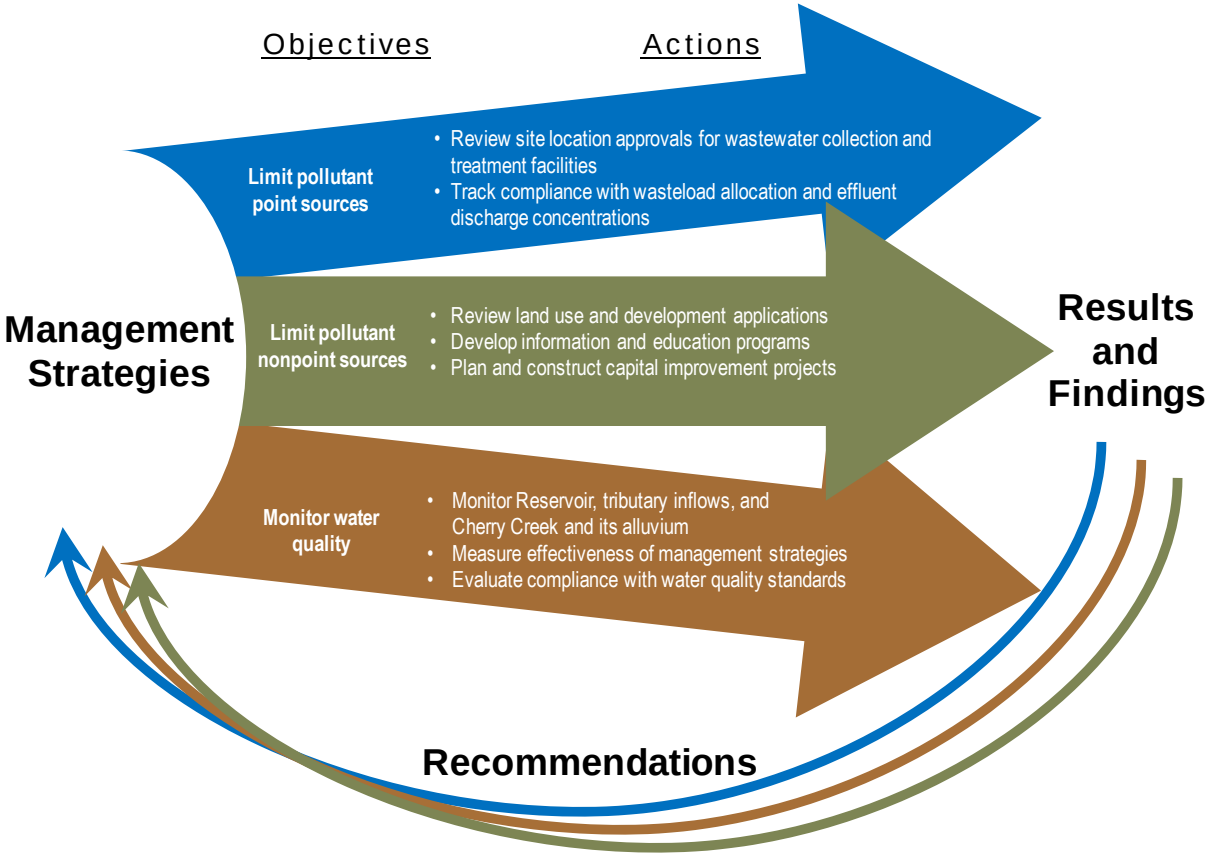


Figure 2-1. Water Quality Management Approach

This section provides information on the Authority's history, members of the Authority, 2008 annual budget and funding sources, and 2008 reference materials.

2.1 History

The Authority was formally created in 1985 by the Colorado Legislature to preserve water quality within the Cherry Creek Reservoir Watershed. Figure 2-2 provides a summary of the Authority's history pertinent to regulations. In August 2007, the Commission held an informational hearing to identify potential changes to

Control Regulation 72. Based on discussions with stakeholders, Division staff, and the Authority, the rulemaking hearing has been rescheduled to March 2009.

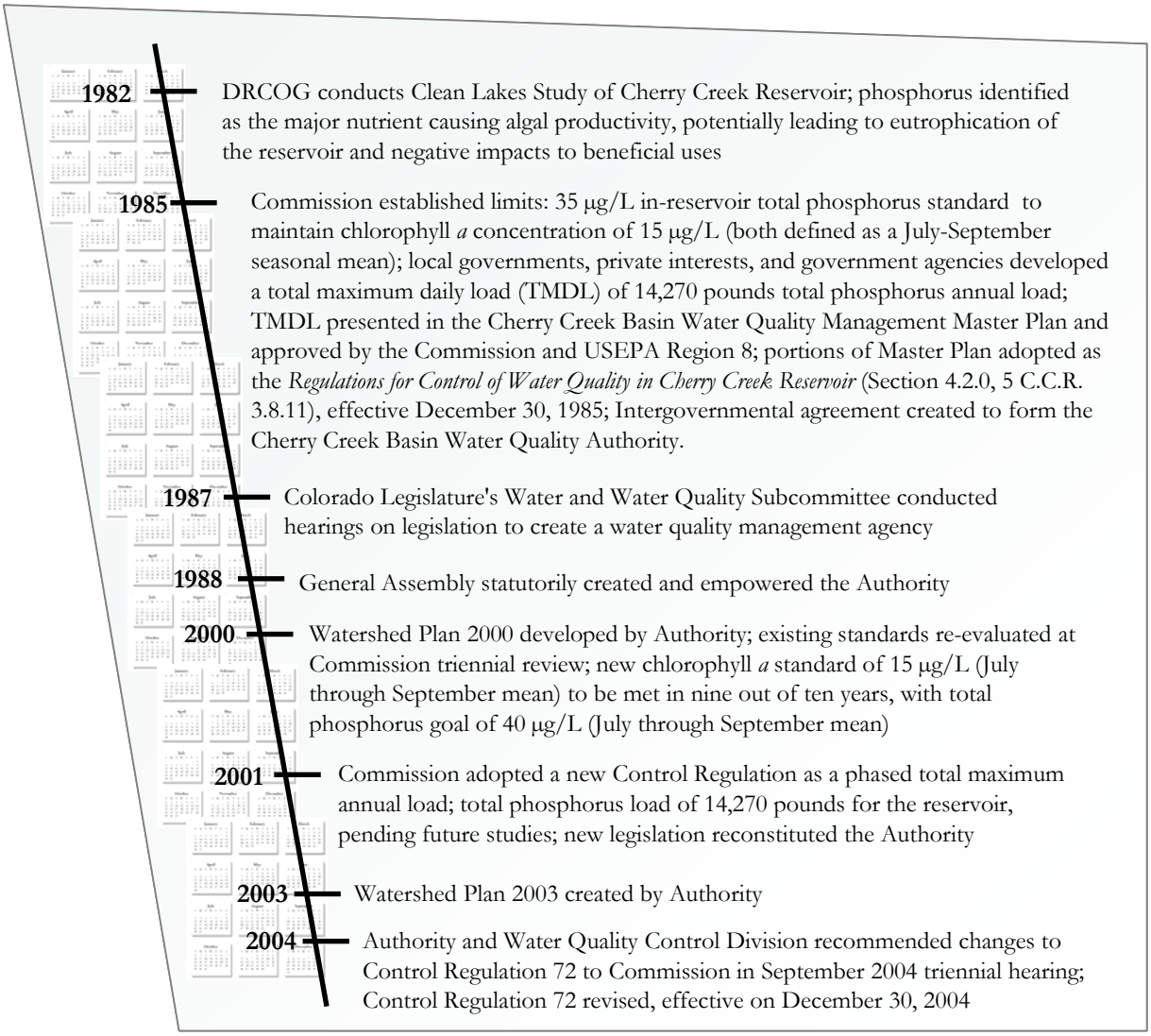


Figure 2-2. Summary of Authority History

2.2 Today's Authority

The Authority consists of a Board and Technical Advisory Committee (TAC). The Board includes representatives from the Watershed land use agencies, a special districts representative, and individuals appointed by the governor. Table 2-1 lists the entities that are represented on the Board, per Control Regulation 72.

The TAC consists of members representing various agencies and interests within the Cherry Creek Reservoir Watershed. The role of the TAC is to consider and report to the Board on matters of a scientific or technical nature, as directed by the Board. Table 2-2 provides a list of entities that are represented on the TAC.

Table 2-1. Authority Board Members	
Entities That Must be Represented	**Number of Representatives**
County (Arapahoe, Douglas)	2
Municipality[1] (Aurora, Castle Rock, Centennial, Foxfield, Greenwood Village, Lone Tree, Parker, Castle Pines North)	8
Special Districts (water and wastewater service providers)	1
Appointed by the Governor	7
Total members of Authority Board	17

Table 2-2. Authority TAC Members	
Entities Represented	**Number of Members**
County (Arapahoe/Southeast Metro Stormwater Authority[1] (SEMSWA), Douglas)	2
Municipality (Aurora, Castle Pines North, Castle Rock, Centennial, Foxfield, Greenwood Village, Lone Tree, Parker)	8
Special districts	1
Board appointed	2
Other (Cherry Creek State Park, City and County of Denver, COE, DRCOG, UDFCD)	5
Total members of TAC	18

1 *SEMSWA was formed by an Intergovernmental Agreement (IGA) among Centennial, Arapahoe County, Arapahoe County Water and Wastewater Authority, East Cherry Creek Valley Water and Sanitation District, and Inverness Water and Sanitation District.*

2 *The Castle Pines North and Foxfield seats is currently vacant.*

2.3 Work Plan

The Authority prepares a Work Plan that guides the activities of the TAC and Board. The Work Plan is a spreadsheet that lists the tasks for the calendar year. As shown on Figure 2-3, the Work Plan from December 2008 provides the following information for each task.

- Task description
- Corresponding category in the Authority's budget
- Fulfillment of appropriate Control Regulation 72 section
- Fulfillment of corresponding Watershed Plan 2003 recommendation
- Schedule for completion
- Progress status

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Cherry Creek Basin Water Quality Authority
Figure 2-3. 2008 Work Plan
(sorted by category)

Budget/Task Category	Task	Task Description	Control Regulation Section	Fulfillment of Control Regulation by:	Watershed Plan 2003 Recommendations	Month Start	Status	Due Date
2008 Ongoing								
Meetings	Monthly Board and TAC meetings					Ongoing	Ongoing	Ongoing
Public Information and Education	Implement Cherry Creek Basin Water Stewardship and Education Initiative		72.6(2)	Implement Public Information and Education Program	L - Develop and implement public involvement plan; A - Consider funding options to achieve capital budget increase	Ongoing	Ongoing	Ongoing
	Update Authority website					Ongoing	Ongoing	Ongoing
TAC Work Plan	Maintain and update TAC Work Plan				B - Implement Watershed Plan 2003 as a coordinated management program	Ongoing	Ongoing	Ongoing
Trading Program	Review Trade Applications		72.5(3)(a)	Trading program	E - Promote trading incentives	Ongoing	Ongoing	Ongoing
Land Use Applications	Review Land Use Development Applications referred to Authority		72.6(1)	Encouraging and ensuring adequate nonpoint source (especially stormwater) BMPs	H - Encourage local gov'ts to work with developers to construct innovative demonstration projects; I - Explore options to reduce septic system loading	Ongoing	Ongoing	Ongoing
Site Location Approval	Review Site Location Approval Applications		72.4(4)	Effluent discharge		Ongoing	Ongoing	Ongoing
Monitoring	Implement reservoir, PRF, and watershed monitoring programs					Ongoing	Ongoing	Ongoing
2008								
Capital Projects	Cottonwood Ck Reclamation	Phase II final design/construction	72.3(4)	Construction of nonpoint source control projects	C - Fund, design, and construct high priority stream improvements	2007	In progress	6/30/08
	Shoreline Stabilization - Mtn Loop	Preliminary design				2/1/2008	In progress	
	Cottonwood Ck Reclamation at Easter Ave	Design/construction				2/1/2008		
	Cherry Ck Stabilization - Eco Park	Design	72.3(4)	Construction of nonpoint source control projects	C - Fund, design, and construct high priority stream improvements	4/1/2008		
	Cherry Ck Stabilization - Vermillion Creek	Design				2/1/2008		
	Stream stabilization - 12-Mile Park	Feasibility w/expanded dog park	72.3(4)	Construction of nonpoint source control projects	C - Fund, design, and construct high priority stream improvements	4/1/2008		
	Operation and Maintenance	Various facilities				3/1/2008		12/1/2008
	Annual inspection of PRFs	Various facilities				6/1/2008		8/31/2008
Reporting - 2007 Monitoring and Annual	Annual Report	Status of Authority activities and water quality	72.9, including 72.5(3)(a),	Gathering and updating required information (see Description) into an Annual Report		1/1/2008	Completed	3/31/2008
	Present Annual Report to WQCC and DRCOG WEPC		72.9	Annual Report		4/1/2008		est July
Reporting - 2007 Annual Report	TAC and WQCD provide comment on draft		72.9	Annual Report		1/25/2008	Completed	2/7/2008
	Board provide comment on draft		72.9	Annual Report		2/15/2008	Completed	2/29/2008
	TAC provide comment on final draft		72.9	Annual Report		2/29/2008	Completed	3/14/2008
	Board provide comment on final draft		72.9	Annual Report		2/29/2008	Completed	3/14/2008
	Submit final to WQCD and WQCC		72.9	Annual Report		3/31/2008	Completed	3/31/2008
Reporting - 2007 Monitoring Report	TAC provide comment		73.9	Annual Report		2/22/2008		3/6/2008
	Board provide comment					3/14/2008		3/21/2008
Phosphorus Facilitator	Develop 2008 scope of work				G - Encourage local governments to work with developers to construct	2007	On hold	1/31/2008
	Implement scope of work				G - Encourage local governments to work with developers to construct	2/1/2008		12/1/2008
Special studies	TMAL Actions Study 2 - Determine PRF phosphorus transport through infiltration	Complete study				2007	Completed	2/1/2008
	TMAL Actions Grant Reporting	Final Reporting				1/2/2007	In progress	3/15/2008
	Determine Approach for remaining studies	Implement "narrower scope" of EMC study				2/1/2008		5/23/2008
Stormwater Quality Requirements	Finalize requirements and associated guidance document					1/2/2008	In progress	5/23/2008
TMAL Revision	Reservoir model - WQCD comments					2007	In progress	1/25/2008
	Finalize Reservoir Model		72.4(4)	Completion of tasks identified	K - Conduct special studies to optimize water quality improvements	1/15/2008	In progress	2/22/2008
	Determine potential watershed load reductions - Watershed Model					1/2/2008	In progress	3/21/2008
	Optimal plan for watershed BMPs					1/21/2008	In progress	4/14/2008
	Final Report	Allowable load to meet current				2/15/2008		3/31/2008
	Decision - Can Watershed Management Achieve TMAL?						In progress	4/14/2008
	TMAL/Allocation Negotiations					5/1/2008		10/15/2008
	Develop TMAL Implementation Plan	Proposal for hearing				7/1/2008		11/1/2008
Additional Work Required						*5/1/2008*		*10/15/2008*
Triennial Review	Draft Hearing Public Notice for March 2009					11/1/2008		11/1/2008
	Testimony preparation and Control Reg revisions					11/1/2008		12/31/2008
	Testimony	Submit testimony				4/30/2008		4/30/2008

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2.4 Financial Matters

REG 72 REPORTING

The Authority receives funding for its activities primarily from property taxes, Park user fees, wastewater bill surcharges, and building permit fees. These primary sources are supplemented with funds from various grants and other fees and charges.

The Authority's budget for the 2008 calendar year was approximately $2,100,000 in revenue and approximately $2,785,000 in expenditures. Expenditures exceeded revenues because of the large Cottonwood Creek reclamation, a capital project for which the Authority had reserve funds to complete. Colorado State Statute § 25-8.5-111(3) dictates that the Authority must spend at least 60 percent of the annual authorized revenues on the construction and maintenance of PRFs. The budgeting process for PRFs is discussed in Section 5.6. The remaining 40 percent is allocated towards monitoring, special studies, planning documents, technical reports or memoranda, and administrative costs.

2.4.1 Funding Sources

Approximately $1,300,000 (65 percent) of the Authority's budgeted revenue was tax based, approximately $477,000 (25 percent) was from fees (from new construction and Cherry Creek State Park usage) and surcharges on wastewater, and $200,000 (10 percent) was from miscellaneous sources, such as reimbursed expenses and interest earnings. Table 2-3 summarizes revenue from fees for the Authority.

For 2008, the Authority was required under provisions of Article X, Section 20, of the Colorado Constitution (TABOR) to temporarily reduce its authorized mill levy. This requirement reduced the Authority's tax-based revenue by approximately $308,000.

Table 2-3. Summary of Revenue from Fees

Revenue Sources	Revenue ($)
Cherry Creek State Park	155,000
Building Permits	189,000
Wastewater Surcharges	133,000
Total Revenue from Fees	477,000

2.5 2008 Reference Documents

The Authority generated documents in 2008 that serve as references for the status of water quality in Cherry Creek Reservoir, guidelines and educational material on water quality BMPs, technical sources on various aspects of water quality, and watershed planning and management strategies. Table 2-4 lists key reference documents generated by the Authority in 2008.

Table 2-4. 2008 Reference Documents
2006 Annual Report of Activities by the Cherry Creek Basin Water Quality Authority Update on activities completed by the Authority in 2006.
2006 Annual Report of Baseline Water Quality Data Collection Study for the Upper Cherry Creek Basin Flow and water quality data collected at surface and groundwater stations in the upper Cherry Creek Reservoir Watershed.
2008 Annual Inspection of Pollutant Reduction Facilities Inspection of PRFs constructed by the Authority at Cherry Creek State Park to assess whether PRFs are functioning as designed and to identify routine, restorative, and rehabilitative maintenance requirements.
2008 Capital Improvement Projects Summary of potential pollutant reduction facilities.
Cherry Creek Reservoir 2006 Annual Aquatic Biological and Nutrient Monitoring Study Characterization of potential relationships between nutrient loading and Reservoir productivity.
Cherry Creek Reservoir Destratification Design Documents Design drawings and specifications for the installation of a submerged focused mixing system in the Reservoir to destratify the deepest portions of the Reservoir, vertically mix algae to compromise their habitat and reduce production of blue-green algae, and oxidize of the deep bottom sediments to reduce the release of nutrients from the sediments into the water column.
Cherry Creek Reservoir – Revised Proposal for TMAL Schedule Schedule proposed by Division and Authority to Commission in December 2007 for Control Regulation 72 Rulemaking Hearing in 2009
Cherry Creek Reservoir Watershed Technical Appendix to Denver Regional Council of Governments (DRCOG) Metro Vision 2020 Clean Water Plan
Cherry Creek Stewardship Partners 2006 Annual Report Update on activities completed by the Partners in 2006.
Cottonwood Creek Reclamation Project Phase I Record Drawings
Depth Profile Study of Phosphorus Concentrations in the Cherry Creek Alluvial Aquifer Results of depth profiling study identified in Control Regulation 72, and discussed in Section 8.
Estimate of Nutrient Loading from Septic Systems in the Cherry Creek Basin
Phosphorus Facilitator Report (2007) Describes coordination of enhanced water quality plans in three developments.
Proposed Recommendations for MS4 NPDES Stormwater Permitting Requirements in the Cherry Creek Reservoir Basin
Reference Reach Evaluation for Cottonwood Creek Reclamation Project Evaluation to show that the proposed reclamation project is appropriately designed with respect to water use, with the intent that the State Engineers Office will view the project as acceptable without an augmentation plan.
Summary of Information Binder for Authority Board Members Summary reference information on Authority mission, guiding documents, projects, and budget.
West Cherry Creek Background Phosphorus Special Study Report Results of background study identified in Control Regulation 72, and discussed in Section 8.
Work Plan A routinely updated comprehensive schedule of activities, as prescribed by Control Regulation 72 and recommended by Watershed Plan 2003.

3. DESCRIPTION OF CHERRY CREEK RESERVOIR WATERSHED

Originally built for flood control, Cherry Creek Reservoir is owned and operated by the COE. The Reservoir, with a surface area of approximately 850 acres, and surrounding land were leased to the State of Colorado for use as the Cherry Creek State Recreation Area in 1957. The 3,915-acre park almost immediately received extensive recreational use, a pattern that has continued to the present day. The park had 1.45 million visitors in 2008. The Reservoir and surrounding state park serve as an important urban recreational site, providing opportunities for a variety of activities, including sport fishing, boating, swimming, bicycling, bird watching, horseback riding, and hiking. Additionally, the state park provides important wildlife habitat, including grasslands, wetlands, forests, meadows, and ponds.

Cherry Creek Reservoir was designed as for flood control management and evolved into a terminal water storage facility, intended to hold runoff water that would then be discharged to maintain an acceptable downstream flow and a predetermined lake level. The Reservoir, along with subsurface flows from below the dam, has maintained Cherry Creek downstream of the Reservoir in a free-flowing condition. As a storage facility with regulated outflows, upstream flows have accumulated, over almost 50 years, sediment to depths of up to 6 meters at the outlet works with an average overall depth of almost 3 meters. The water in the Reservoir undergoes chemical changes from the influences of inflows, sediments, sunlight, temperature, and wind, all of which influence algal growth.

The Cherry Creek Reservoir's Watershed includes approximately 245,500 acres and 32 sub-watersheds (Figure 3-1). The northern portion of the Watershed has been urbanizing over the past twenty years, especially in the sub-watersheds immediately adjacent to the Reservoir. Developed land uses include high to moderate density suburban residential areas, large lot subdivisions, commercial and light industrial parks, and office buildings. Traditional agricultural and agribusiness uses are still present, but mostly in the southern upstream half of the Watershed. The Reservoir is currently classified for warm water aquatic life, primary recreation, water supply, and agriculture.

3.1 Water Quality History and Regulations

Figure 2-2 in Section 2, entitled Summary of Authority History, provides background information on the Authority, water quality, and changes in regulations. The Cherry Creek Reservoir current chlorophyll *a* standard of 15 μg/L has only been met in three of the past 17 years, and the phosphorus goal of 40 μg/L has never been achieved in the past 17 years. However, the phosphorus loads have been lower than the TMAL of 14,270 pounds in 15 of the past 17 years. In 2008, Reservoir chlorophyll *a* was 16.6 μg/L and phosphorus was 118 μg/L, while the phosphorus load to the Reservoir was 9,144 pounds.

Watershed Plan 2003 identifies potential investigations and strategies that will help arrive at achievable goals and standards. Information from investigations and special studies, discussed in Section 8, will assist in determining how to refine the phased TMAL and identify additional control measures. In the meantime, the phased TMAL process provides a framework for the adoption of point source and nonpoint source controls that will provide protection for the Reservoir.

Table 3-1 lists the current Phase I TMAL annual phosphorus allocations, per Control Regulation 72.

Figure 3-1. Cherry Creek Reservoir Watershed

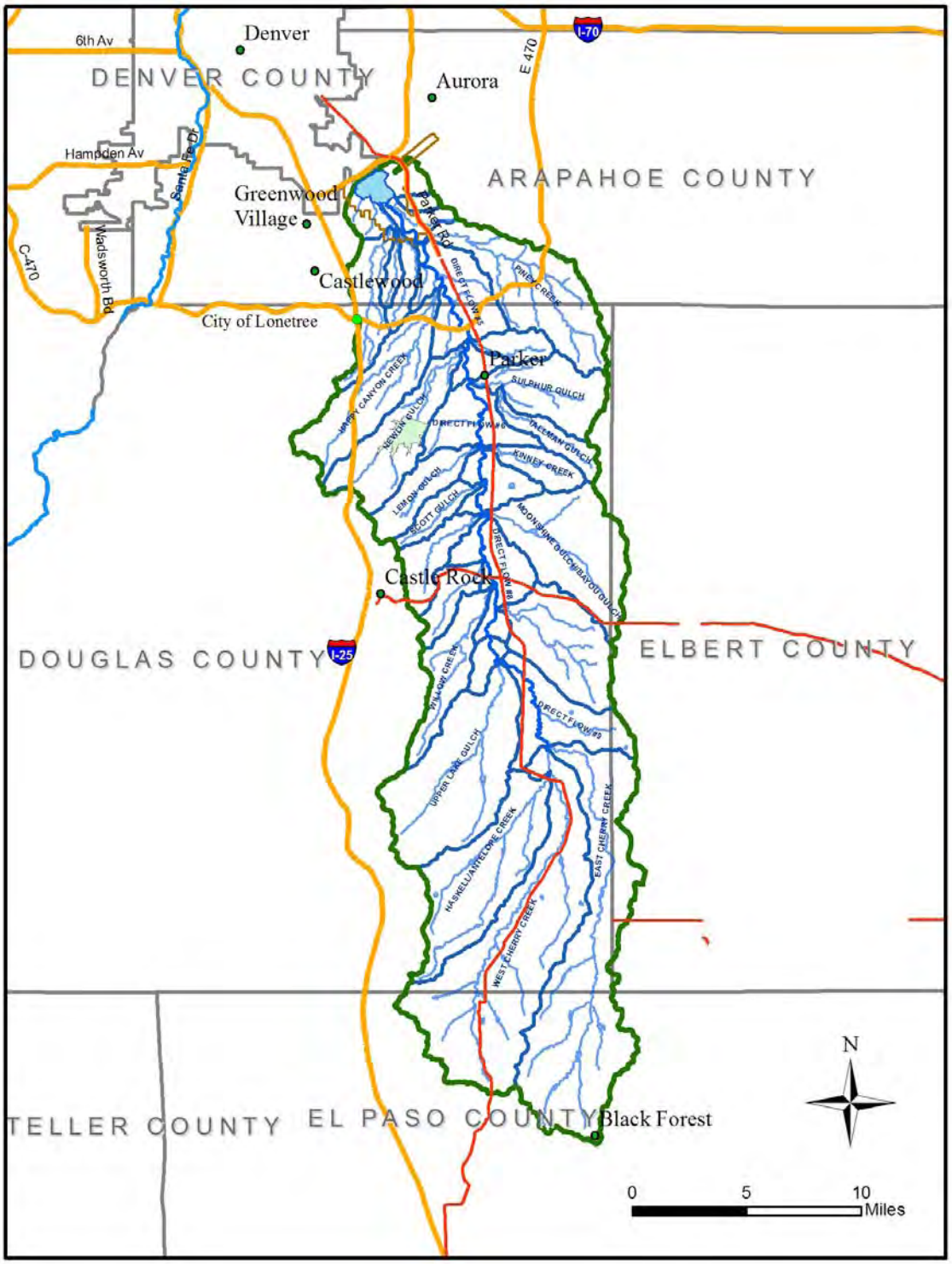

Table 3-1. Phase I TMAL Annual Phosphorus Allocations	
Allocation Type	**Total Phosphorus Pounds/Year**
Nonpoint and Regulated Stormwater Sources	10,506[1]
Background Sources	1,170
Wastewater Facility Sources (Including Reserve Pool and Phosphorus Bank)	2,094
Industrial Process Wastewater Sources	50
Individual Sewage Disposal Systems	450
Total Maximum Annual Phosphorus Load	14,270

[1] *As part of the 2004 Triennial Review Hearing for Control Regulation No. 72, the Commission eliminated the 216 pounds allocated in the Phosphorus Bank for phosphorus trading, which limited the Trading Program. The 216 phosphorus pounds originally in the Phosphorus Bank are now accounted for in the Nonpoint and Regulated Stormwater Sources.*

3.2 Revisions to DRCOG Clean Water Plan Technical Appendix

The TAC and special districts participated in the review of the DRCOG Clean Water Plan Technical Appendix and provided comments to DRCOG to assist in updating to the appendix.

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4. WASTEWATER FACILITY CONTROLS

Wastewater and industrial process wastewater sources must have a sufficient phosphorus wasteload allocation prior to discharging in the Cherry Creek Reservoir Watershed. Wasteload allocations are listed in Table 4-1, where each facility is limited to an annual allocation of phosphorus pounds that can be discharged. Wastewater utilities in the Cherry Creek Reservoir Watershed are also required to meet water quality effluent limits and follow procedures for the purpose of limiting phosphorus loads that can ultimately reach Cherry Creek Reservoir. Six point source dischargers within the Cherry Creek Reservoir Watershed provide centralized wastewater treatment service. Two point source dischargers are located outside the Watershed, but land apply reuse water as irrigation within the Watershed.

4.1 Wasteload Allocation

REG 72 REPORTING

Wastewater treatment facilities provide phosphorus removal and treatment using either secondary treatment followed by land application or advanced wastewater treatment followed by land application or direct discharge.

4.1.1 Monthly and Annual Loading

STEPS REG 72

The Colorado Discharge Permit System permits require dischargers to monitor and quantify the concentration and total pounds of phosphorus discharged. Tables 4-1 and 4-2 present the phosphorus allocations and annual and monthly loads, respectively, for the wastewater dischargers in 2008.

Table 4-1. Cherry Creek Reservoir Watershed Point Source Allocation and 2008 Point Source Phosphorus Annual Contribution[1]

Facility	Allocation (pounds)	2008 Phosphorus (pounds)[1]
Arapahoe County Water and Wastewater Authority/Cottonwood Water & Sanitation District[2]	402	154
Pinery Water and Sanitation District	304	52
Inverness Water and Sanitation District	129	2
Parker Water and Sanitation District[3]	593	195
Meridian Water and Sanitation District	113	0
Stonegate Village Metropolitan District[1]	161	313
Plum Creek Wastewater Authority[4]	25	11
City of Aurora[4]	10	
Semi-Urban Areas[3, 5]	141	
Industrial Process Wastewater Sources[6]	50	
Subtotal	1,928	
Reserve Pool	216	
Phosphorus Bank	0	
Total	2,144	727

[1] *The 2008 phosphorus pounds are preliminary as reported by the dischargers.*

[2] *Arapahoe County Water and Wastewater Authority (ACWWA) has 57 pounds of conditionally approved phosphorus trade credits in addition to its 402 pound allocation.*

[3] In December 2005, the Authority Board approved the Parker Water & Sanitation District Wastewater Utility Plan Amendment and an allocation from the semi-urban area of 60 pounds.
[4] In 2004, phosphorus pounds were transferred from the semi-urban area allocation to the Plum Creek Wastewater Authority and the City of Aurora for Land Applications within the Cherry Creek Watershed.
[5] Semi-urban areas are potential development areas outside the DRCOG urban growth boundary or are assigned areas not affiliated with a service provider. These areas have not been included within a designated service area assigned to existing wastewater facilities that have wasteload allocations but are designated planning areas planned for urbanization after 20 years.
[6] Industrial users include sand and gravel operations and DirecTV.

Table 4-2. 2008 Point Source Phosphorus Monthly Contribution [1]

Month	Discharges to Cherry Creek					Discharges to Lone Tree Creek
	Parker Water and Sanitation District (pounds/ month)	Pinery Water and Sanitation District (pounds/ month)	Stonegate Village Metropolitan District[2] (pounds/ month)	Inverness Water & Sanitation District (pounds/ month)	Plum Creek Wastewater Authority[3] (pounds/ month)	Arapahoe County Water and Wastewater Authority (pounds/month)
January	17.90	4.60	95.30	0.00	0.00	15.90
February	23.10	6.80	12.40	0.00	0.00	7.70
March	19.00	4.70	54.70	0.00	0.25	20.30
April	20.80	4.40	106.90	0.00	1.24	14.40
May	18.00	3.40	41.50	0.00	0.98	15.20
June	13.00	2.70	0.00	0.82	2.63	11.00
July	13.70	4.40	0.00	1.50	1.75	4.30
August	13.30	4.50	0.00	0.00	1.67	9.10
September	13.50	4.60	0.00	0.00	1.16	12.00
October	15.40	2.50	0.00	0.00	0.88	17.00
November	15.30	4.20	0.90	0.00	0.55	14.30
December	12.20	5.00	1.40	0.00	0.00	12.80
Total	195.20	51.80	313.10	2.32	11.11	154.00

[1] *The 2008 phosphorus pounds provided are preliminary as reported by the dischargers.*
[2] *Reported discharged loads from Stonegate exceed the facility's wasteload allocation.*
[3] *The Plum Creek Wastewater Authority discharges in the Cherry Creek Reservoir watershed are through reuse irrigation and only occur during the irrigation season.*

The Stonegate Village Metropolitan District (Stonegate) wastewater treatment plant violated phosphorus discharge limits in both 2007 and 2008 with discharge of phosphorus concentrations approximately in the 0.25 mg/L range, exceeding the 0.05 mg/l Cherry Creek Basin. Stonegate worked with the Division on bringing down the phosphorus load and was charged with making system improvements to the system to meet compliance goals. In summer 2008, Stonegate made improvements to the tertiary filtration system which brought the phosphorus loads within Cherry Creek Basin standards. Following discussions with the Division and the Authority Board, it was decided that the Authority would not require Stonegate to purchase phosphorous credits for this violation.

4.1.2 Temporary Transfer and Reserve Pool Actions

REG 72 REPORTING

Control Regulation 72 allows the temporary transfer of the unused portion of a phosphorus wasteload allocation from an existing discharger to another facility (Section 72.5(1)). Both the transferring and receiving facilities must agree upon the temporary transfer.

STEPS REG 72

There were no temporary transfers or reserve pool actions in 2008.

4.2 Wastewater Permits and Limits

REG 72 REPORTING

Control Regulation 72 requires that the Annual Report also include wastewater facility permit violations with regard to phosphorus concentration limits and annual phosphorus loads.

Beginning August 1, 2004 direct dischargers in the Cherry Creek Reservoir Watershed must discharge phosphorus at a 30-day average effluent concentration less than 0.05 mg/L and dischargers using land application must discharge a 30-day average phosphorus concentration less than 0.05 mg/L divided by the return flow factor.

Where land application relies on lysimeters to determine phosphorus groundwater returns, the effluent concentration prior to land application shall not exceed 1.0 mg/L total phosphorus.

4.3 Site Location Approval Review

REG 72 REPORTING

As the designated regional water quality management agency for the Cherry Creek Reservoir Watershed, the Authority reviews applications for site location approval, as required by Control Regulation 72, for site location and design approval of domestic wastewater treatment works. Site location approval reviews address protection of the Cherry Creek Reservoir with respect to phosphorus, general water quality, protection of downstream water supplies, and adequacy of proposed design processes and capacity.

Applications for site location approval are reviewed to determine if the criteria in the following documents have been met.

- Cherry Creek Basin Water Quality Management Master Plan/Control Regulation 72 (Commission, December 2004).
- Emergency Response Plan Criteria for the Cherry Creek Reservoir Watershed (Authority, March 2002).
- Regulation No. 22, "Site Location and Design Approval Regulations for Domestic Wastewater Treatment Works" (Commission, June 2004).
- Metro Vision 2020 Clean Water Plan: "Wastewater Utility Plan Guidance" (Denver Regional Council of Governments, January 2003) and "Lift Station Report Guidance and Checklist" (DRCOG, October 2000).
- Policy 96-1, "Design Criteria Considered in the Review of Wastewater Treatment Facilities" (Commission, expiration date May 31, 2007).

The Authority developed the Emergency Response Plan Criteria for the Cherry Creek Reservoir Watershed to establish criteria for emergency response plans, and requires that emergency response plans are included with each application for site location approval.

In addition, the Authority performs a cursory review of the pump selection and sizing for lift stations to ensure that there were no obvious problems with the equipment proposed for the lift station. The purpose of the review is summarized as follows.

- Provide a summary and brief review of the engineering report and application for site location approval relative to the requirements of the Authority.
- Provide opinions or best professional judgment on the thoroughness and completeness of the engineering report and application for site location approval.

- Provide opinions on whether the engineering report and application meet all criteria as defined by the control regulations.

DRCOG relies on completeness and thoroughness of review by the Authority for acceptance of the site location approval because the Authority is a designated 208 agency. The Authority re-reviewed two lift station applications for in 2008, which were the Sierra Ridge Lift Station which was originally submitted in 2006 as well as the Cherry Creek State Park Lift Station originally submitted in 2007.

The Cherry Creek State Park contacted the Authority in February 2007 regarding a small lift station it would be constructing for the Park Shooting Center. Due to the small capacity (<2,000 gallons per day [gpd]), the lift station did not go through a formal Site Location Approval, but the Park did provide the Authority with drawings and engineering report for the facility. The Park is providing an emergency on-site storage tank that can store up to 40 hours of flow (approximately 3,333 gallons of storage). Wastewater flows will be treated at the East Cherry Creek Valley Water and Sanitation District, outside the Watershed.

4.3.1 Site Application Follow-Ups

The Authority contacted previous applicants for feedback on the Site Location Approval review process. To assess the effectiveness of the site application review efforts, applicants who had submitted site application reviews from 2003 to 2006 were contacted and asked to provide feedback on the Authority's Site Location Approval process. Of the 12 applicants contacted by the Authority for 24 applications, four responded with feedback. A summary of the responses is provided below in Table 4-3.

Table 4-3. Summary of Feedback From Site Applicants on Site Location Approval Process

Project Name	Applicant	Ultimate Owner	Response
Cottonwood South Lift Station	Private Developer	Parker Water and Sanitation District	All comments were addressed in the final design. The following modifications were made: (1) provided an overflow containment pond, (2) provided isolation valve on by-pass around flow meter, and (3) odor problems would be monitored and mechanical fans were added to the wet well and valve/meter valve. Overflow storage was incorporated. It was difficult to address the cost and maintenance requirements for the overflow containment. The required capabilities have not been needed yet, and they don't foresee them to be needed. As-built drawings were provided.
Eastern Water Treatment Plant Lift Station	Town of Castle Rock	Plum Creek Wastewater Authority (Chatfield Basin)	All comments were addressed and changes were incorporated. No design modifications were necessary. Forcemain differential flow measurements and overflow storage were provided as recommended by the Authority. It was difficult to meet the time requirements; approximately 3 months and additional budget was needed for the Authority to review, respond, and approve. Not aware of positive or negative impacts from comments. As-built drawings were provided.
Valley Country Club Lift Station	Arapahoe County Water and Wastewater Authority	Arapahoe County Water and Wastewater Authority	All comments were addressed and changes were incorporated. Included a metering vault and flow meter at outfall of forcemain and dual forcemains were combined. Overflow storage was constructed for the Valley Country Club Lift Station, and design of the differential flow measurement has been delayed due to traffic congestion. Difficult to determine how much storage was required. Overall time was balanced with station redundancy. Difficult to provide power to the differential flow measurement. Addressed with solar power. Comments regarding overflow capabilities were useful. Record drawings have been provided.

Table 4-3. Summary of Feedback From Site Applicants on Site Location Approval Process

Project Name	Applicant	Ultimate Owner	Response
Sierra Ridge Lift Station	Sierra Ridge Metropolitan District	Parker Water and Sanitation District	Plans for site are to utilize a force main system.

For the three respondents who continued with the lift station construction all comments and suggestions made by the Authority were incorporated into the final design. While these applicants followed the Authority's recommendations, some respondents provided constructive feedback on the review process. The Parker Water and Sanitation District noted that it incorporating the Authority's suggestions was difficult because of the additional cost and time necessary to fully address the Authority's concerns. Plum Creek Wastewater Authority stated that an additional three months and associated increased budget were needed to allow the Authority to review, respond, and approve the Eastern Water Treatment Plant Lift Station. The Arapahoe County Water and Wastewater Authority stated that the comments made by the Authority on overflow capabilities were useful.

4.4 Progress Made

- Wastewater facility discharges did not exceed annual permitted wasteload allocations or effluent phosphorus concentrations, with the exception of Stonegate.
- The total annual phosphorus pounds discharged in the Basin from the wastewater discharges was less than the total annual wasteload allocation.
- The Authority received feedback from four applicants on the Site Location Approval process.

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5. NONPOINT AND REGULATED STORMWATER SOURCE CONTROLS

Due to the broad scope of nonpoint and regulated stormwater sources in the Cherry Creek Reservoir Watershed, several programs are in place to target nonpoint and regulated stormwater source pollutant reduction. Regulated stormwater sources discharge from regulated entities under the Colorado Discharge Permit System (Control Regulation 61). Programs include regulations for stormwater controls and long-term planning for PRF construction, discussed in this section, as well as public education and outreach programs (Section 7) and Cherry Creek Reservoir and Watershed monitoring.

The term BMP is used herein to describe those stormwater quality measures required under the regulated stormwater program for new and redevelopment land disturbances. The term PRF, which is constructed by the Authority, refers to stormwater quality measures, such as stream stabilization or online detention, implemented to address non-point stormwater sources from existing and future land disturbances. However, regulated stormwater is often contained in the runoff that flows into a PRF, so PRFs also address regulated stormwater. Since the Authority monitors inflow and outflow from all PRFs, the inflow monitoring represents the integrated affect of all BMPs implemented in the area tributary to the PRF.

5.1 Land Use Agency Implementation of Stormwater Permit Requirements

STEPS REG 72

In 1999, the National Pollutant Discharge Elimination System (NPDES) Stormwater Phase II Rule expanded the Phase I Rule to include several of the land use agencies that are part of the Authority. Prior to 2004, the City of Aurora and the Colorado Department of Transportation (CDOT) were the only agencies in the Cherry Creek Reservoir Watershed covered under the Phase I Rule. Phase II permits became effective on March 10, 2003.

The Phase II Rule requires small municipal separate storm sewer systems (MS4s) to, at a minimum, adopt BMPs for six minimum control measures, implement them to the "maximum extent practicable," identify measurable goals for control measures, show an implementation schedule of activities or frequency of activities, and define the entity responsible for implementation. These requirements fit closely with the current programs in the Cherry Creek Reservoir Watershed as part of Control Regulation 72. Erosion and sediment control and post-construction BMP programs for each agency under the NPDES Phase II requirements are complimentary to the same programs required under Control Regulation 72. Phase II permittees in the Cherry Creek Reservoir Watershed formed cooperative workgroups to coordinate Phase II compliance and identify opportunities for effective stormwater program implementation to minimize overlap and redundancies.

REG 72 REPORTING

Stormwater permit reporting information was provided to the Authority by the land use agencies on the following key elements (Table 5-1).

- Sediment and erosion control permit, inspection, and enforcement actions
- Construction BMP inspection and enforcement actions
- Permanent BMP construction, inspection, and maintenance actions

Detailed information on implementation for each Phase I and Phase II permittee can be found in the Stormwater Annual Reports for MS4s submitted to the Division.

5.2 Cherry Creek Reservoir Watershed Stormwater Quality Requirements

In 2000, the Authority adopted requirements related to construction activities and post-construction control of stormwater quality in the Cherry Creek Reservoir Watershed entitled the "Cherry Creek Reservoir Watershed Stormwater Quality Requirements" (Requirements). The purpose of the Requirements is to recommend implementation of substantive BMP measures to control the quality of stormwater runoff from land disturbances on private and public property. The Requirements are necessary to reduce and maintain nonpoint and regulated stormwater sources in accordance with the TMAL set forth in Control Regulation 72. In addition, the requirements establish the minimum construction and post-construction BMPs in the Reservoir Watershed for all new development activities.

Table 5-1. Summary of Cherry Creek Reservoir Watershed Permit, Inspection, and Enforcement Actions

Land Use Agency[1]	Permit Inspection Actions[2]	Permit Enforcement Actions[2]	Other
Arapahoe County[1]	Illicit discharges: 9 Construction: 942 inspections Indicator Inspections: 58 Post-Construction and Operation and Maintenance inspections: 284	Illicit discharges: 8 enforcement actions Construction Enforcement Actions: 2 written, 4 verbal notifications Post-Construction: 2 written actions	All entities have public education and outreach programs that include, but are not limited to: Coordination with other entities (Authority, Phase II Co-op workgroup, Partners, UDFCD). Distribution of issue-specific fact sheets and brochures to residents and commercial entities. Participation on school programs (e.g., project WET). Educational projects such as willow planting with scout troops. Web sites, hot lines, surveys, public service announcements.
Douglas County	Illicit discharges: 155 Construction: 1653 inspections (GESC) Single-family dwelling construction: 4762 DESC inspections No complaints regarding permanent water quality BMPs	Illicit discharges: 14 response actions Level I GESC Violations (stop work orders): 22 DESC complaint visits: 2226	
City of Aurora	Illicit discharges: 17 Construction Inspections: 604, 136 within Cherry Creek Basin Projects requiring Operation and Maintenance: 53	No Notices of Violation (NOV) for Illicit Discharges Construction NOV: 42 total, 10 within Cherry Creek Basin, 1 stop work order Final Construction and Permanent BMP Operation and Maintenance: 53	
City of Centennial[3]	Illicit discharges: 11 inspections for potential illicit discharges, 1 warning clean-up letter issued. Construction: 436 inspections or actions, 3 re-inspections Post-construction: 56 inspections of Permanent BMPs, 4 sites inspected for long-term operation and maintenance	Illicit discharges: 3 warning letters. 1 citations issued Construction: 26 non-compliance follow-up inspection or actions, 3 re-inspection fines issued. Post-construction: no enforcement action	
City of Greenwood Village	Illicit discharges: 58 dry weather inspections Construction: 353 active construction sites with 28 full level inspections and 1151 reconnaissance inspections. Post-construction: 29 BMP inspections for final construction and 97 inspections for permanent BMP Operation and Maintenance:	Illicit discharges: 2 actions to identify source of discharge and require responsible party to mitigate. Construction: estimated 6 verbal notifications and one building inspection withheld Final Construction and Permanent BMP Operation and Maintenance: no enforcement actions	
City of Lone Tree[4]			

Table 5-1. Summary of Cherry Creek Reservoir Watershed Permit, Inspection, and Enforcement Actions

Land Use Agency[1]	Permit Inspection Actions[2]	Permit Enforcement Actions[2]	Other
Town of Castle Pines North[4]			
Town of Castle Rock	Illicit discharges: 253 outfall, 15 hotline response inspections Construction: 1273 inspections (GESC) and 1376 inspections for single-family residential (DESC) Post-construction BMPs: 38 construction, 267 Operation and Maintenance inspections	Illicit discharges: 14 enforcement actions Construction: 624 notices of non-compliance issued, 2 stop work orders Post-Construction: no enforcement actions	
Town of Parker[1]	Illicit discharges: 105 outfall inspections for potential illicit discharges Construction: 225 inspections or actions Post-construction: 243 inspections of detention basins	Illicit discharges: 5 reported illicit discharges. 0 citations issued Construction: 225 inspections or actions, 3 Stop Work Orders issued, 11 Notices of Intent to Issue Stop Work Order issued. Post-construction: no enforcement action	
CDOT[4]			
Southeast Metro Storm Water Authority (SEMSWA)	Illicit discharges: 11 inspections for potential illicit discharges, 1 warning clean-up letter issued. Construction: 436 inspections or actions, 3 re-inspections Post-construction: 56 inspections of Permanent BMPs, 4 sites inspected for long-term operation and maintenance	Illicit discharges: 3 warning letters. 1 citations issued Construction: 26 non-compliance follow-up inspection or actions, 3 re-inspection fines issued. Post-construction: no enforcement action	

GESC = Grading, erosion, and sediment control (permitting/inspection process for land-disturbing activities)

DESC = Drainage, erosion, and sediment control (permitting/inspection process for detached single-family residential)

1 *The land use agencies do not separately track inspection and enforcement action within the Cherry Creek Reservoir Watershed. Information provided represents actions for the entire land use agency area.*

2 *Foxfield is not a phase II community and is not included in this table.*

3 *The Southwest Metro Storm water Authority (SEMSWA) has the MS4 permit for the City of Centennial and is a member of the TAC.*

4 *Data requested, but not submitted to Authority in time for inclusion in annual report.*

5.2.1 Update Control Regulation 72

Since 2003, land use agencies within the Cherry Creek Reservoir Watershed have had NPDES Phase II stormwater permits which have requirements that meet, and in some cases, exceed the Authority Requirements. As a result, the Authority and land use agencies are recommending changes to Control Regulation 72 and developing an accompanying guidance document. Proposed changes will be presented to the Commission at the 2009 rulemaking hearing. Control Regulation 72 currently includes language from the Phase II stormwater regulation (i.e., six minimum control measures) and the majority of the Authority's model ordinance (e.g., specific BMPs and submittal requirements), which was developed in 1999. Now that MS4 permits and associated programs are in place in the Cherry Creek Reservoir Watershed, the Authority and land use agencies in the Watershed have proposed changes to Control Regulations 38 and 72 and the Authority's Stormwater Quality Requirements to accomplish the following:

- Provide the basic requirements for stormwater quality management, particularly for areas that do not have a Phase II permit or to cover specific requirements not addressed by the land use agency permit requirements (e.g., 40-acre requirement for construction, BMPs for transportation corridors, stream stabilization).

- Simplify and remove some of the detail from the Control Regulation so that the language does not have to be changed at every rulemaking hearing to be consistent with permit language. This allows changes in technology and practices to be more easily incorporated into the Authority's requirements.
- Remove inconsistencies between the individual land use agency requirements and MS4 permits. For example, there can be confusion with two sets of requirements that differ in terminology, submittal, review, etc.
- Continue to provide protection for the Reservoir. Changes to Control Regulation No. 72 are intended to be technology-based and maintain consistency in the Watershed.

5.2.2 Develop a Guidance Document

The Control Regulation 72 Section 72.7 Guidance Document will replace the Stormwater Quality Requirements and will provide a more detailed explanation of requirements to comply with Control Regulation 72. As the Colorado Phase II Municipal Guidance provides more specific direction for coverage under a Colorado Phase II municipal stormwater discharge permit, the Section 72.2 Guidance Document provides more detailed requirements for application, review, and technical content to comply with Control Regulation 72.

The Authority is developing the Guidance Document by first comparing and then integrating the Cherry Creek Reservoir Basin MS4 permit, Authority Stormwater Quality Requirements, Control Regulation No. 61, and the Phase II Municipal Guidance document. The Authority and land use agencies collectively identified where more clarification is needed, which is intended to enhance implementation and compliance. The process has included requesting input from the Division. To respond to specific requests for clarification from the Division, the Authority developed a position paper that provides recommendations for the interpretation and implementation of the NPDES stormwater requirements for MS4s within the Cherry Creek Reservoir Watershed. The position paper also provides clarity and consistency in interpretation of the municipal stormwater requirements in Control Regulation 72.

The Guidance Document establishes three tiers of development and redevelopment based on the intensity of development, as measured by impervious surface. All three tiers must implement the same level of construction BMPs, but each tier has a different requirement for post-construction BMPs. The primary distinction between new development and redevelopment is whether impervious surfaces are new (total area) or existing (increased area). The Authority, the MS4 permitted land use agencies of the Authority, and CDOT (collectively called "Permittees") are proposing the following recommendations to clarify the permit requirements within the basin:

1. Clarify the definition of New Development and Significant Redevelopment, including highways and roadway re-construction, to include a threshold impervious value that triggers water quality capture volume (WQCV) requirements for post-construction BMPs.

2. Define when the increase in impervious area is an appropriate basis for triggering WQCV-based post-construction BMPs for Significant Redevelopment.

3. Clarify the definition of maintenance activity for highways and roadways, large lot development, and trail construction that would be granted an authorized exclusion under the provisions of Control Regulation No. 72 for post-construction BMPs. This language would only be for the municipal Permittees, as CDOT has obtained an automatic exclusion from the Division for maintenance activities that meet specific requirements.

The Commission will consider the Authority's proposal during the March 2009 hearings, which may change some or all of the above requirements.

5.3 Land Use Application Review

The Authority serves as a referral agency in the land use application process for nine local land use agencies within the Cherry Creek Reservoir Watershed. When a land use agency receives an application for land use or development, a copy is sent to the Authority for review. The Authority then has the opportunity to comment on the potential water quality impacts of the proposed application prior to construction and to determine whether the proposed project complies with the Authority's Requirements.

In March 1997, Brown and Caldwell, as consultant to the Authority, began providing review of land use and development applications on behalf of the Authority. Table 5-2 provides a review of the number of land use and development applications that the Authority has reviewed annually since March 1997.

Table 5-2. History of Land Use and Development Applications Reviewed by Authority

Year	Number of Land Use and Development Applications Reviewed by Authority
March – December 1997	103
1998	179
1999	135
2000	190
2001	144
2002	126
2003	156
2004	176
2005	189
2006	177
2007	199
2008	183
Total	**1957**

In 2008, the Authority reviewed and provided comment on 183 land use and development applications. Table 5-3 provides a breakdown of the various agencies that referred land use applications to the Authority in 2008.

Table 5-3. Sources of Land Use and Development Application Referrals

Referring Agency	Number of Land Use and Development Applications Referred to Authority in 2008
Arapahoe County	27
Douglas County	20
City of Aurora	15
City of Centennial	34
Town of Castle Pines North	5
Greenwood Village	0
Town of Castle Rock	3
Town of Parker	72
Total	**183**

The Authority's review of each application focuses on nonpoint pollutant source impacts and water quality considerations related to the proposed project. Review comments generally fall into the categories listed in Table 5-4. The Authority took no exception for 75 percent of the land use applications reviewed, and did not recommend approval for 14 percent. In many of these cases, the Authority reserves the right to review future submittals to determine if recommendations were incorporated.

Table 5-4. Summary of Comments on Land Use and Development Applications in 2008

Comment Category	Number of Applications	Percent of Total Applications (184)
No exception	**139**	**75%**
No exception, minimum requirements are met	28	
No exception, provided additional recommendations met	12	
No exception, reserve right to review subsequent submittals	67	
No exception, provided baseline BMPs	31	
No exception, previous concerns were addressed	1	
No exception, project is part of larger approved project	0	
No approval	**23**	**14%**
No approval until BMPs requirements are met	1	
No approval, provided recommendations	22	
Insufficient materials (e.g., drainage reports not provided)	1	
BMP recommendations only (early in application process)	0	0%
Special cases	7	4%
Comments not required (e.g., notice of annexation)	2	1%
Not in Cherry Creek Reservoir Watershed	11	6%

5.4 Compliance With Cherry Creek Reservoir Watershed Stormwater Quality Requirements

The Authority's review of applications for land use change in the Cherry Creek Reservoir Watershed provides the following benefits.

1. A better understanding of where and how development is occurring in the Cherry Creek Reservoir Watershed. Currently, the bulk of development is occurring in the central Reservoir Watershed around the Town of Parker, City of Aurora, and Town of Castle Rock in several tributaries that previously were undeveloped. This pattern points to the need to focus on preventing or minimizing erosion in the tributaries by stabilizing the tributary drainage ways simultaneously with, if not in advance of, development.

2. A better understanding of how well developers are complying with Authority Requirements and improved communication with the land use agency personnel. Currently, the Authority's review and comments are integral to the development process and a negative response from the Authority can result in changes to the land use application.

3. An opportunity for the Authority to work more closely with developers during the initial stages of land use planning to identify projects where water quality enhancements would be more appropriate. The Authority develops these opportunities through the Phosphorus Facilitator program (Section 5.5) and coordination with land use agency staff.

4. The opportunity to stress the importance of meeting minimum requirements for BMPs through negative referrals. These BMPs have resulted in implementation of better water quality plans, some of which have gone beyond minimum requirements.

5.4.1 Proprietary Best Management Practices

The Authority and local land use agencies receive requests to utilize proprietary BMPs for erosion and sedimentation control and to substitute proprietary BMPs for the Authority's minimum BMP requirement, which is extended detention basins. The Authority relies primarily on recommendations of the Urban Drainage and Flood Control District (UDFCD), provided in the Urban Storm Drainage Criteria Manual Volume 3 Best Management Practices (UDFCD 2008), when evaluating proprietary BMPs. Referrals to the Authority have been reviewed on a case-by-case basis and the Authority has approved the use of proprietary BMPs in some cases, as a test-case for others, and not approved in other applications.

The Authority does not have the resources to properly evaluate all proprietary BMPs to make a specific recommendation on which units are acceptable and which are not. The Authority relies on the design engineer and other independent agencies, such as the UDFCD, to provide guidance, justification, and recommendations. The Authority, therefore, requires the applicant's engineer to evaluate various BMP units and recommend a specific unit based on the following criteria.

- The ability to remove floatables, oil/grease, and phosphorus. Contaminant removal efficiency should be the primary basis for selecting a unit. The standard deviation in performance differences, as stated by the manufacturer, should be considered.
- Requirements of the local jurisdictions.
- Operation and maintenance requirements that are assigned to a governmental or quasi-governmental organization. These cases will be given priority over other organizations, such as home owner associations.
- Cost is a secondary consideration for selecting one unit over the other after the other criteria are considered.

The UDFCD, in cooperation with all the membership land use agencies and interested parties, started the revision process to the Urban Storm Drainage Criteria Manual Volume 3 Best Management Practices which will consider, among other items, proprietary BMP requirements. The Authority has accepted the invitation from UDFCD to be a member of the technical advisory committee providing input into the process. Work on Volume 3 revisions will likely continue through 2009.

5.5 Phosphorus Facilitator

STEPS REG 72

In 2008, the Authority suspended the Phosphorus Facilitator program partly due to the proposed change in phosphorus goal from load to concentration. If the Commission approves the change in the goal from load to concentration, the Authority will reconsider the role and perhaps the need for a phosphorus facilitator in the future. The discussion below relates to a phosphorus load focus, which may change after the March 2009 hearing. Refer to the Authority's 2007 Annual Report for additional information on past program results.

The role of the Phosphorus Facilitator, an independent consultant, is to investigate opportunities to improve water quality by working with developers and local governments to improve land use plans and exceed minimum requirements for immobilization of phosphorus. The development of such plans is being accomplished through a coordinated working relationship between a land use agency, a developer, and their

planners and engineers (collectively called "development group"). The intent is to identify water quality opportunities within a parcel of land before a developer selects a land use plan, and to encourage the developer to implement an enhanced water quality plan. The land use agency can provide various incentives to encourage developers to implement enhanced water quality plans. However, sometimes the developer recognizes the benefits of an enhanced water quality plan in terms of cost savings, greater open space, and good-will and implements the plan without local government incentives.

5.6 Capital Improvement Projects

REG 72 REPORTING

STEPS REG 72

In accordance with statutory requirements, the Authority must spend at least 60 percent of the annual budget on design, construction, operation, and maintenance of pollutant abatement projects. This was accomplished in 2008. To meet this requirement, the Authority conducts a multi-year, CIP planning process (currently five-year projections are made) to construct potential PRF projects. Potential PRFs are identified and evaluated, and costs are estimated over the life of design and construction for the project. The five-year projections, which are part of the Authority's annual budgeting process, are separated into design, capital, land acquisition, water augmentation requirements, and operations and maintenance costs. These costs are then spread out over a multi-year period for longer-range planning purposes, subject to available Authority funds.

The first step in the process is development of a list of all potential PRFs (called the master PRF list), which includes capital and operation and maintenance costs and potential benefits in terms of phosphorus reduction. As pollution reduction opportunities are identified during the year, they are evaluated at the conceptual level to determine costs and benefits. If project costs and benefits appear to be reasonable, the TAC recommends to the Board that the project be included on the master PRF list. Once the Board approves the project for inclusion on the master list, any future work towards design and construction, also authorized by the Board, is considered to be part of capital expenses of the Authority.

The next step is to select the best projects from the master list of PRFs to be included on the five-year CIP list. The TAC annually evaluates the projects on the master list and forwards recommendations to the Board for inclusion on the five-year CIP. The Board then annually selects projects from the five-year CIP, based on recommendations from the TAC and subject to available funds. Table 5-5 summarizes the proposed CIP list for 2009-2013. The PRF projects that progressed during 2008 and those projects recommended for further consideration moving forward are discussed below.

- Reservoir Destratification
- Cottonwood Creek Stream Reclamation, Phase II
- PRF operation and maintenance
- Reservoir Shoreline Stabilization at Mountain and Lake Loop Trails

5.6.1 Reservoir Destratification

Reservoir destratification employs aggressive and focused mixing of the Reservoir with the goal of reducing the potential for algal blooms and potentially reducing. Reservoir destratification is not specifically a PRF, because the project does not reduce external nonpoint source pollutants to the Reservoir, but it is a capital improvement project identified to improve water quality.

CHERRY CREEK BASIN WATER QUALITY AUTHORITY

Table 5-5. Summary of Recommended Pollutant Reduction Facilities
2009 Five Year Capital Improvement Projection (1000$)

		Project Budget						Previous Expend.	Residual PRF Costs	Proposed 2009 Budget					Proposed 2010 Budget	Proposed 2011 Budget	Proposed 2012 Budget	Proposed 2013 Budget
Project No.	Project Title	Capital[1]	Land	Water	Total	O&M	Authority Portion	Note 11		Design[6]	Capital	Land	Water	Total	Total	Total	Total	Total
CCB-13.2	Cottonwood Creek Reclamation within CCSP[3]	$ 2,405	$ -	$ -	$ 2,405	$ 12	97%	$ 2,329	***$ 85***	$ 14	$ 71	$ -	$ -	***$ 85***	***$ -***	***$ -***	***$ -***	***$ -***
CCB-13.3	Cottonwood Creek Stream Stabiliation at Easter Avenue	$ 1,350	$ -	$ -	$ 1,350	$ 1	25%	$ -	***$ 338***	$ -	$ 338	$ -	$ -	***$ 338***	***$ -***	***$ -***	***$ -***	***$ -***
CCB-5.7	Cherry Creek Stream Stabilization at Eco-Park (Arap County)[17]	$ 532	$ -	$ -	$ 532	$ 1	29%	$ -	***$ 154***	$ 59	$ -	$ -	$ -	***$ 59***	***$ 95***	***$ -***	***$ -***	***$ -***
CCB-5.10	Cherry Creek Stream Stabilization at Vermillion Creek	$ 1,323	$ -	$ -	$ 1,323	$ 2	28%	$ -	***$ 370***	$ 56	$ -	$ -	$ -	***$ 56***	***$ 315***	***$ -***	***$ -***	***$ -***
CCB-5.9	Cherry Creek Stream Stabilization at 12-Mile Park (CCSP)[20]	$ 300	$ -	$ -	$ 300	$ 1	100%	$ 1	***$ 299***	$ 60	$ -	$ -	$ -	***$ 60***	***$ -***	***$ 239***	***$ -***	***$ -***
CCB-17.2	Reservoir Shoreline Stabilization, Mountain Loop Trail [13]	$ 550	$ -	$ -	$ 550	$ 5	100%	$ -	***$ 550***	$ 75	$ -	$ -	$ -	***$ 75***	***$ 475***	***$ -***	***$ -***	***$ -***
CCB-16	Stream Corridor Preservation[2]	$ -	$ 500	$ -	$ 500	$ -	100%	$ -	***$ 500***	$ -	$ -	$ 100	$ -	***$ 100***	***$ 100***	***$ 100***	***$ 100***	***$ 100***
CCB-7.1	McMurdo Gulch Stream Stabilization	$ 890			$ 890	$ 2	50%	$ -	***$ 445***	$ 73	$ 372	$ -	$ -	***$ 445***	***$ -***	***$ -***	***$ -***	***$ -***
CCB-5.4	Cherry Creek Stream Stabilization at Mainstreet (Parker)[17]	$ 1,776	$ -	$ -	$ 1,776	$ 1	11%	$ -	***$ 200***	$ -	$ -	$ -	$ -	***$ -***	***$ 200***	***$ -***	***$ -***	***$ -***
CCB-5.6	Cherry Creek Stream Stabilization at Lincoln Aveneue (Parker)[17]	$ 1,447	$ -	$ -	$ 1,447	$ 1	21%	$ -	***$ 304***	$ -	$ -	$ -	$ -	***$ -***	***$ -***	***$ -***	***$ 304***	***$ -***
CCB-5.11	Cherry Creek Stream Stabilization at Norton Open Space[17]	$ 329	$ -	$ -	$ -	$ 1	46%	$ -	***$ 151***	$ -	$ -	$ -	$ -	***$ -***	***$ -***	***$ -***	***$ 150***	***$ -***
CCB-18	ISDS Sewer Service[18]	$ 350	$ -	$ -	$ 350	$ -	100%	$ -	***$ 350***	$ -	$ -	$ -	$ -	***$ -***	***$ 100***	***$ -***	***$ 250***	***$ -***
CCB-5.8	Cherry Creek Stream Stabilization U/S Arapahoe Rd (Centennial)	$ 518	$ -	$ -	$ 518	$ 1	25%	$ -	***$ 130***	$ -	$ -	$ -	$ -	***$ -***	***$ 130***	***$ -***	***$ -***	***$ -***
CCB-5.1	Cherry Creek Sediment Pond at Arapahoe Road[4]	$ 2,355	$ 50	$ -	$ 2,405	$ 90	18%	$ 70	***$ 420***	$ -	$ -	$ -	$ -	***$ -***	***$ -***	***$ 410***	***$ -***	***$ -***
CCB-12.1	Bowtie Phase I[9]	$ 616	$ 450	$ -	$ 1,066	$ 6	100%	$ -	***$ 1,066***	$ -	$ -	$ -	$ -	***$ -***	***$ -***	***$ 500***	***$ 466***	***$ 50***
	SUB-TOTALS	***$ 14,741***	***$ 1,000***	***$ -***	***$ 15,412***	***$ 124***		***$ 2,400***	***$ 5,363***	***$ 337***	***$ 781***	***$ 100***	***$ -***	***$ 1,218***	***$ 1,415***	***$ 1,249***	***$ 1,270***	***$ 150***
	OPERATIONS AND MAINTENANCE									**Design[6]**	**Capital**	**Power**	**Other**	**Total**		***$ -***	***$ -***	***$ -***
	Rehabilitation Categories																	
OM-1	Restore Cottonwood Perimeter Road	$ 296	$ -	$ -	$ -	$ 296	100%	$ -	***$ 296***	$ 43	$ 253	$ -	$ -	***$ 296***	***$ -***	***$ -***	***$ -***	***$ -***
OM-8	Cottonwood/Peoria sediment removal[14]	$ 24	$ -	$ -	$ -	$ 24	25%	$ -	***$ 6***	$ -	$ -	$ -	$ -	***$ -***	***$ -***	***$ -***	***$ -***	***$ -***
	SUB-TOTALS	***$ 320***				***$ 320***		***$ -***	***$ 302***	***$ 43***	***$ 253***	***$ -***	***$ -***	***$ 296***	***$ -***	***$ -***	***$ -***	***$ -***
	Restorative Categories																	
OM-2	Shop Creek Wetlands[12]	$ -	$ -	$ -	$ -	$ 35	100%	$ -	***$ 35***	$ -	$ 35	$ -	$ -	***$ 35***	***$ -***	***$ 10***	***$ -***	***$ -***

CHERRY CREEK BASIN WATER QUALITY AUTHORITY

Table 5-5. Summary of Recommended Pollutant Reduction Facilities
2009 Five Year Capital Improvement Projection (1000$)

		Project Budget						Previous Expend.	Residual PRF Costs	Proposed 2009 Budget					Proposed 2010 Budget	Proposed 2011 Budget	Proposed 2012 Budget	Proposed 2013 Budget
Project No.	Project Title	Capital[1]	Land	Water	Total	O&M	Authority Portion	Note 11		Design[6]	Capital	Land	Water	Total	Total	Total	Total	Total
OM-3	Quincy Drain embankment	$ -	$ -	$ -	$ -	$ -	100%	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
OM-4	East Boat Ramp riprap[12]	$ -	$ -	$ -	$ -	$ 15	100%	$ -	$ 15	$ -	$ 15	$ -	$ -	$ 15	$ -	$ -	$ -	$ -
OM-10	East Shade Shelter[12]	$ -	$ -	$ -	$ -	$ 11	100%	$ -	$ 11	$ -	$ 11	$ -	$ -	$ 11	$ -	$ -	$ -	$ -
OM-11	Dixon Grove[12]	$ -	$ -	$ -	$ -	$ 13	100%	$ -	$ 13	$ -	$ 13	$ -	$ -	$ 13	$ -	$ -	$ -	$ -
OM-5	Tower Loop[12]	$ -	$ -	$ -	$ -	$ 18	100%	$ -	$ 18	$ -	$ 18	$ -	$ -	$ 18	$ -	$ -	$ -	$ -
OM-12	Cottonwood Stream Stabilization	$ -	$ -	$ -	$ -	$ 4	100%	$ -	$ 4	$ -	$ 4	$ -	$ -	$ 4	$ -	$ -	$ -	$ -
OM-13	Shop Creek Sediment Removal	$ -	$ -	$ -	$ -	$ 25	25%	$ -	$ 6	$ -	$ -	$ -	$ -	$ -	$ 6	$ -	$ -	$ -
OM-14	Mountain Loop	$ -	$ -	$ -	$ -	$ 10	100%	$ -	$ 10	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 10
OM-6	Interpretive Signage restore	$ -	$ -	$ -	$ -	$ -	50%	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	SUB-TOTALS	***$ -***				***$ 130***		***$ -***	***$ 112***	***$ -***	***$ 95***	***$ -***	***$ -***	***$ 95***	***$ 6***	***$ 10***	***$ -***	***$ 10***
	Routine Categories																	
OM-7	Reservoir Destratification[8]	$ 285	$ -	$ -	$ -	$ 285	100%	$ -	***$ 285***	$ 20	$ 65	$ -	$ -	***$ 85***	***$ 50***	***$ 50***	***$ 50***	***$ 50***
	SUB-TOTALS	***$ 285***	***$ -***	***$ -***	***$ -***	***$ 285***		***$ -***	***$ 285***	***$ 20***	***$ 65***	***$ -***	***$ -***	***$ 85***	***$ 50***	***$ 50***	***$ 50***	***$ 50***
	SUB-TOTAL O&M	***$ 605***	***$ -***	***$ -***	***$ -***	***$ 735***		***$ -***	***$ 699***	***$ 63***	***$ 413***	***$ -***	***$ -***	***$ 476***	***$ 56***	***$ 60***	***$ 50***	***$ 60***
	GRAND TOTAL	***$ 15,346***	***$ 1,000***	***$ -***	***$ 15,412***	***$ 860***		***$ 2,400***	***$ 6,061***	***$ 400***	***$ 1,194***	***$ 100***	***$ -***	***$ 1,694***	***$ 1,471***	***$ 1,309***	***$ 1,320***	***$ 210***

NOTES:

1 Includes engineering, administration, and contingency
2 Specific project not identified. Budget based on available funds.
3 WQCD 319 Grant provides $76,467. Phase I completed in 2004 at a const cost of $475,000. Phase II completed in June 2008 at const cost of $1, 252,124.
4 Total CIP = $4,278M. Budget for CCBWQA stream stabilization portion of project as partners with local government and UDFCD after u/s Cherry Creek stabilization measures in place
5 Multi-phase project to restore and enhance wetlands along Cherry Creek. WQCD 319 Grant provides $63,800 toward total project of $159,500.
6 Includes technical feasibility, design, construction observation and administrative costs
7 Due to lowering of the operating water level in the Reservoir, project may be infeasible. Evaluate water level changes on project for future budget considerations.
8 Additional work projected for 2009 to address compressor issues.
9 Construction of project delayed until Piney Creek stabilization is further along and stabilization of u/s Cherry Creek
10 Equipment bid = $301,566, installation = $455,823, total const. = $757,389 (AMEC memo 8/14/2006). AMEC services = $93,000, BC services = $11,300, Total projection = $861,689
11 Accumulative expenditures for the project, based on previous years accounting and estimate of current year expenses
12 Repair work included in "2008 PRF Maintenance Program" constructed in 2009
13 Cost based on similar projects for east side of Reservoir, from Tower Loop to the East Boat Ramp.
14 Assume Authority provides 25% of funds, with remaining under UDFCD cost sharing with Arapahoe County for O&M
15 O&M for CCSP projects based on 2006 Annual O&M Inspection Report
16 Cost of land and water acquisition unknown. $100k used as "place holder". 2008 Budget for technical feasibility
17 Time line based on CIP projections. Parker requested Assistance funds of $200k for CCB-5.4 and $150k for CCB-5.11
18 Capital costs and potential benefits unknown. $100k for technical feasibility in 2010. CIP estimate of $250k is a place holder for purpose of projection

5.6.1.1 Project Purpose and History

The Authority has been implementing watershed-based BMPs and constructing PRFs for 17 years. However, the chlorophyll *a* standard (15 μg/l) was exceeded from 1994 through 2005 and the phosphorus goal (40 μg/l) has been exceeded since 1992. Similar results were seen in 2008, with a seasonal chlorophyll *a* average of 16.6 μg/l and phosphorus loads measured at 118 μg/l. The Reservoir has an overabundance of phosphorus. Algal growth is currently limited by nitrogen during a large part of the summer growing season. Despite the Authority's programs to reduce phosphorus loads from the Reservoir Watershed, it will likely take many years before phosphorus becomes the limiting nutrient and water quality benefits are seen in Cherry Creek Reservoir.

A 2004 special study of in-lake nutrient enrichment indicated that, in the 2003 growing season, nitrogen was a limiting nutrient and that artificially mixing Cherry Creek Reservoir could decrease the tendency for algal blooms and potentially lower overall average chlorophyll *a* concentrations. In addition, anoxic bottom water, typical of eutrophic conditions, occurs irregularly in summer despite the top-to-bottom mixing (polymixis) that occurs on windy days in shallow areas. When the Reservoir is stratified, significant amounts of ammonia, iron, and phosphate are released to the deep water and subsequently move to the surface waters when the lake mixes a few days or weeks later. Continuous reservoir mixing would move oxygen rich water from the surface to the bottom, which may reduce the release of ammonia, iron, and phosphates.

The Authority conducted a technical feasibility investigation, including 35 percent level design, construction specifications, and cost estimate, in 2005 into in-lake management techniques that could be beneficial to reducing chlorophyll *a* and nutrient concentrations and increasing dissolved oxygen concentrations in the near term. The Authority considered destratification as a method to reduce algal growth by limiting its exposure to light in the photic zone. The consultant team recommended the installation of a submerged focused mixing system in that portion of the Reservoir greater than 20 feet deep. The system went into final design and installation 2006-2007 (?).

The Reservoir destratification system is projected to achieve the following:

1. Reduce the production of blue-green algae blooms by vertical mixing to make the habitat of the Reservoir less suitable for the production of blue-green algae.
2. Decrease the seasonal mean (July-September) chlorophyll *a* concentrations by approximately 8 μg/L under typical year conditions.
3. Decrease annual peak chlorophyll *a* concentrations by up to 30 μg/L.
4. Reduce the releases of phosphorus and nitrogen from the bottom sediments into the Reservoir in a typical year by 810 lbs/yr and 1,140 lbs/yr, respectively; according to the 2005 Feasibility Report for Cherry Creek Reservoir Destratification, December 5, 2005, AMEC Earth and Environmental.
5. Increase dissolved oxygen concentrations in the deepest and most vulnerable zones of the Reservoir into the range of 5 mg/L.

5.6.1.2 Project Activity

The Reservoir Destratification system began operation on April 4, 2008 and was shut down for the winter on November 28, 2008 so as not to interfere with winter ice recreational uses. During the eight month operating period, the system experienced some problems, mostly associated with overheating of the compressor. A number of improvements were made to the compressor building and shroud to improve ventilation which proved to be effective during the extreme July and August air temperatures. The modifications allowed the system to operate about 90 percent of the time from start-up to shut-down based on operating 24-hours a day. The Authority is reviewing the 2008 operations and may consider additional modifications or improvements to allow the system to run 100 percent of the time from start-up to shut-down.

Improvements to compressor building for destratification system.

Initial monitoring results suggest that the period of stratification may have been reduced in frequency and duration in comparison to previous years' data for potential periods of stratification. The monitoring data also suggest that the average water temperature in the Reservoir may have dropped slightly (see Section 9 Water Quality Monitoring).

5.6.2 Cottonwood Creek Stream Reclamation

The Cottonwood Creek Stream Reclamation project begins at West Lake View Road (aka the Perimeter Road), within Cherry Creek State Park, and extends about 11,600 feet upstream to the Cottonwood/Peoria Street PRF (completed in 2002).

5.6.2.1 Project Purpose

The primary purpose of the reclamation project is to reduce soil erosion of the streambed and stream banks, which contains phosphorus and other pollutants that make their way into Cherry Creek Reservoir and contribute to water quality degradation in the Reservoir. Cottonwood Creek reclamation will go beyond simply stabilizing the creek in place. The design is intended to re-create, a natural, well-vegetated, functional stream system that will provide water quality, habitat, and aesthetic benefits for the Authority and the Park. Based on the Authority's experience with the Shop Creek channel, the proposed concept for Cottonwood Creek channel can reduce phosphorus loading and concentrations through filtration in wetlands treatment and other vegetation, infiltration, and settling, in addition to immobilizing phosphorus through stream bed and bank stabilization. With substantial completion of Phase II in June 2008, both phases of the Cottonwood Creek Reclamation are now functionally complete. The total project cost is $2,405,000. Maintenance activities including mowing, vegetation replacement under warranty, and planting of additional vegetation are planned for the spring of 2009.

5.6.2.2 Project History

The feasibility analysis was completed in January 2003 and final design for two phases of the project began in February 2003. Phase I design from Peoria Street to the confluence with Lone Tree Creek was completed and bid in December 2003. A contract was awarded for $477,299 and construction of Phase I began in late December 2003 and was substantially complete as of May 3, 2004. A contract for Phase II was awarded in January 2008, in the amount of $1,284,000 with the final cost of Phase II being $1,252,100.

The Authority has worked closely with Park staff and the Park Board to develop a concept that was acceptable to the Park. The Park Board officially approved the project at its November 2003 meeting.

Cottonwood Creek after completion of Phase 2 – Choke point forcing floods to spill into the floodplain, providing pollutant reduction.

5.6.2.3 Project Activity

Substantial completion of Phase I was accomplished on May 3, 2004 and Phase II on June 26, 2008, which includes the reach from Peoria Street down to the confluence with Lone Tree Creek then downstream to West Lake View Road (aka perimeter road). Design of Phase II of the reclamation began in early 2004, and was coordinated with the relocation, by Greenwood Village, of Peoria Street and the planned expansion of the shooting range in Cherry Creek State Park. Relocation of Peoria Street provided the opportunity to move Cottonwood Creek back to its historic location in the valley, affecting the restoration portion of the project. Expansion of the shooting range was accommodated by relocating the main channel to the west of the range, which will reduce, but not eliminate, the potential for flooding of the shooting range. Since construction of Phase II is dependent on relocation of Peoria Street, the street relocation had to be near completion before starting Phase II construction. Peoria Street realignment was substantially completed by September 2007.

Final design of Phase II was restarted in October 2007, including preparation of construction drawings. Phase II extends approximately 8,600 feet from the Park perimeter road upstream to a point about 600 feet upstream of the confluence of Cottonwood Creek and Lone Tree Creek. Of this length, approximately 6,200 feet of Cottonwood Creek was relocated to what is believed to be the historic channel location at the low point in the valley. The construction of a new road alignment for Belleview Avenue and Peoria Street out of the valley bottom made this alignment restoration possible.

The goal of the project was to stabilize the creek banks and invert by incorporating natural riffle-pool grade control structures and riparian overbank vegetation. Water quality will be improved by reducing erosion and increasing vegetative filtering, infiltration, and wetland processes.

5.6.3 Reservoir Shoreline Stabilization at Mountain and Lake Loop Trails

The Cherry Creek Reservoir Shoreline Stabilization at Mountain and Lake Loop Alternative Development and Analysis (Project) was part of the Authority's 2008 Capital Improvement Program (2008 CIP). The preliminary design contract for the project was awarded in June 2008. The Project area is located within Arapahoe County and Cherry Creek State Park, located along West Lake View Road approximately 0.75 miles from the west (Dayton Street) Park entrance. The Project area covers approximately 6.5 acres, including the area between the foot trail and the shoreline and approximately 2,300 feet of shoreline.

Example of shoreline erosion at Mountain and Lake Loop Trails

Project objectives were to evaluate and design shoreline and bank stabilization measures that:

1. Minimize sediment from wind, rain, ice, surface runoff, wave action, and park visitor access erosion within the project area from reaching the Reservoir.
2. Minimize water quality impacts from parking lot and other impervious surface runoff.
3. Minimize operation and maintenance requirements while preserving long-term performance.
4. Integrate and enhance existing and proposed multiple uses within Cherry Creek State Park.

The preliminary design Project is divided into three phases:

- **Phase I - Identify Project Constraints**. Compile physical information (e.g., topography, recreation facilities, utilities, endangered species studies, etc.) and prepare plans and sections illustrating existing conditions. Assess the Project for: a) shoreline stability, b) wind, rain, ice, pedestrian, and runoff related erosion, c) vegetation sustainability, and d) visitor experience.
- **Phase II - Investigate Alternatives**. Investigate alternate solutions to address issues and constraints identified during Phase I. Compile alternatives into a Recommended Alternative Plan and integrate available future Park plans into the Recommended Alternative Plan. Provide preliminary cost estimate and qualitative benefits of Recommended Alternative Plan.
- **Phase III - Preliminary Design**. Upon selection of Alternative Plan by the TAC, prepare Preliminary Design (35 percent). Identify direct and indirect costs and qualitative benefits of Selected Alternative Plan and present results in a Preliminary Design Report.

The preliminary design was accepted by the Authority in December 2008 with the submittal of the design report[1]. The recommended plan includes:

1. Strategically placed points and/or jetties constructed from earth and manmade materials.
2. Bio-edge shoreline treatment constructed from void-filled riprap with new vegetation.
3. Hard-edge shoreline treatment constructed of boulders or man-made materials
4. Beach cuts to create a scalloped shoreline with gently sloped beaches.
5. Breakwater jetty constructed from rock and boulders.

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[1] Wenk and Associates. December 2008. *Cherry Creek State Park – Mountain and Lake Loop Shoreline Stabilization and Water Quality Improvements.*

6. Reconfiguration of parking areas in conjunction with stormwater diversion, infiltration, and bio-swales for treatment.

Final design for the project is included in the Authority's 2009 CIP.

5.6.4 Projects Projected for 2009 Activity

The Authority established the 2009 budget in 2008. In 2009, the Authority anticipates construction of the additional capital projects as listed below. Those projects that involve cost sharing for design and/or construction will require development of an intergovernmental agreement or memorandum of understanding.

- Cottonwood Creek Reclamation Phase II – Additional vegetation planting.
- Cottonwood Creek Reclamation at Easter Avenue. Construction cost sharing with SEMSWA.
- Cherry Creek Stream Stabilization at Eco-Park. Design and construction cost sharing with Arapahoe County.
- Cherry Creek Stream Stabilization at Vermillion Creek. Design and construction cost sharing with Arapahoe County.
- Reservoir Shoreline Stabilization at Mountain Loop Trail. Final design.
- Cherry Creek Stream Stabilization at 12-Mile Park. Preliminary design.
- McMurdo Gulch Stream Stabilization. Design and construction cost sharing with Castle Rock.

5.6.5 Operations and Maintenance Activities

The Authority is required by statute and Control Regulation 72 to operate and maintain (or arrange for) all PRFs constructed by the Authority. To this end, the Authority includes in its annual budget funds for operation and maintenance for specific facilities For Operations and Maintenance (O&M) purposes, there are currently two IGAs with State Parks, one covering operation and maintenance of PRFs within Cherry Creek State Park and the second covering Cherry Creek Reservoir destratification facilities.

In 2008, the Authority developed a standard set of contract documents and specifications (CDs) for capital and maintenance type projects that are an adaptation of the UDFCD construction contract documents. These CDs were used by the Authority to bid and award in December 2008 the first comprehensive contract for routine and rehabilitative maintenance of PRFs in the amount of $91,910. The project called the 2008 PRF Maintenance Program includes Shop Creek, East Boat Ramp, East Shade Shelter, Dixon Grove, and Tower Loop PRFs, which began construction in January 2009.

PRF maintenance at Dixon Grove.

In December 2008, the Authority also issued the notice to proceed with final design of the Cottonwood Creek Wetland project (aka perimeter road pond) with anticipation of construction in the fall of 2009. This project will restore the wetlands and capacity (volume) of the wet detention pond constructed in 1996. Rehabilitation of the Cottonwood Creek Wetlands PRF has been delayed until completion of the stream stabilization of Cottonwood Creek from Peoria Street to West Lake View Road since the wetlands pond has functioned as a sediment trap since its construction in 1996. Once rehabilitation is completed, only routine maintenance type activities may be required for several years.

5.6.5.1 PRF O&M Agreement

In 2004, the Authority began drafting an agreement with Cherry Creek State Park for maintenance of all existing and future PRFs located within the Park. The agreement, which was signed on January 12, 2006, identifies requirements for routine and restorative maintenance activities and responsibilities between the Authority and the State. As a condition of the PRF agreement, the required annual inspection of PRFs located within the Park was conducted in May 2008 and recommendations were made to the Authority for consideration in the 2009 budget.

5.6.5.2 Destratification O&M Agreement

In 2006, the Authority and the State worked together to develop an operations and maintenance agreement for the mixing facilities. This agreement again sets forth the Authority's responsibility for restorative and rehabilitative maintenance of the facilities, but also sets the long-term goal of eventual removal of the system and continued commitment by the Authority to implementing watershed management strategies. The Agreement was finalized in 2007.

5.7 Riparian and Wetlands Protection

REG 72 REPORTING

As described in the Section 5.6, the Authority has contributed wholly, or in part, to the construction of projects during 2008 as part of its capital improvement program that address riparian and wetlands enhancement and restoration. In addition to capital projects, the Authority's Requirements also recognize the importance of stream corridors to water quality by placing additional restrictions on development within the stream preservation area. When a land disturbance is proposed within the stream preservation area (except for implementation of water quality facilities themselves), the Authority requires additional BMPs (above minimum requirements). These additional BMP must enhance infiltration of stormwater to protect and enhance riparian habitat. In addition, the Authority's near future focus for PRFs will be more on implementing upper-basin, stream stabilization measures for Cherry Creek and its tributaries after completing projects within the Park.

5.8 Progress Made

REG 72 REPORTING

The Authority has made progress in meeting the requirements of Control Regulation 72 for control of nonpoint and regulated stormwater source pollution in the following ways.

Cottonwood Creek riparian vegetation takes hold after a flood event.

- The Authority coordinated and assisted local land use agencies in implementing Phase II stormwater permit requirements consistent with Control Regulation 72.
- The Authority increased the local land use agencies understanding of Authority goals and requirements relative to water quality through development and distribution of education materials and by providing review comments on land use change applications. The Authority reviewed 184 land use and development applications for nonpoint and regulated stormwater pollutant source impacts. Of the 184 applications, the Authority took no exception for 139 of the applications.
- The Authority completed the first operation year of the Reservoir destratification system for in-lake management, completed construction of Cottonwood Creek Reclamation Phase II, completed preliminary

design of Shoreline Stabilization for Mountain and Lake Loop Trails, and allocated funds for further activity during 2009. Although currently all but one of the PRFs are located within Cherry Creek State Park, the Authority continues to focus on watershed BMPs and PRFs in the upper basin, such as Cottonwood Creek Reclamation at Easter Avenue and McMurdo Gulch in Castle Rock.

- The Authority continued its process to update the Authority's Stormwater Quality Requirements for consistency with Control Regulation 72 and the land use agency stormwater quality requirements developed as part of the Phase II stormwater permits. The revised document, in the form of a guidance document, represents the collective experience of the Authority and the land use agencies while implementing Phase II stormwater regulations and other measures to protect the water quality of the Cherry Creek Reservoir Watershed.

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6. TRADING PROGRAM AND RESERVE POOL

The Authority initiated the Cherry Creek Reservoir Watershed phosphorus trading program in 1997[1]. The trading program allows point source dischargers and other entities requiring a load or wasteload allocation (i.e., allocatee) to receive phosphorus pounds for new or increased phosphorus allocations in exchange for phosphorus load reductions from other sources. The Authority can also sell or lease phosphorus credits through the Reserve Pool.

The Authority did not receive any new trade project applications in 2008.

6.1 Trading Program

REG 72 REPORTING

The Authority is authorized to implement and maintain a Trading Program in the Cherry Creek Reservoir Watershed that allows phosphorus trading from the Phosphorus Bank. The goal of the Trading Program is to encourage and facilitate the construction of nonpoint source control projects and retrofit existing stormwater facilities with water quality enhancements that were not in the original design. Watershed-based trading is a successful water quality management strategy that will provide net reductions to the phosphorus TMAL, as well as provide additional environmental benefits in the Cherry Creek Reservoir Watershed. Trading provides incentive for landowners, local governments, and allocatees to subsidize the design and construction of additional stormwater controls and phosphorus removal technologies that go beyond baseline BMPs. Watershed-based trading is a water quality management strategy that promotes incentive opportunities for entities in the Cherry Creek Reservoir Watershed to implement additional phosphorus removal technologies needed to achieve the Cherry Creek Reservoir TMAL, sooner than later.

Through the Trading Program, entities in the Watershed that require a load or wasteload allocation (i.e., point source dischargers, holders of wastewater reuse authorizations, entities providing land applications, industrial dischargers) can receive phosphorus pounds for new or increased phosphorus wasteload allocations from the Phosphorus Bank in exchange for phosphorus loading reductions from nonpoint source control projects that are built by the entity or third parties. These entities are also called "allocatees." Landowners, local governments, and allocatees can construct phosphorus removal projects and receive credits for their own use or to transfer to an allocatee.

6.1.1 Trading Program Guidelines

The Authority completed revisions to the Trading Program and Reserve Pool Guidelines in 2006.

6.1.2 Tracking Trades

An example of how trades are tracked is provided in Table 6-1, which reflects the ACWWA trade project approved in 2003. ACWWA constructed a project to remove 165 pounds and, by applying a calculated trade ratio of 2.9:1, ACWWA received 57 phosphorus credits. For accounting, ACWWA will received an increased allocation of 57 pounds and the nonpoint/regulated stormwater allocation was reduced by 114 pounds, by applying a conservative 2:1 ratio (minimum allowable trade ratio). This resulted in a net reduction of the TMAL.

[1] Subject to approval by the Commission the phosphorus goal will be changed from mass to a concentration based goal for the watershed and will result in termination of the trading program as it currently exists.

Table 6-1. Example of Tracking Trades			
Facility	**Allocation**		**Post Trade Allocation**
ACWWA/Cottonwood	402	+ 57→	459
Pinery Water and Sanitation District	304		304
Parker Water & Sanitation District	593		593
•	•		•
•	•		•
•	•		•
Semi-urban Areas	141		141
Subtotal	1,878		1,935
Reserve Pool	216		216
Trading Program (currently held pounds)	0		0
Total Point Source Allocation	**2,094**		**2,151**

Allocation Source	Allocation, lbs/yr		Post Trade Allocation, lbs/yr
Nonpoint and Regulated Stormwater	10,506	-(2 x 57)→	10,392
Background	1,170		1,170
Wastewater Facilities	2,094	+ 57→	2,151
Industrial Process Wastewater	50		50
Individual Sewage Disposal Systems	450		450
Total Maximum Annual Load	**14,270**		**14,213**

6.2 Reserve Pool

The Authority is authorized to implement and maintain the sale or lease of phosphorus pounds from the Reserve Pool. The Reserve Pool includes 216 pounds of phosphorus credits from projects already constructed by the Authority (and approved by the Commission) and can be sold by the Authority to allocatees in the Watershed. The Reserve Pool phosphorus credits are based on the following historic Authority projects:

- Shop Creek detention and wetlands (1991)
- Quincy Drainage detention (1995)
- East Shade Shelter streambank improvements and parking area retrofit (1995)
- Cottonwood Perimeter Road pond (near Reservoir) (1997)

The 216 pounds of phosphorus allocated to the Reserve Pool are available for transfer and may be purchased or leased from the Authority at a price established by the Authority. Pounds sold or leased from the Reserve Pool are subtracted from the Reserve Pool and allocated to the entity acquiring the pounds, for long-term or short-term use.

There were no Reserve Pool actions in 2008.

6.3 Progress Made

REG 72 REPORTING

No new trade projects were proposed in 2008.

7. PUBLIC EDUCATION ACTIONS AND PARTNERSHIPS

REG 72 REPORTING

As part of the Authority's water quality management approach (Figure 2-1), and as prescribed by Control Regulation 72, the Authority is committed to providing educational programs that provide policy makers, government agencies, local land use agencies, private industry, and the general public with information and suggested actions to reduce nonpoint source pollution to Cherry Creek Reservoir.

7.1 Education Initiative

STEPS REG 72

The Authority has provided staff and funding to support the Partners in developing a comprehensive and coordinated education strategy and action plan on a reservoir watershed scale. This plan was completed in 2004 and is entitled the Cherry Creek Basin Water Stewardship and Education Initiative (Education Initiative).

The purpose of the Education Initiative is to set forth the approach recommended by the Partners and the Authority. This document contains a compilation of the key education and public involvement goals, strategies, and activities that will be used to engage the community in active stewardship of Cherry Creek, parks, open space, trails, and tributaries within the Watershed. In coordination with key stakeholders in the Cherry Creek Watershed, the Education Initiative makes recommendations and identifies next steps for the development and implementation of a public information and education outreach program for the Cherry Creek Watershed that meets the regulatory requirements of Control Regulation 72 and the objectives identified in Cherry Creek Basin Watershed Plan 2003.

7.1.1 Cherry Creek Stewardship Partners

The Partners is an association of a broad range of stakeholders actively promoting effective stewardship and providing education and outreach activities in the Cherry Creek Reservoir Watershed. The Partners emerged from the first Cherry Creek Reservoir Watershed forum held in the fall of 1999. The Partners bring together representatives from:

- Land use jurisdictions
- State and federal resource management agencies
- Conservation, recreation, and historic preservation groups
- Business communities
- Interested citizens

In 2008, the Authority provided $20,000 to the Partners to help implement priority activities identified in the Education Initiative. In addition to organizing and sponsoring a wide variety of activities in the Cherry Creek Reservoir Watershed that support water quality goals, the Partners are frequently asked to help identify, plan, and support open space projects such as restoration of riparian areas along Cherry Creek at the Cherry Creek Valley Ecological Park, restoration support for the Cottonwood Creek PRF, and projects that provide a positive and fun spin on our watershed's recreational opportunities, such as the 2005, 2006, 2007, and 2008 "Run for the Watershed" relay race.

These projects take much time and effort in planning, coordination, and successful completion. The Partners enable Watershed entities, such as stormwater permittees, the Park, and the Authority, to more efficiently implement collaborative education and outreach activities. The following provides a summary of the Partners' 2008 outreach accomplishments, which are further described in the Partners' 2008 Annual Report

(www.cherry-creek.org). For more information refer to the Cherry Creek Stewardship Partners 2008 Annual Report included as Attachment A.

Table 7-1. The Partners 2008 Outreach Accomplishments

Date	Activity	Location	Participants
Activities Enabling Participants to Get to Know the Watershed			
January	Audubon Raptor Walk	Cottonwood Creek	12
March	Habitat Monitoring & Assessment	CCVEP	20
April	Riparian Planting Project	17-Mile Historic Park	50
	Alternatives to chemical pest management	Tagawa Garden Center	8
May	Troop Inlet Stenciling	4-Square Mile	20
June	Habitat Monitoring & Assessment	CCVEP	12
Ongoing	Troop 117 Eagle Scout Project Support	CCSP	80
December	Habitat Monitoring & Assessment	CCVEP	3
		Total	**205**
School and Teacher Education and Training			
February	Metro Regional Science Fair	DMNS	300
April	State Science & Engineering	CSU	350
	Science Fair Presentation	CCBWQA	12
May	Colorado Department of Education Service Learning Presentation	Denver	5
June	Aurora Project WET Teacher Training Support	Aurora	150
July	Teachers Workshop	Cherry Creek and Aurora Schools	20
Ongoing	Classroom Visits & Field Trips	Various	240
		Total	**1,077**
Integrating Watershed Interests			
May	Southeast Denver Duck Drop	George Wallace Park	200
	14th Annual Aurora Water Fest	Aurora Com. College	150
	WEED Network Meeting promoting cross-boundary coordination of weed mitigation efforts	Denver Federal Center	60
July – August	Maintenance support	Cherry Creek	50
	Lake Appreciation Day – Americorps	Cottonwood Creek – Thistle Pull	120
September	Run for the Watershed	Cherry Creek Basin	112
November	Annual Conference	Wildlife Experience	100
		Total	**792**

7.1.1.1 Colorado Cares Day at Cherry Creek Reservoir

On July 25, 2008, the Partners coordinated activities at Cherry Creek State Park that celebrated Lake Appreciation Day. The park offered several different volunteer opportunities including thistle management and shoreline clean up. Over 150 volunteers participated by cutting and safely disposing of over 20 cubic yards of Scotch thistle seed heads.

Other activities included a fishing program with free fishing rods for the first 30 kids and free pontoon rides. There were about 50 children at the fishing clinic and 40 visitors enjoyed the pontoon rides. The day provided the park with much needed volunteer assistance and a fun event for all. Projects included shoreline clean-up, noxious weed removal, and wetlands trail renovations. An additional leisure activity included a free evening program at the campground amphitheatre.

7.1.1.2 Tenth Annual Cherry Creek Stewardship Partners Conference

The Authority, which is an active member of the Partners, contributed funding for the Partners' 10th annual conference held on November 7, 2008. The conference theme for 2008 was "Thriving Partnerships, Effective Projects." Several TAC members take lead roles in planning and coordinating the conference as well as participating in the conference as session moderators. Four Authority consultants and a Board member made presentations.

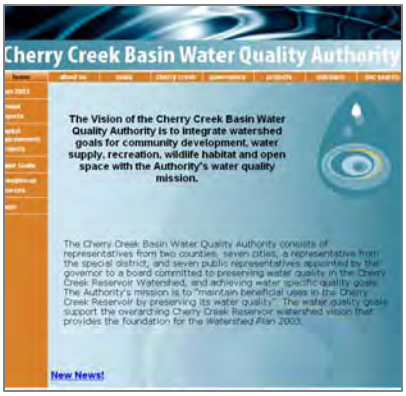
7.1.1.3 Run for the Watershed

The Partners organized the annual Run for the Watershed Relay, "Celebrating the splendor and diversity of the Watershed, from the top of the basin downhill to Cherry Creek State Park." The relay spanned 50 miles with 13 race legs ranging from a 2-mile walk to a 6-mile run.

7.1.1.4 Teachers Training Workshops

In July 2008, the Partners planned and presented four half-day teacher training workshops to educate teachers in Watershed issues. These workshops included the basics of the geology and earth science of the Cherry Creek Watershed and how BMPs, such as detention ponds and stream bank stabilization, work to improve water quality in the Basin.

7.2 Website



The Authority website provides information and education on water quality issues within Cherry Creek Reservoir Watershed and also serves as a storehouse of documents generated by, and related to, the Authority. The website can be found at www.cherrycreekbasin.org/cc_home.asp.

Small content changes were made through the year including: adding new News items, replacing dated documents, adding or updating content on pages, and image recompressing for faster loading of pages. Also included on the website is information on the Pre-Hearing Statements in preparation for the March 2009 Regulation 72 Commission hearing. The past annual reports and the CIP projections were among the top five most downloaded documents.

7.3 Collaboration with Other Entities

The Authority has built relationships with several entities to carry out water quality objectives.

7.3.1 Land Use Agencies

The Authority continues to work directly with the nine local land use agencies and CDOT in the Cherry Creek Reservoir Watershed. Activities include:

- Routine monthly TAC meetings and subcommittees to scope and coordinate special projects (e.g., Stormwater Quality Requirements revisions).
- Review of land use and development applications for compliance with the Authority's Requirements (Section 5.2).

7.4 Progress Made

The Authority made progress in meeting the requirements of Control Regulation 72 for implementing public information and education programs in the following ways.

- The Authority leveraged resources by supporting the Partners and coordinating with other entities to implement the Education Initiative, a comprehensive and coordinated education strategy and action plan.
- The Authority continued the use of its website through cooperation with the Partners to facilitate the dissemination of information to parties interested in Authority activities.
- The Authority collaborated on information and education efforts with other entities with common interests and goals for the Watershed.
- The Cherry Creek Stewardship Partners facilitated broad community involvement and benefited long-term environmental stewardship through outreach efforts, reaching an estimated 2,074 people.

8. PHASED TMAL ACTIVITIES

The Commission adopted Control Regulation 72 as a phased TMAL to provide for the implementation of point and nonpoint source requirements and controls while concurrent required investigations are implemented "to better define hydrology, phosphorus sources, chemical processes, and relative loads to the Watershed and reservoir" (Commission 2004). The Commission recognized "that until additional investigations are completed, a new TMAL cannot be calculated."

Control Regulation 72 identifies 13 specific activities to provide reasonable progress in attaining water quality standards and support revisions to the TMAL. Table 8-1 provides a description and status of these activities and other studies that have since been identified. A more comprehensive review of these activities can be found in the Authority's *Summary of Activities to Comply with Phased TMAL Requirements*[3]. The Authority completed one study in 2007 and an additional study is ongoing.

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Table 8-1. Updated List of Activities and Proposed Priorities

Proposed Priority	Special Study	Description/Purpose	Status
1	Evaluation of phosphorus removal effectiveness of nonpoint source control.	Evaluate the infiltration component of various detention/retention BMPs to determine the infiltration contribution to phosphorus loading in the Watershed. Results used to estimate performance of BMPs to predict impacts of future growth and controls on phosphorus loads by the Watershed model.	Completed in 2008.
2	Depth profiling of nutrient content for groundwater.	Conduct alluvial sampling at various depths to determine phosphorus concentration variation with depth of alluvium.	Completed August 2006.
3	Further quantification of soil and groundwater background phosphorous levels.	Characterization of Cherry Creek water quality based on limited human influences (i.e., natural, background conditions). The results would be used to establish background as part of the TMAL source load.	Completed in 2007.
4	Further development of event mean concentrations (EMCs) for storm water flows.	Characterization of storm runoff quality based on monitoring runoff of various land uses in the Cherry Creek Watershed. EMCs are used in the Watershed model to predict impacts of future growth and controls on phosphorus loads.	The Authority provided evidence and believes that the background phosphorus special study and the calibrated Watershed Model demonstrate the appropriateness of the background EMC used in the model and that no further investigation into EMC for undeveloped land is necessary at this time (Ruzzo 2009).
5	Monitoring of shallow alluvial groundwater loading in tributaries.	Purpose is to better understand fate and transport of phosphorus for the Watershed model and ultimately for determining TMAL allocations.	The Authority provided evidence that there is sufficient existing data such that additional groundwater studies for tributary alluvial phosphorus contributions are not warranted (Ruzzo 2009).

[3] William P. Ruzzo, PE, LLC. January 2009. *Summary of Activities to Comply with Phased TMAL Requirements.*

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Table 8-1. Updated List of Activities and Proposed Priorities			
Proposed Priority	**Special Study**	**Description/Purpose**	**Status**
6	Quantification of individual sewage disposal system phosphorus loading.	Purpose is to better understand fate and transport of phosphorus for the Watershed model and ultimately for determining TMAL allocations.	The Authority provided evidence that, if the Commission does change to a concentration based TMAL, then previous investigations provide data to support that ISDS are not a significant source of phosphorus concentration and no further investigations are required at this time (Ruzzo 2009).
7	Characterization of Watershed hydrology to establish reference condition for evaluation of phosphorus loading.	Develop specific set of hydrologic conditions to represent an index hydrological year such that annual phosphorus loads can be referenced to this index. Results used to adjust the TMAL for wet and dry runoff conditions.	The Authority provided evidence that, if the Commission does change to a concentration based TMAL, then the characterization of Watershed hydrology special study is complete (Ruzzo 2009).
8	Revised calculation of background sources, industrial process wastewater sources, and individual sewage disposal systems sources of phosphorus contributions.	Complete special studies and revise the Watershed model to identify these point and nonpoint source components of the TMAL.	The Authority provided evidence that, if the Commission does change to a concentration based TMAL, then the new TMAL may be a flow-weighted phosphorus concentration of 0.20 mg/L (Ruzzo 2009)
9	Reservoir study on groundwater inflow.	Evaluate groundwater flow and phosphorus flux into the Reservoir. This study is not required by the Control Regulation, but the Division identified this as a high priority.	Completed on February 9, 2005.
10	Reservoir nutrient studies.	Determine the concentration of phosphorus in the Reservoir necessary to suppress the growth of algae by a field study of nutrient limitations.	Completed on January 22, 2004
11	Implementation of lower phosphorus effluent limits.	No direct discharge with an effluent total phosphorus concentration greater than 0.05 mg/L as a 30-day average and no land application discharge of a 30-day flow-weighted average total phosphorus concentration greater than 0.05 mg/L/land application return flow factor.	Completed on August 1, 2004.
12	Identification of industrial process wastewater sources and associated phosphorous loading.	Investigate existing industrial process type land uses to estimate contribution to phosphorus loading in Cherry Creek and to establish limits for the TMAL.	There are minor industrial land users within the Cherry Creek Basin, including DirecTV who has allocation for phosphorus in its permit.
13	Construction of nonpoint source control projects.	The Authority plans and implements a capital improvement program on an ongoing basis.	See Section 5 for details of projects completed in 2008.

8.1 Planning Progress for Rulemaking Hearing Review

The rulemaking hearing was initially scheduled for August 2007 and, as jointly proposed by the Authority and the Division at the 2006 informational hearing, the Authority was going to propose changes to Control Regulation No. 72, including an updated schedule for revising the TMAL. In March 2007, the Division requested the Authority present a complete revised TMAL at the August 2007 hearing. The Authority did not believe this allowed enough time to adequately develop a revised TMAL and the Division proposed moving the hearing to April 2008. The Authority still did not feel these additional few months would be sufficient to develop the revised TMAL but agreed that it would move forward and work closely with the Division to try to meet the schedule. The Authority continued to work with Division staff in making progress with watershed and reservoir modeling, completing studies that provide supporting information to

the TMAL, and implementing management strategies such as capital projects for pollutant reduction and water quality improvement.

The Authority had made progress on the watershed and reservoir modeling, but the TMAL revision process included substantial stakeholder discussion to come to agreement on the TMAL and allocations. Based on the Authority and Division proposal, the Commission scheduled a new hearing date for March 2009. The proposed schedule acknowledged other options that may need to be considered (e.g., evaluation of Reservoir water quality standard), which, if needed, could be addressed through the Control Regulation No. 38 Rulemaking hearing process. In addition, if other options, such as changes to water quality standards are considered, they could be also be addressed at a March 2009 hearing.

8.2 Three Special Studies Funded by the "TMAL Actions" Grant

The Authority was awarded a Colorado Nonpoint Source Grant to conduct the following three implementation actions, or special studies, required for the Cherry Creek Reservoir phased TMAL.

A. Conduct depth profiling of phosphorus concentrations in the Cherry Creek alluvium. This study was completed in 2006.

B. Determine background phosphorus levels in alluvial soils, groundwater, and surface water for the revised TMAL. This study was completed in 2007.

C. Quantify phosphorus infiltration to the alluvium from pollutant reduction facilities. This study was completed in the first quarter of 2008 and is discussed below.

The objectives of the grant project focus on fate and transport of phosphorus through the Cherry Creek Reservoir Watershed, including determining soil-phosphorus equilibrium, confirming effectiveness of BMPs, and defining background phosphorus.

8.2.1 Quantify Phosphorus Infiltration to the Alluvium from Pollutant Reduction Facilities

The Authority retained Lytle Water Solutions, LLC to evaluate the potential for infiltration from PRFs into the underlying alluvium and whether this phosphorus is ultimately reaching the Reservoir. The Authority quantifies phosphorus immobilization through PRFs and trade projects can receive phosphorus credits for BMP removals; therefore, the study is intended to confirm the measured removals do not overestimate load reductions. The Authority had initially selected three sites for the BMP monitoring study, but due to issues with access, the study was delayed many months to investigate and select other monitoring locations. The following three projects were selected and monitoring began in October 2006.

Cottonwood\Peoria Street Detention - This site is a good example of a large, extended detention basin with wetlands, so it is considered as enhanced.

The TriMark Windemere Extended Detention Basin at Peoria Street - This BMP has reasonable access, sufficient drainage area to result in frequent storm runoff, and suitable locations for boreholes and monitoring wells. This site is a good example of a typical extended detention basin that includes a concrete trickle channel. Since concrete trickle channels will likely continue to be a standard for extended detention basins in the metropolitan area, this site is considered a good example for monitoring.

The Inverness Pond Tributary Cottonwood Creek - This BMP has reasonable access, sufficient drainage area to result in frequent storm runoff, and suitable locations for boreholes and monitoring wells. This site is also a good example of an enhanced BMP, since it includes a "serpentine" low flow channel and wetlands in the bottom.

Quarterly reporting in 2007 indicated that phosphorus loading in the ground water beneath the BMP sites is minimal. In addition, there is little indication that there is a significant loss of phosphorus from the BMPs to the alluvium. This study was completed in March 2008.

8.3 Watershed Model Update

The Authority redeveloped the Watershed Model to predict total phosphorus loads from the Watershed to the Reservoir. The purpose of the model is to predict long-term changes in phosphorus loads, concentrations, and watershed yield volumes resulting from changes in the Watershed land uses, pollutant management strategies, and wastewater plant operations. The model accounts for the interaction of the stream and alluvium, which have different runoff volumes and transport velocities resulting in significantly different annual flows and loads into the Reservoir. In addition, surface flows contain both particulate and dissolved phosphorus, whereas alluvial flows contain primarily dissolved forms of phosphorus. Therefore, it was determined that the Watershed Model should separate and track surface flows and alluvial flows as well as dissolved and particulate phosphorus forms, requiring a more sophisticated model than proposed in 2000.

Phosphorus load is calculated and routed in two different forms. Dissolved phosphorus is that portion of the load that is assumed to travel at the same velocity as the surface and alluvial flow, thus it is treated as a conservative ion. Particulate phosphorus is that portion of the load that is only present in surface flow and is assumed to settle or filter out when runoff infiltrates from the surface to the alluvium. Particulate phosphorus can also be mobilized during higher stream flow events that erode or scour the channel bed or banks, picking up particulate phosphorus attached to eroded material.

The redeveloped Watershed Model was created by an experienced team in the fields of hydrology, hydraulics, groundwater flow, and computer modeling over a three year period. After calibrating the model by comparing output for an eight-year simulation period to measured data and checking the model output for reasonableness by peer review, the model was used to project impacts of future watershed changes, including development and new stormwater controls on phosphorus loads and concentrations and runoff volumes. Key findings of the Watershed Model analysis included:

- Implementation of post-construction BMPs and completion of Rueter-Hess Reservoir could reduce flow-weighted median inflow concentration and phosphorus loads into the Reservoir when compared to existing conditions, even with a 250 percent population growth in the Watershed. Therefore, the Watershed Model demonstrated that the proposed Reservoir chlorophyll *a* standard of 25 μg/L could be met eight (8) out of ten (10) years and that currently identified beneficial uses of the Reservoir would continue to be protected, even with continued growth in the Watershed.
- Substantial reduction of external phosphorus loads are expected to occur with completion of Rueter-Hess Reservoir and implementation of minimum standard BMPs for future development, but will *not* result in a similar reduction in phosphorus concentrations in the Reservoir inflow. These results support the proposed shift from a load-based watershed management strategy for phosphorus to a concentration-based strategy. However, modeling of BMPs for future development along with Rueter-Hess Reservoir demonstrated that the proposed Reservoir chlorophyll *a* standard of 25-μg/L could be met eight out of 10 years.
- Implementation of enhanced BMPs could further reduce external phosphorus concentrations to the Reservoir, providing an even greater benefit to Reservoir water quality. Enhanced BMPs consist of additional treatment of storm water beyond extended detention basins (EDB), such as filtering or infiltration. The cost of enhanced BMP (present worth of $131,000,000) was found to be from 4 percent to 9 percent of the capitalized value of the Reservoir, which is estimated to be from $1.4 to $3.3 billion. The cost of enhanced BMPs would be borne by new development and represents an increase in the current costs for BMPs.
- Retrofitting existing detention basins could further reduce external phosphorus concentrations, providing even greater benefit to Reservoir water quality. Existing detention basins are BMPs that were constructed prior to the 2001 effective date of Control Regulation 72. The retrofit would consist of supplemental filtration or other treatment of discharges from existing detention basins. The cost of retrofitting existing detention basins (present worth of $55,000,000) was found to be from two percent to four percent of the capitalized value of the Reservoir, which is estimated to be from $1.4 to $3.3 billion. The Authority could retrofit existing detention basins but will need to consider its right to access such detention basins.
- Increasing the point source discharge limitation from 0.05 to 0.10 mg/L increased the median phosphorus loads from 9,098 pounds to 9,145 pounds (1 percent) when compared to other simulated watershed scenarios. Increasing the point source discharge limit to 0.10 mg/L has minimal impact on phosphorus loads and concentrations entering the Reservoir, since both loads and concentrations increases are less than 1 percent.

8.4 Cherry Creek Reservoir Model Update

The relationship between algal biomass (chlorophyll *a*) and phosphorus has been one of the most studied paradigms in limnology, with regression models based on data from multiple lakes and reservoirs often revealing a significant correlation between algal biomass and phosphorus. However, the similar statistical regression analyses discussed in the Reservoir Model Report authored by Dr. Nürnberg and Dr. LaZerte of Freshwater Research demonstrate that there is no statistically significant correlation between seasonal mean chlorophyll *a* and Reservoir total phosphorus concentrations.

The uncertainty associated with the linkage of external/internal phosphorus loads to Reservoir phosphorus concentrations and then to chlorophyll *a* concentrations indicated to Dr. Nürnberg that other empirical relationships between chlorophyll *a* and Watershed variables should be explored. During this process, Dr. Nürnberg identified a an important correlation between the log transformed seasonal (July through September) mean chlorophyll *a* concentration and the log transformed annual flow-weighted total phosphorus concentration of the inflow. This empirical relationship supports the proposal to retain chlorophyll *a* as the in-lake standard and to revise the total phosphorus load-based TMAL to a total phosphorus concentration-based TMAL. This relationship also helped formulate the basis for proposing a

chlorophyll *a* standard that was consistent with historical conditions of the Reservoir, yet would serve as a threshold indicator of nuisance algal blooms and protect and preserve the water quality of the Reservoir.

8.5 Progress Made

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The Authority has continued to develop and implement point, nonpoint, and regulated stormwater source controls and has worked with the Division to complete one more, and make progress on the final, required investigations for the phased TMAL.

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- The Authority completed the study to evaluate the potential for infiltration from PRFs into the underlying alluvium and whether this phosphorus is ultimately reaching the Reservoir.
- The Authority completed the redeveloped watershed phosphorus fate and transport model and the Reservoir model
- The Authority submitted its Prehearing Statement as the proponent of proposed changes to the Classification and Numeric Standards for South Platte River Basin, Laramie River Basin, Republican River Basin, Smoky Hill River Basin, ("Regulation No. 38" or "Classification and Numeric Standards Regulation") and Cherry Creek Reservoir ("Reservoir") Control Regulation ("Regulation No. 72" or "Control Regulation") in preparation for the March 2009 hearing before the Commission.

9. WATER QUALITY MONITORING – POINT SOURCE AND NONPOINT SOURCE LOADS

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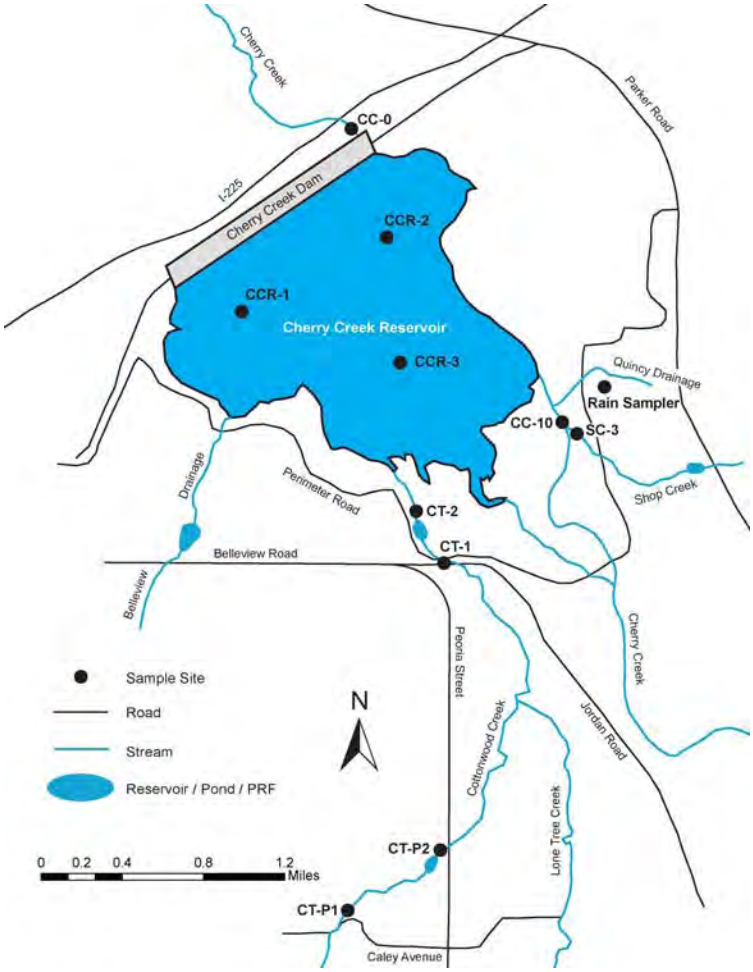
The Authority continued to implement a routine annual water quality monitoring program in the Cherry Creek Reservoir and basin. The program monitors Reservoir water quality, Reservoir inflow and loading, Reservoir outflow, surface and groundwater quality in the Watershed, and effectiveness of Authority PRFs.

Figure 9-1. Sampling Sites on Cherry Creek Reservoir and Selected Streams



The Authority conducted Reservoir and tributary sampling at ten sites in 2008, including three sites in Cherry Creek Reservoir, six sites on tributary streams, and one site on Cherry Creek downstream of the Reservoir. The Authority conducts sampling at sites upstream and downstream of the Cottonwood Creek-Peoria Pond and the Cottonwood Creek Perimeter Pond to evaluate the effectiveness of these PRFs.

Watershed monitoring includes an additional seven surface water sites along Cherry Creek, from Castlewood Canyon to Cherry Creek Reservoir, and seven alluvial groundwater well locations from Franktown to Cherry Creek Reservoir (Figure 9-2). Complete data reports are provided in the Cherry Creek Reservoir 2008 Annual Aquatic Biological-Nutrient Monitoring Study and Cottonwood Creek Phosphorus Reduction Facility Monitoring Report prepared by GEI Consultants, Inc. (2008 Annual Monitoring Report), and the 2008 Water Quality Data Report – Baseline Water Quality Data for the Upper Cherry Creek Basin prepared by John C. Halepaska and Associates, Inc. More details regarding assumptions, calculations, analyses, and results are provided in the 2008 Annual Monitoring Report.

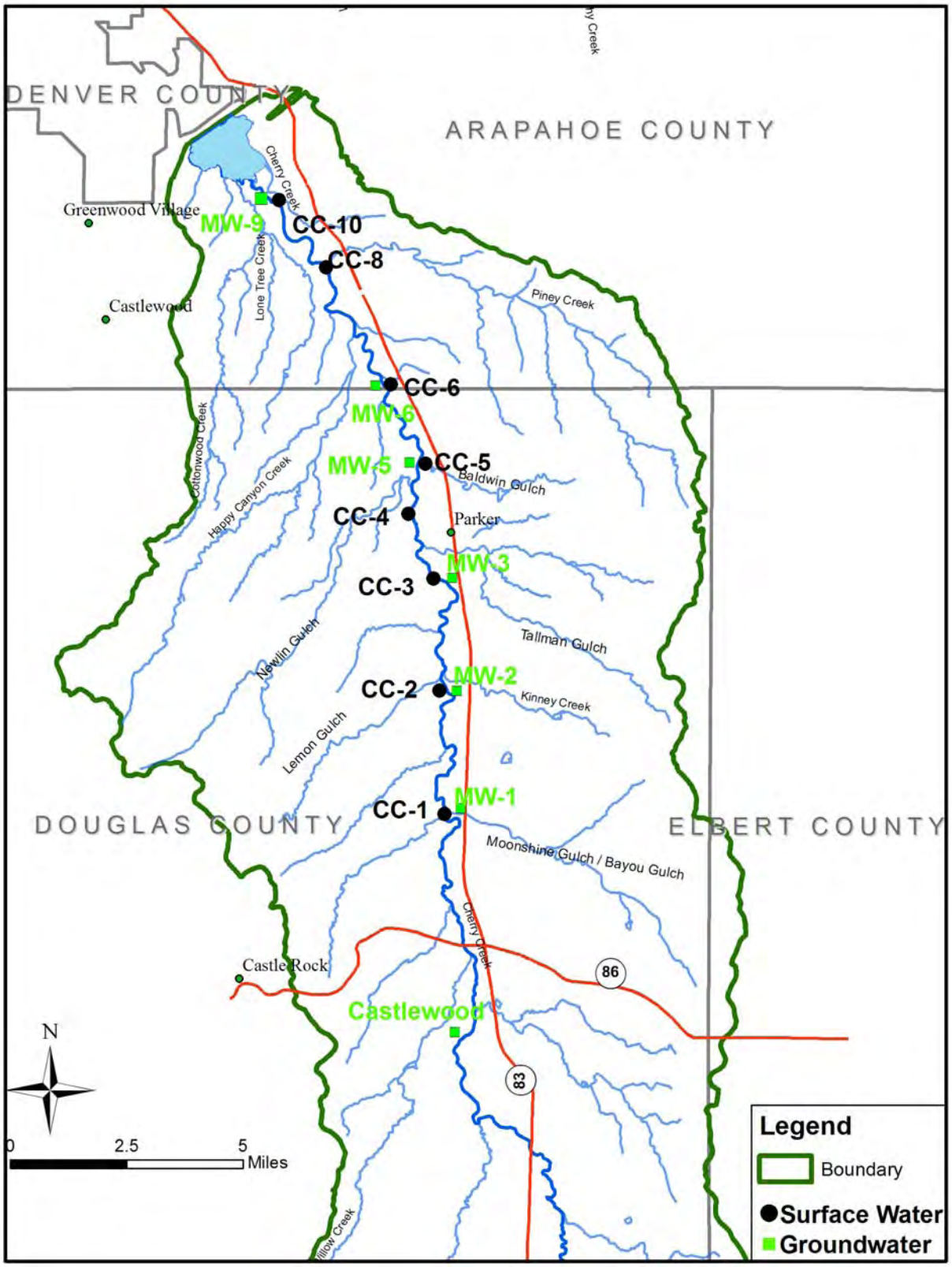


Figure 9-2. Surface Water and Alluvial Groundwater Sampling Sites in the Watershed

9.1 Summary of Long-Term Cherry Creek Reservoir Water Quality

Presented below is a summary of water quality in Cherry Creek Reservoir as determined by various constituents. This summary is based on the past 17 years of monitoring, as presented in the 2008 Annual Monitoring Report. Data are untransformed and generally represent whole-lake mean values with estimates of variation. However, data used in statistical analyses may be transformed depending upon the distributional characteristics of the data. If the transformation did not improve normality, the untransformed data were used in subsequent analyses.

9.1.1 Chlorophyll *a*

- Whole-lake chlorophyll *a* concentrations varied greatly throughout 2008, ranging from 5.7 µg/L in mid-May to 33 µg/L in mid-March. The annual mean chlorophyll *a* concentration was 16.1 µg/L.
- The 2008 seasonal mean chlorophyll *a* concentration was 16.6 µg/L, which is greater than the July-September chlorophyll *a* standard of 15 µg/L (Table 9-1). Despite meeting the standard for the previous two years, the 2008 seasonal mean chlorophyll *a* concentration exceeded the chlorophyll standard. While the seasonal mean chlorophyll *a* concentration has varied greatly over the long term (1992-2008), there has been a significant decreasing trend ($p<0.001$) in summer mean chlorophyll *a* concentration since 1999.

Table 9-1. Water Quality (July–September Average Concentration) and Total Phosphorus Load Data for Cherry Creek Reservoir, 1992 – 2008

Year	Chlorophyll *a* (µg/L)	Total Phosphorus (µg/L)	Total Nitrogen (µg/L)	Annual Phosphorus Load (lbs/yr) [1]	Annual Inflow (ac-ft/yr) [1]	Flow-weighted Phosphorus Concentration (µg/L)	Net Phosphorus Load (lbs/yr) [2]
1992	17.4	66	970	**5,364**	9,210	214	3,921
1993	**14.4**	62	826	**3,114**	5,851	196	2,186
1994	15.4	59	1,144	**3,784**	6,998	199	2,729
1995	15.6	48	913	**5,736**	11,788	179	4,302
1996	18.1	62	944	**4,425**	7,654	213	3,102
1997	22.3	96	1,120	**5,675**	10,391	200	4,076
1998	26.5	89	880	**13,322**	20,902	234	9,311
1999	28.9	81	753	17,672	27,604	235	10,913
2000	25.2	81	802	**13,788**	18,611	272	9,362
2001	26.1	87	757	**9,099**	17,246	194	4,402
2002	18.8	74	858	**3,525**	7,511	173	1,681
2003	25.8	90	1,121	**9,390**	14,953	231	4,717
2004	18.4	102	977	**8,974**	17,203	192	5,553
2005	17.1	116	990	**10,725**	18,534	213	7,080
2006	**14.7**	87	914	**6,492**	12,799	187	3,206
2007	**12.6**	118	716	19,772	29,586	246	11,703
2008	16.6	118	800	**9,144**	18,841	178	4,316
Mean	19.6	84	911	8,824	15,040	209	5,445
Median	18.2	87	913	8,974	14,953	200	4,316

Notes:

[1] *The annual phosphorus load represents the total load to the Reservoir from stream, alluvium, and precipitation. The COE monitors inflow as a function of change in storage (i.e., Reservoir volume) based on changes in Reservoir level, measured outflow, precipitation, and evaporation.*

[2] *The net external phosphorus load is the total load to the Reservoir minus the Reservoir outflow load.*

Bold indicates value meets the respective standard, goal, or TMAL value.

9.1.2 Phosphorus

- Whole-lake total phosphorus concentrations ranged from 45 µg/L in mid-May to 151 µg/L in early July. The 2008 annual mean total phosphorus concentration was 91 µg/L.
- The 2008 seasonal mean total phosphorus concentration was 118 µg/L, which exceeded the seasonal phosphorus goal of 40 µg/L. The seasonal mean total phosphorus concentrations have varied greatly over the years, with the 2008 mean total phosphorus concentration being considerably greater than the long-term median of 87 µg/L. In contrast to chlorophyll trends since 1999, the seasonal mean phosphorus concentrations have revealed a significantly increasing trend. Cherry Creek Reservoir has exceeded the existing seasonal phosphorus goal in all years since 1989.

9.1.3 Nitrogen

- Whole-lake total nitrogen concentrations ranged from 619 µg/L in mid-May to 914 µg/L in mid-March. The 2008 annual mean total nitrogen concentration was 791 µg/L.
- The 2008 seasonal mean total nitrogen concentration was 800 µg/L, which is less than the long-term median value of 913 µg/L. There is no total nitrogen goal or standard for Cherry Creek Reservoir. The seasonal mean total nitrogen concentration has also varied greatly over the long term, and since 1999 has revealed a significant increasing trend.

9.1.4 Transparency

- Lake transparency values (as measured by Secchi depth) in 2008 ranged between 0.57 m in early July to 1.61 m in mid-May. The seasonal mean Secchi depth was 0.80 meters, which is less than the long-term mean value of 1.07 meters. [Note: A Secchi disk is lowered into the water to measure transparency or clarity of the water. The Secchi depth is the depth at which the disk is no longer visible from the surface.]

9.1.5 Temperature and Dissolved Oxygen

- Periodic thermal stratification was observed in the Reservoir in 2008. During periods of stratification, the lower layers of the Reservoir experienced decreased dissolved oxygen concentrations (e.g., <5 mg/L). Low dissolved oxygen concentrations were also observed during the summer season when the lake was not thermally stratified.

9.1.6 Phosphorus Loading

The Cherry Creek and Cottonwood Creek loads are based on flow that is normalized to the COE inflow.

- The 2008 total external phosphorus load is 9,144 lbs, which is less than the phased TMAL of 14,270 lbs.
- The long-term median annual total phosphorus load is 8,974 lbs/yr for the past seventeen years, meeting the phased TMAL each year, except for 1999 and 2007 (Table 9-1).

9.2 Cherry Creek Reservoir - Summary of 2008 Data

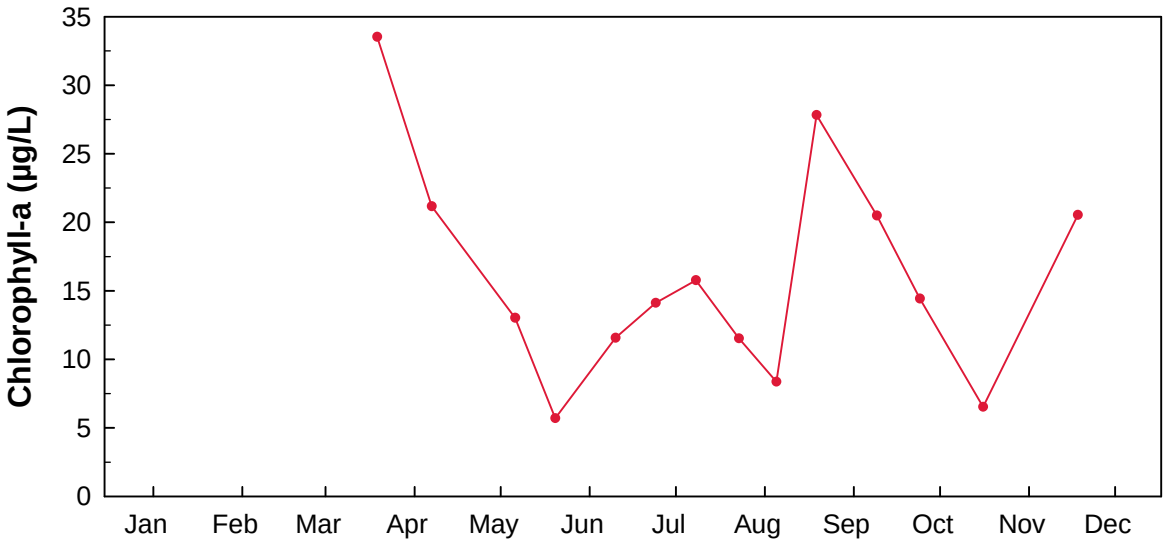
Presented below is a summary of 2008 water quality data for various constituents. This information is also summarized in the 2008 Annual Monitoring Report.

9.2.1 Chlorophyll *a*

The annual pattern of chlorophyll *a* concentrations revealed the greatest level following the transition from ice-off in late February (Figure 9 3). From early April to early August, chlorophyll *a* concentrations often were less than 20 µg/L. Following a summer storm event in mid-August, the whole-lake chlorophyll *a* concentration greatly increased to 27.8 µg/L. From late August, the chlorophyll *a* concentration decreased over time. The mean annual chlorophyll *a* concentration was 16.1 µg/L, and the seasonal (July through

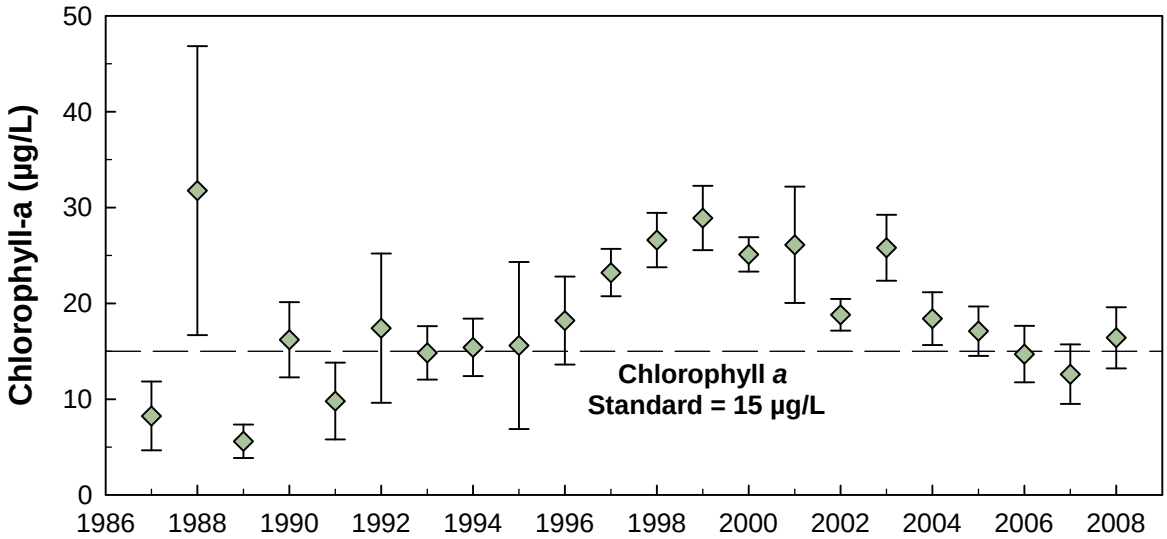
September) mean chlorophyll *a* concentration was 16.6 µg/L. Even though the seasonal mean chlorophyll *a* level is relatively low for the Reservoir, the standard was exceeded for 2008.

Figure 9-3. Concentration of Chlorophyll *a* (µg/L) in Cherry Creek Reservoir, 2008



The long-term chlorophyll *a* record shows considerable variability within and among the seasons, with the standard being met in only six of the past 22 years. Since 1987, there has been no significant trend in the July through September mean concentration of chlorophyll *a* in Cherry Creek Reservoir (Figure 9-4). However, since 1999 there has been a steady decline in the seasonal mean chlorophyll *a* concentration.

Figure 9-4. Seasonal Mean (July to September) Chlorophyll *a* Concentrations Measured in Cherry Creek Reservoir, 1987 to 2008

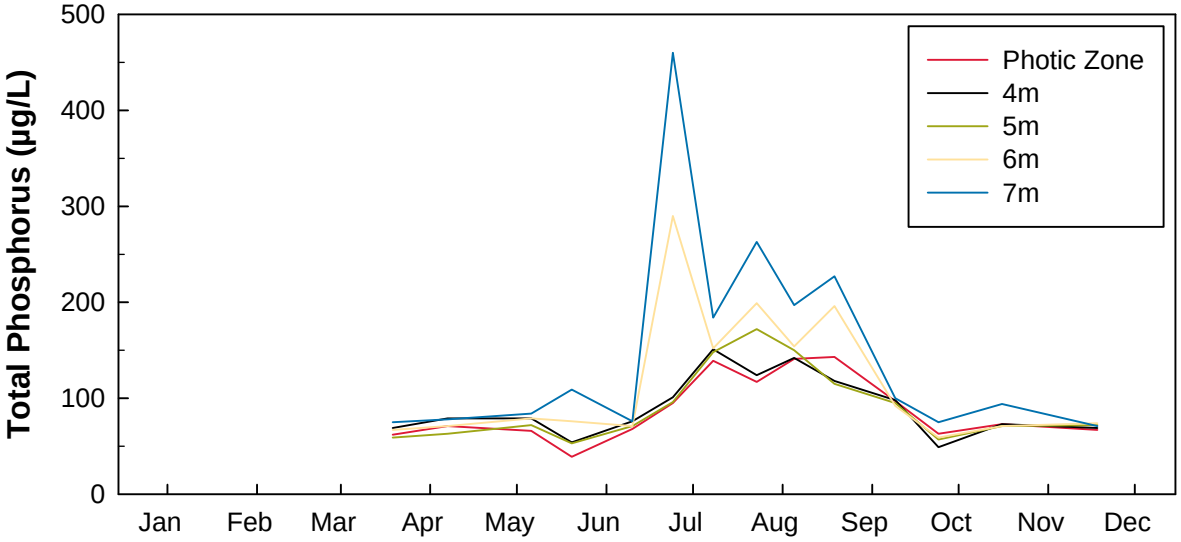


Note: Error bars represent a 95 percent confidence interval around each mean.

9.2.2 Phosphorus

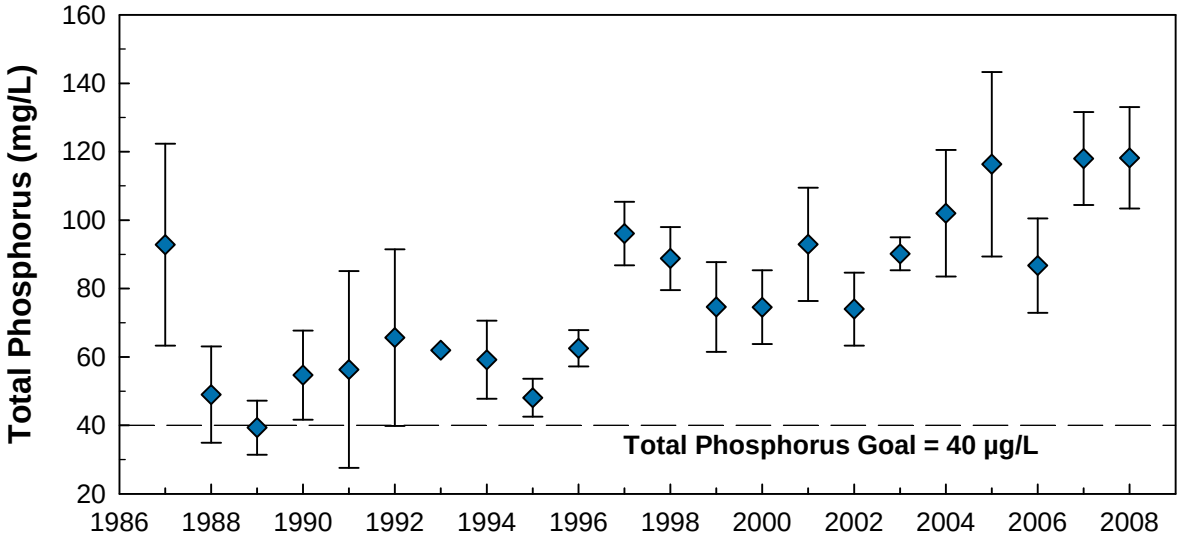
Nutrient profile samples collected in 2008 showed a well-mixed reservoir in spring and fall. There were periods of nutrient release from bottom sediments from June through late August as evidenced by increasing total phosphorus concentrations with increasing depth (Figure 9-5). During a portion of this period (June and July) the total dissolved phosphorus fraction in the 7 meter water layer accounted for 60 to 77 percent of the total phosphorus content, indicating that phosphorus was being released from the sediments during that time.

Figure 9-5. Total Phosphorus Concentrations Measured in Cherry Creek Reservoir, 2008



Routine monitoring data collected since 1987 indicate an increasing trend ($p < 0.01$) in the summer mean concentration of total phosphorus (Figure 9-6). In 2008, the summer mean concentration of total phosphorus was again 118 µg/L, which is considerably greater than the long-term (1987-2008) median value of 87 µg/L, and the goal of 40 µg/L.

Figure 9-6. Seasonal Mean (July to September) Total Phosphorus Concentrations (µg/L) Measured in Cherry Creek Reservoir, 1987-2008



Note: Error bars represent a 95 percent confidence interval around each mean.

9.2.3 Temperature and Dissolved Oxygen

Analysis of past Cherry Creek Reservoir temperature profiles indicates that stratification occurs when there is a >2°C difference between surface and bottom temperatures. Differences of approximately 1°C suggest a recent mixing event. Using these criteria, Cherry Creek Reservoir was investigated for periods of stratification using the continuous temperature record at depths for Site CCR-2 (May to September) and dissolved oxygen levels (Figure 9-7 and Figure 9-8). Temperature loggers were deployed on March 11, 2008, when the Reservoir exhibit little variation in water temperatures from the surface to bottom layer. It was not until early May when the Reservoir began to show evidence of variation in water temperature; therefore, the period of record presented herein was shortened to May to September, to provide greater clarity regarding thermal stratification. Despite the operation of the destratification system from mid-April to late November, seasonal storm events resulted in Reservoir mixing during early and mid-May, early June, and again in early August. The storm events in early June and August were strong enough to completely mix the entire water column and to create brief periods of thermally stratified conditions that followed each storm event. In June, the Reservoir remained stratified for approximately 13 days before the destratification system eroded the thermal stratification. The stratified period in early August was shorter, lasting approximately 5 days. During the stratification period in mid-June, the deeper water layers of the Reservoir began to exhibit low dissolved oxygen concentrations (<5mg/L). These low dissolved oxygen levels persisted in the deeper waters throughout much of the summer period, despite the effectiveness of the destratification system at minimizing thermal stratification.

Figure 9-7. Temperature (°C) Profiles Recorded During Continuous Monitoring at Site CCR 2 in 2008 (highlighted areas represent thermal stratification and duration)

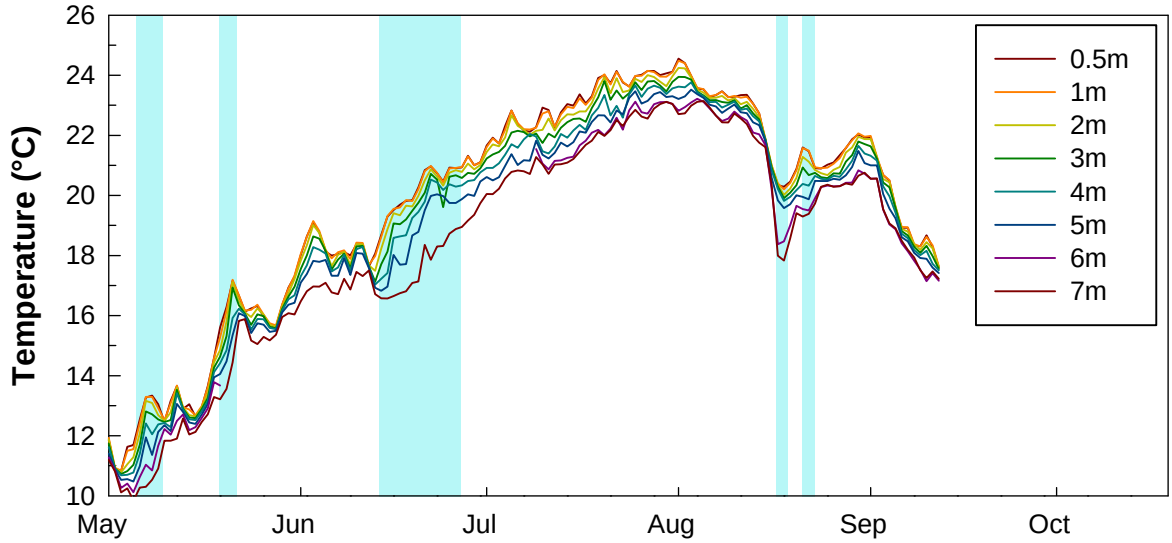
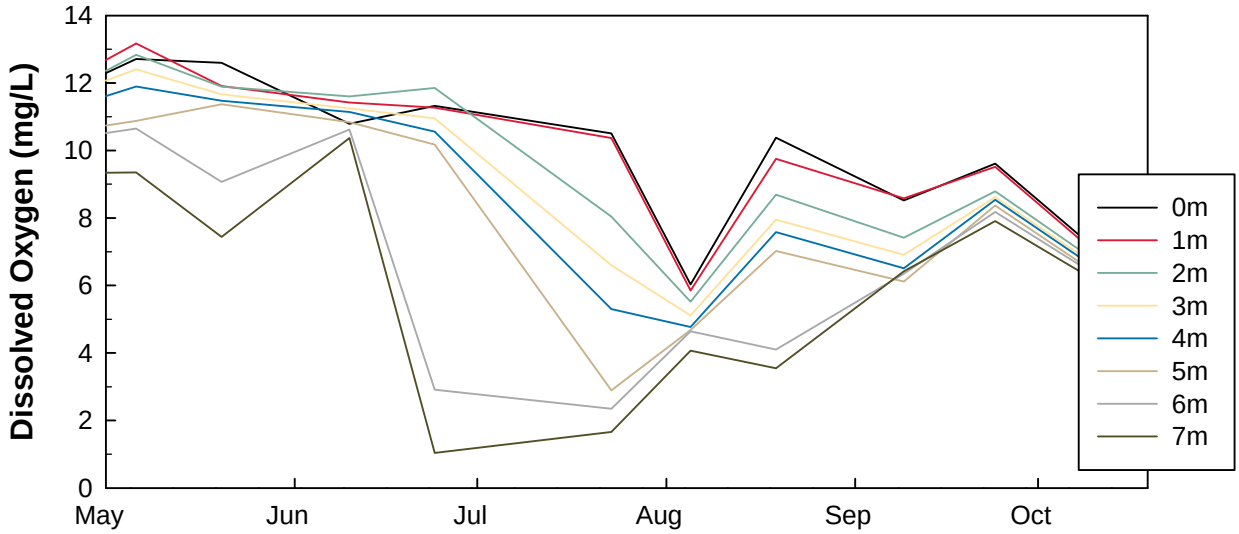


Figure 9-8. Dissolved Oxygen (mg/L) Profiles Recorded During Routine Monitoring at Site CCR 2 in 2008



9.3 Cherry Creek Mainstem Monitoring

The Cherry Creek mainstem Watershed monitoring was initiated in 1994 (Phase I Baseline Water Quality Data Collection Study) and is conducted by John C. Halepaska and Associates, Inc. The monitoring includes semi-annual sampling at seven surface water sites and six alluvial groundwater sites along Cherry Creek for the following constituents.

- Nitrate
- Ammonia

- Total dissolved phosphorus
- Total phosphorus (surface water only)
- Soluble reactive phosphorus (SRP)
- Chloride
- Sulfate

The sampling frequency over the years was reduced from monthly monitoring to semiannual monitoring (May and November) in 2003. Table 9-2 shows the list of water quality monitoring sites for the Cherry Creek mainstem. Sites shown in gray were not sampled during the 2008 sampling events. Surface water and groundwater sites are paired at the same location and given corresponding numbers (e.g., CC-1 and MW -1). A summary of surface and groundwater monitoring data is provided in the following sections.

Table 9-2. Quality Monitoring Stations for Cherry Creek Mainstem

Site	Description
Surface Water Location (upstream to downstream)	
Castlewood	0.2 mile north of the USGS Cherry Creek near Franktown gaging station
CC-1	1 mile south of Scott Road
CC-2	¾ mile south of Stroh Road
CC-3	1 mile south of West Parker Road (no longer a water quality sampling location)
CC-4	½ mile south of Lincoln Avenue
CC-5	½ mile north of Lincoln Avenue (not sampled; inaccessible due to construction)
CC-6	On Arapahoe/Douglas County Line
CC-7	¾ mile south of Arapahoe Road (no longer a water quality sampling location; abandoned in 2000 due to development)
CC-8	½ mile north of Arapahoe Road
CC-9	In the Park near Nature Center. In 2002, site replaced by CC-10 (GEI)
Groundwater (upstream to downstream)	
MW-1	Monitoring well adjacent to Pinery production well #6
MW-2	Monitoring well E-2 downgradient of Pinery discharge
MW-3	Parker KOA production well
MW-4b	Parker NPDES monitoring well M-3 (no longer a water quality sampling location)
MW-5	Monitoring well adjacent to Arapahoe Loyd #2 production well
MW-6	Monitoring well adjacent to Arapahoe Race #1 production well
MW-7	Monitoring well adjacent to Arapahoe Ford #2 production well (no longer a water quality sampling location; abandoned in 2000 due to development)
MW-8	Arapahoe Deem production well (no longer a water quality sampling location)
MW-9	Monitoring well in Park near Nature Center
Kennedy	Denver production well adjacent to Kennedy Golf Course (downstream from Reservoir and not included in the following data analyses)

9.3.1 Soluble Reactive Phosphorus

- The SRP concentrations in the underlying alluvial aquifer range from <0.08 to 0.54 mg/L, with a median of 0.18 mg/L (1994-2008). Figure 9-9 and Figure 9-10 present annual average alluvial SRP concentrations.
- The SRP concentrations in Cherry Creek range from <0.20 to 0.37 mg/L, with a median of 0.16 mg/L (1994-2008). Figure 9-11 and Figure 9-12 present annual average surface water SRP concentrations.

- Trends in SRP over time (1994 to present) indicate a decreasing trend for the most upstream surface water and groundwater sites and an increasing trend at the most downstream groundwater site (Table 9-3).

Table 9-3. Summary of Soluble Reactive Phosphorus Temporal Trend Analysis

Site	Type	Trend	Slope (mg/L per year)
Castlewood	Upstream surface water	Yes, decreasing	-0.002
CC9/CC10	Downstream surface water	No	
MW-1	Upstream groundwater	Yes, decreasing	-0.002
MW-9	Downstream groundwater	Yes, increasing	0.003

Note: To minimize the effects of seasonality, the Seasonal Kendall tau test was applied, which is a nonparametric test for trend (i.e. uses the relative magnitude of the data rather than the actual values) and removes seasonal cycles.

- Spatial trend evaluations to determine whether SRP concentrations are significantly different between upstream and downstream sites and surface and groundwater sites are summarized in Table 9-4.

Table 9-4. Spatial Differences in Soluble Reactive Phosphorus

Site	Spatial Difference in SRP Concentration?
Surface water upstream and downstream (Castlewood and CC9/CC10)	Yes, downstream>upstream
Groundwater upstream and downstream (MW-1 and MW-9)	Yes, upstream>downstream
Upstream surface water (CC1) and upstream groundwater (MW-1)	Yes, groundwater>surface water
Downstream surface water (CC9/CC10) and downstream groundwater (MW-9)	Yes, groundwater>surface water

Note: A Mann-Whitney test, which is a nonparametric test for determining if two sets of observations come from the same distribution, was conducted at a 99 percent confidence level to determine spatial differences. Non-detect values were set equal to the detection limit.

Figure 9-9. Average SRP Concentrations in Cherry Creek Groundwater as a Function of Location

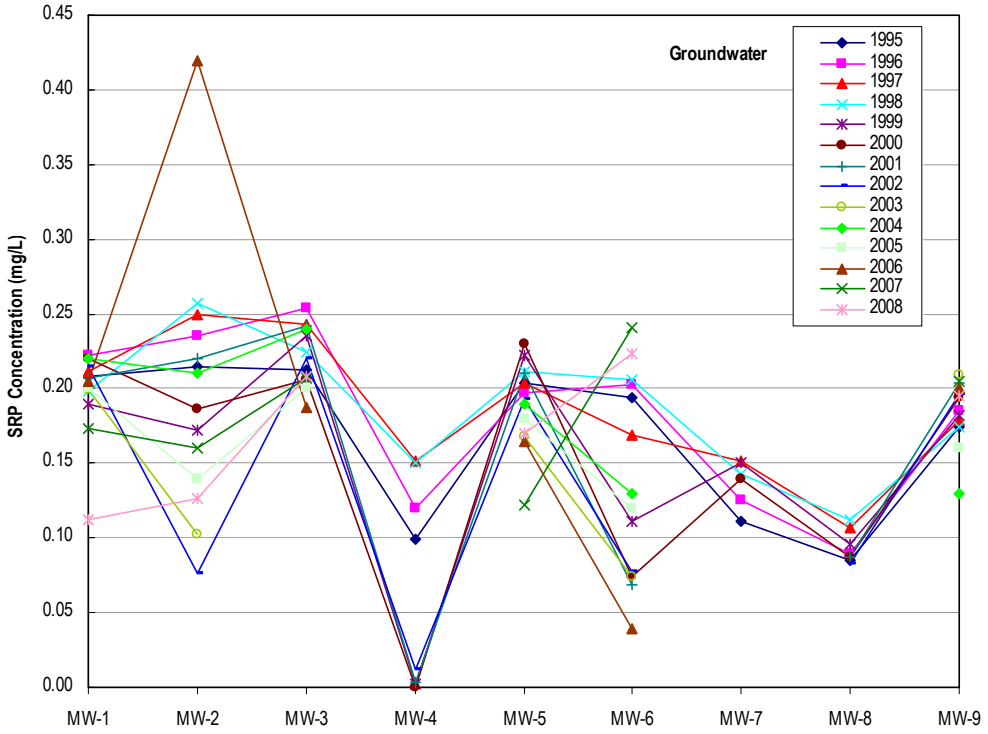


Figure 9-10. Average SRP Concentrations in Cherry Creek Groundwater as a Function of Time

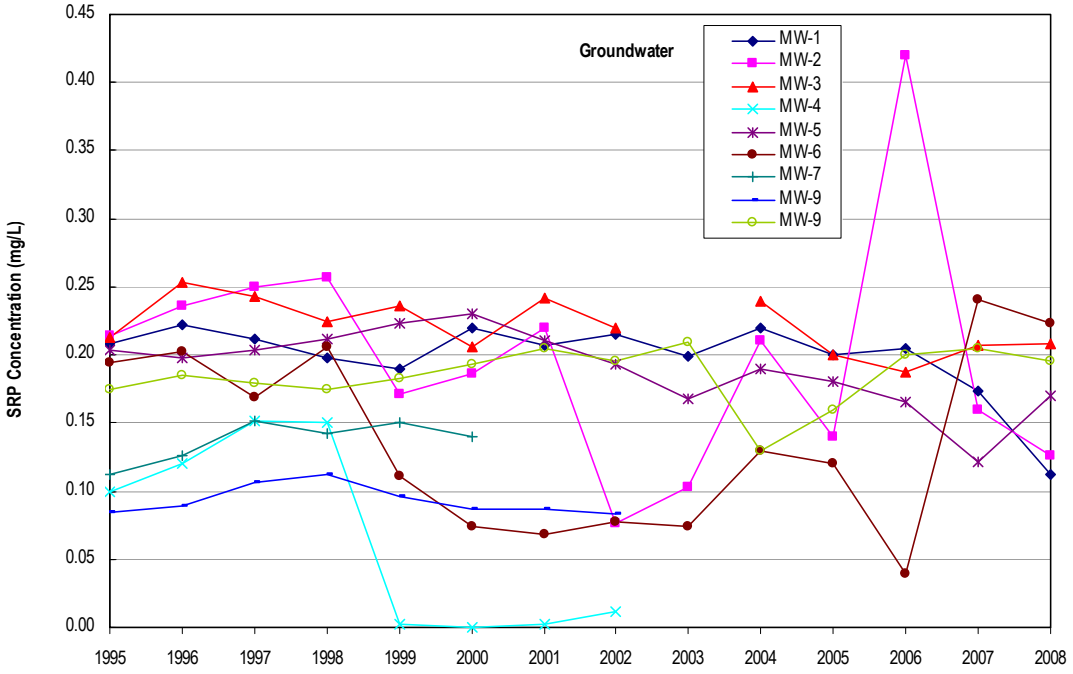


Figure 9-11. Average SRP Concentrations in Cherry Creek Surface Water as a Function of Location

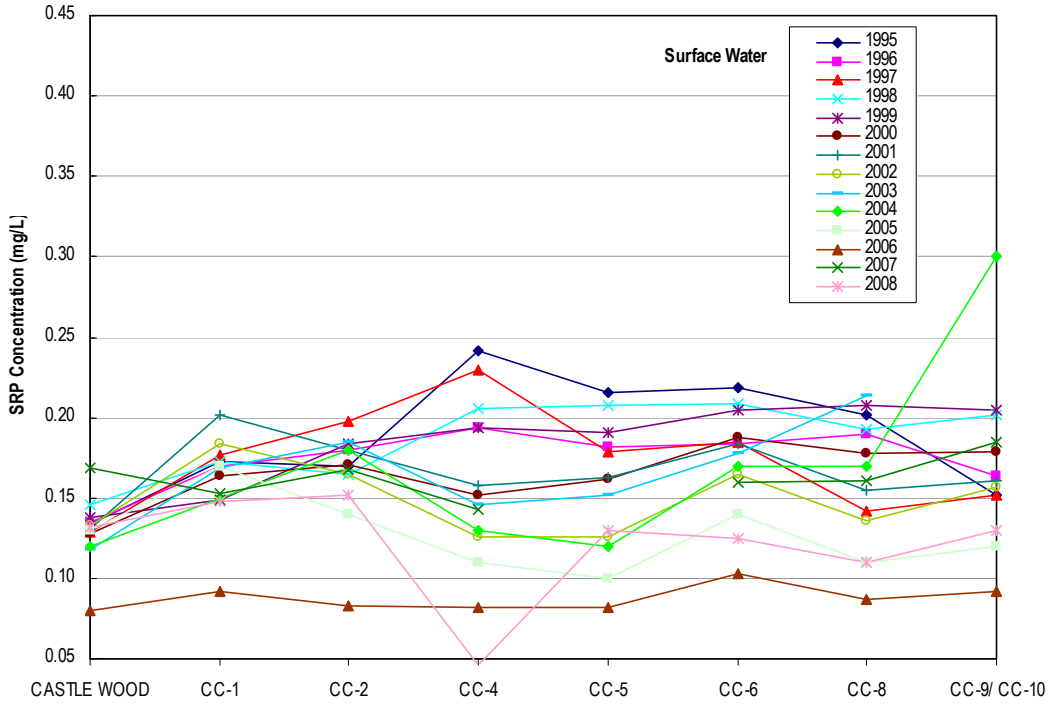
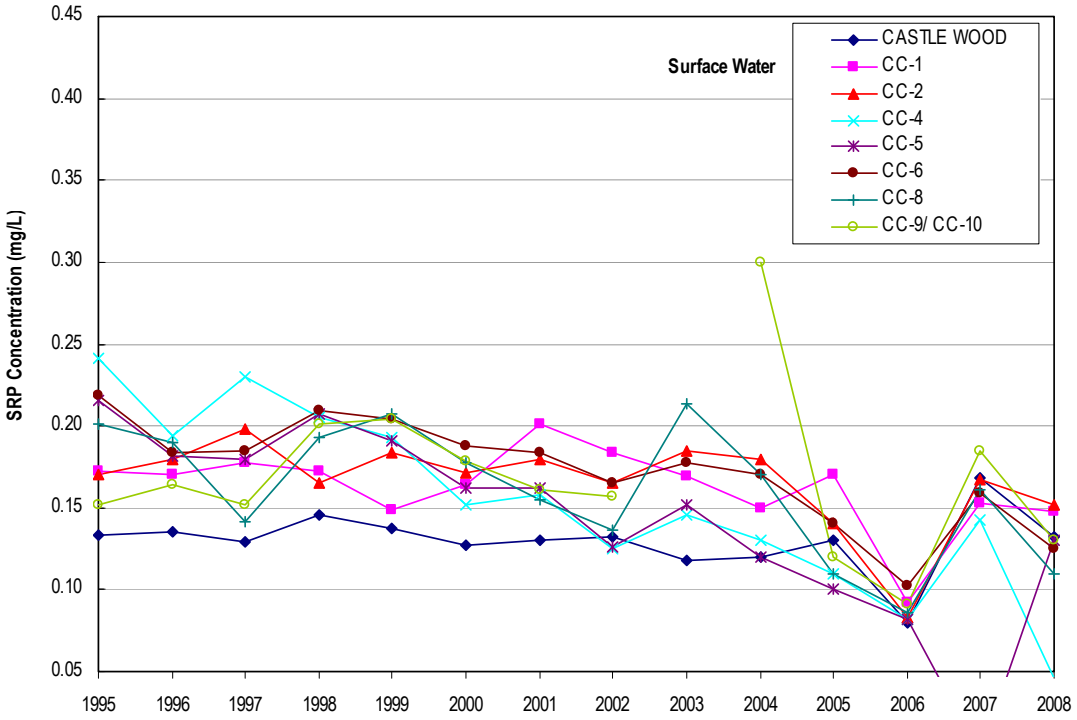


Figure 9-12. Average SRP Concentrations in Cherry Creek Surface Water as a Function of Time



9.3.2 Nitrate

- The nitrate concentrations in the underlying alluvial aquifer range from <0.1 to 12.10 mg/L, with a median of 0.80 mg/L (1994-2008). Figure 9-13 and Figure 9-14 present annual average alluvial nitrate concentrations.
- The nitrate concentrations in Cherry Creek range from <0.01 to 16.7 mg/L (the maximum from 2006) with a median of 0.16 mg/L (1994-2008). Figure 9-15 and Figure 9-16 present annual average surface water nitrate concentrations.
- As shown in Figure 9-13, there are fluctuations in nitrate concentration between sampling sites, which is not expected since nitrate is conservative and does not attenuate over distance except from dispersion and biological assimilation. The shallow water table may facilitate assimilation of nitrate by riparian plants.
- Trends in nitrate over time (1994 to present) indicate increasing trends for the most upstream and downstream Cherry Creek sites and decreasing trends for the most upstream and downstream alluvial aquifer sites (Table 9-5).

Table 9-5. Summary of Nitrate Temporal Trend Analysis

Site	Type	Trend	Slope (mg/L per year)
Castlewood	Upstream surface water	Yes, increasing	0.007
CC9/CC10	Downstream surface water	Yes, increasing	0.040
MW-1	Upstream groundwater	Yes, decreasing	-0.040
MW-9	Downstream groundwater	Yes, decreasing	-0.243

Note: To minimize the effects of seasonality, the Seasonal Kendall tau test was applied, which is a nonparametric test for trend (i.e. uses the relative magnitude of the data rather than the actual values) and removes seasonal cycles.

- Spatial trend evaluations to determine whether nitrate concentrations are significantly different between upstream and downstream sites and surface and groundwater sites are summarized in Table 9-6.

Table 9-6. Spatial Differences in Nitrate

Site	Spatial Difference in Nitrate Concentration?
Surface water upstream and downstream (Castlewood and CC9/CC10)	Yes, downstream>upstream
Groundwater upstream and downstream (MW-1 and MW-9)	No
Upstream surface water (CC1) and upstream groundwater (MW-1)	Yes, groundwater > surface water
Downstream surface water (CC9/CC10) and downstream groundwater (MW-9)	Yes, groundwater > surface water

Note: A Mann-Whitney test, which is a nonparametric test for determining if two sets of observations come from the same distribution, was conducted at a 99 percent confidence level to determine spatial differences. Non-detect values were set equal to the detection limit.

Figure 9-13. Average Nitrate Concentrations in Cherry Creek Groundwater as a Function of Location

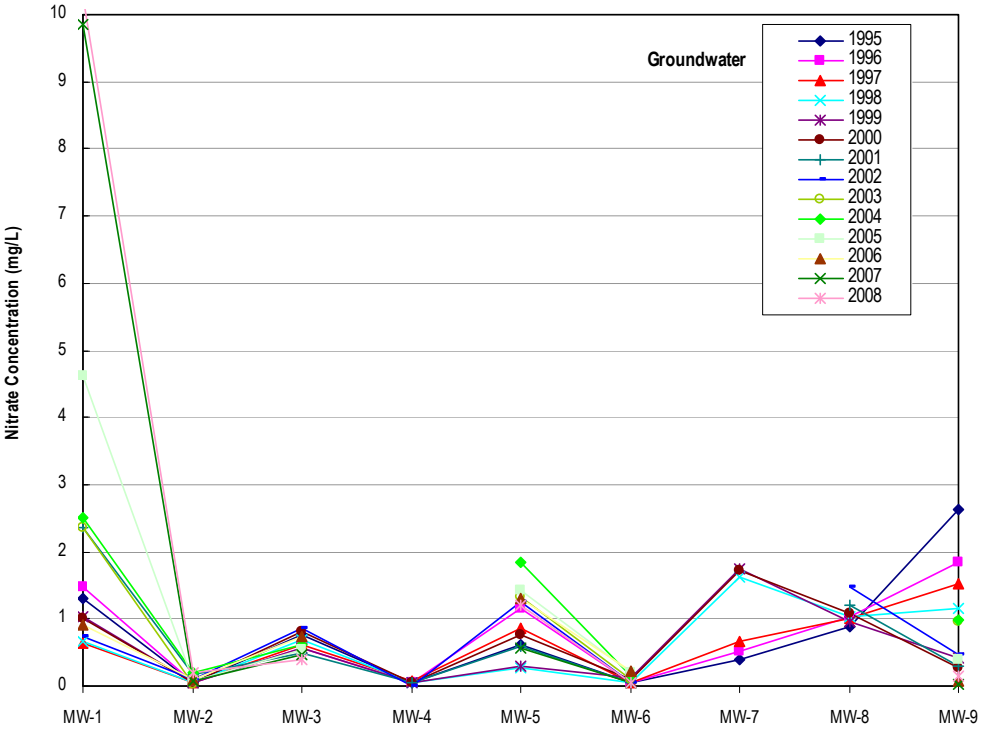


Figure 9-14. Average Nitrate Concentrations in Cherry Creek Groundwater as a Function of Time

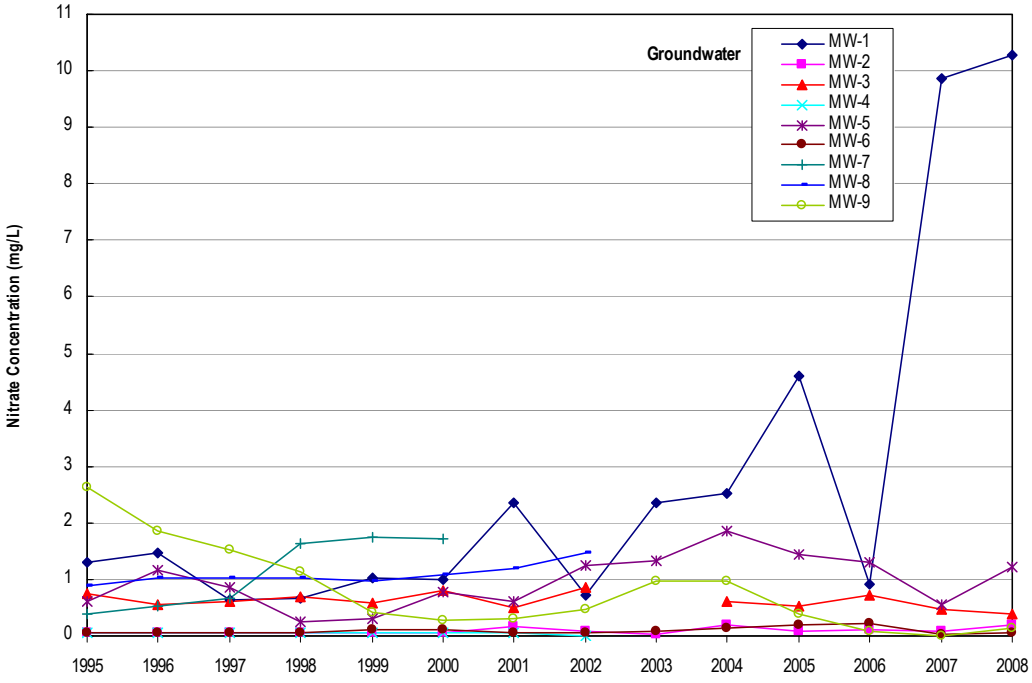


Figure 9-15. Average Nitrate Concentrations in Cherry Creek Surface Water as a Function of Location

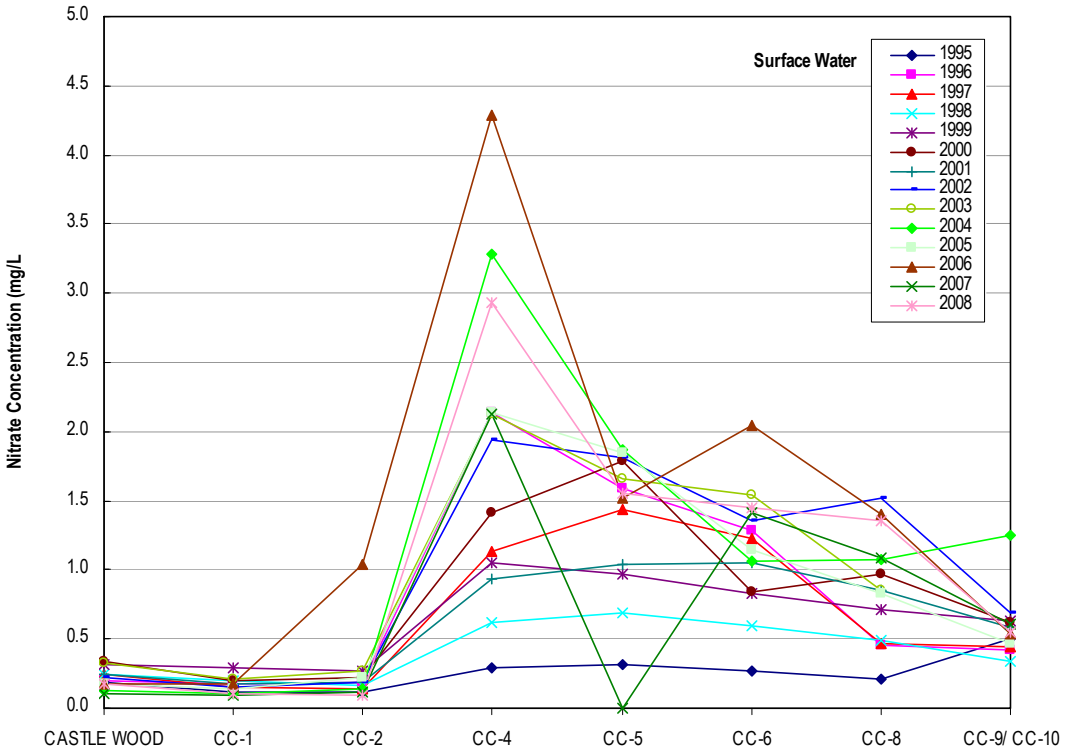
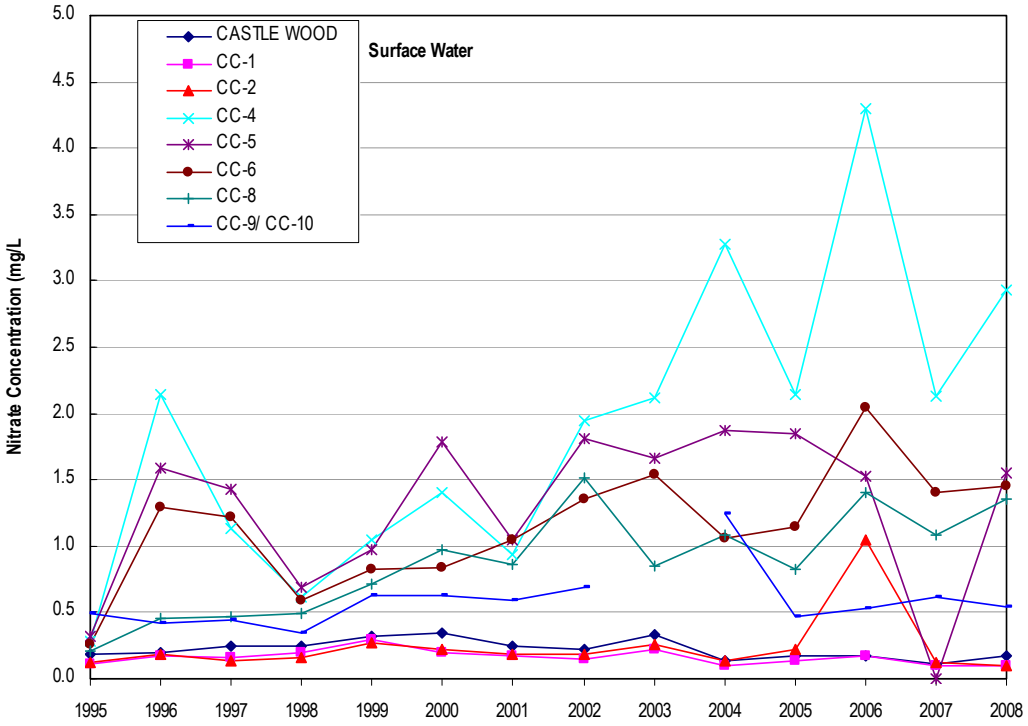


Figure 9-16. Average Nitrate Concentrations in Cherry Creek Surface Water as a Function of Time



9.3.3 Nutrient Loading

Nutrients that can limit or enhance algal growth in a reservoir have many sources, either within the reservoir (internal loading) or from outside the reservoir (external loading). Fish and plankton excrement, direct sediment re-supply, and the decay of organic matter are all internal sources of nutrients in a reservoir. Based on past modeling efforts, net internal phosphorus loading to Cherry Creek Reservoir has been estimated to be 2,000 lbs/yr (Nürnberg and LaZerte 2008). Recent studies evaluating internal loading using a variety of methodologies suggest phosphorus loading ranges between 810 lbs/yr and 1,590 lbs/yr (AMEC et al. 2005), and alluvial phosphorus loads of approximately 1,170 lbs/yr (Lewis et al. 2005). Note that the phased TMAL of 14,270 lbs/year set in the May 2001 hearing does not include internal loads.

External sources of nutrients include inflow from streams and precipitation, which carry nutrients from soil erosion, agricultural and residual runoff, treated wastewater, and airborne particulates. Phosphorus loading was determined for several primary sources in 2008, including the tributary streams Cottonwood Creek, Cherry Creek, and Shop Creek, as well as from precipitation and alluvium, as summarized below.

9.3.4 Inflowing Streams

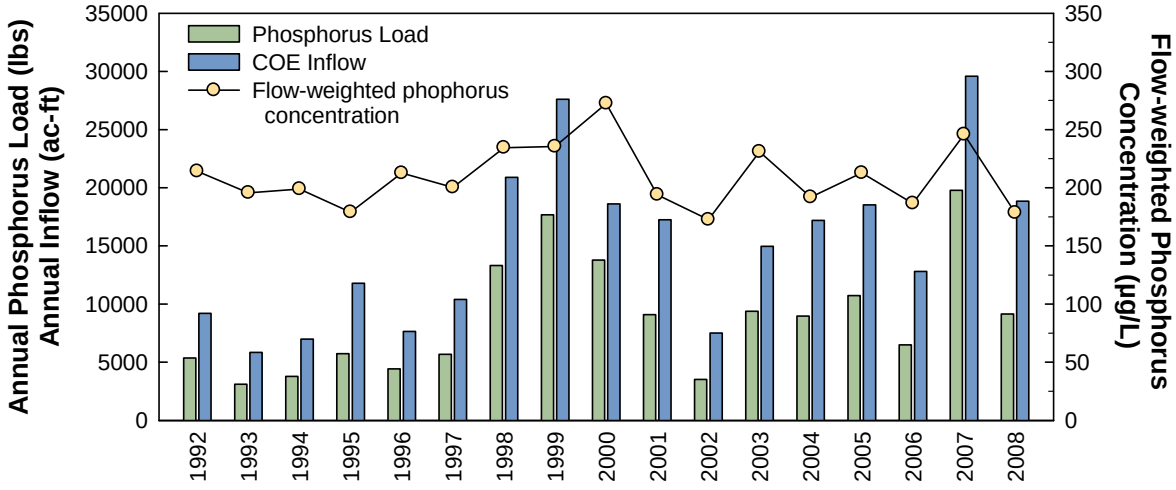
Total phosphorus loading to the Reservoir from surface flows of Cherry Creek, Cottonwood Creek, and Shop Creek was estimated at 7,879 lbs in 2008 (Table 9-7). The annual flow-weighted phosphorus concentration was 178 µg/L, which is less than the long-term median value of 200 µg/L (Figure 9-17).

Table 9-7. Estimated Net Phosphorus Loading (lbs/yr) into Cherry Creek Reservoir, 1992 to 2008

Data Source	Shop Creek	Cherry Creek	Cottonwood Creek	Subtotal for Streamflows*	Cherry Creek Alluvium	Direct Precipitation	Total External Load	Cherry Creek Export	Net Load
1992	105	3,142	408	3,925	1,010	429	5,364	1,443	3,921
1993	69	1,524	179	1,773	1,027	314	3,114	928	2,186
1994	100	2,437	164	2,700	857	227	3,785	1,055	2,730
1995	73	2,251	1,402	4,160	1,015	561	5,736	1,434	4,302
1996	95	2,467	599	3,161	916	349	4,425	1,323	3,102
1997	145	3,110	884	4,139	1,033	487	5,659	1,599	4,060
1998	162	9,963	1,633	11,840	1,033	449	13,322	4,010	9,311
1999	--	11,788	1,314	16,167	1,033	471	17,672	6,759	10,913
2000	--	10,714	1,644	12,357	1,033	398	13,788	4,426	9,362
2001	--	5,642	1,820	7,707	1,033	359	9,099	4,697	4,402
2002	--	1,815	505	2,320	916	288	3,525	1,843	1,681
2003	--	6,337	974	7,934	1,033	423	9,390	4,673	4,717
2004	--	5,710	1,753	7,486	1,033	454	8,974	3,421	5,553
2005	--	7,843	1,502	9,345	1,033	346	10,725	3,644	7,080
2006	--	3,813	1,272	5,084	1,033	375	6,492	3,287	3,206
2007	--	16,142	2,133	18,408	1,033	331	19,772	8,042	11,730
2008	--	7,121	758	7,879	1,015	250	9,144	4,828	4,316
Mean	107	5,989	1,114	7,434	1,005	383	8,823	3,377	5,445
Median	100	5,642	1,272	7,486	1,033	375	8,974	3,421	4,316

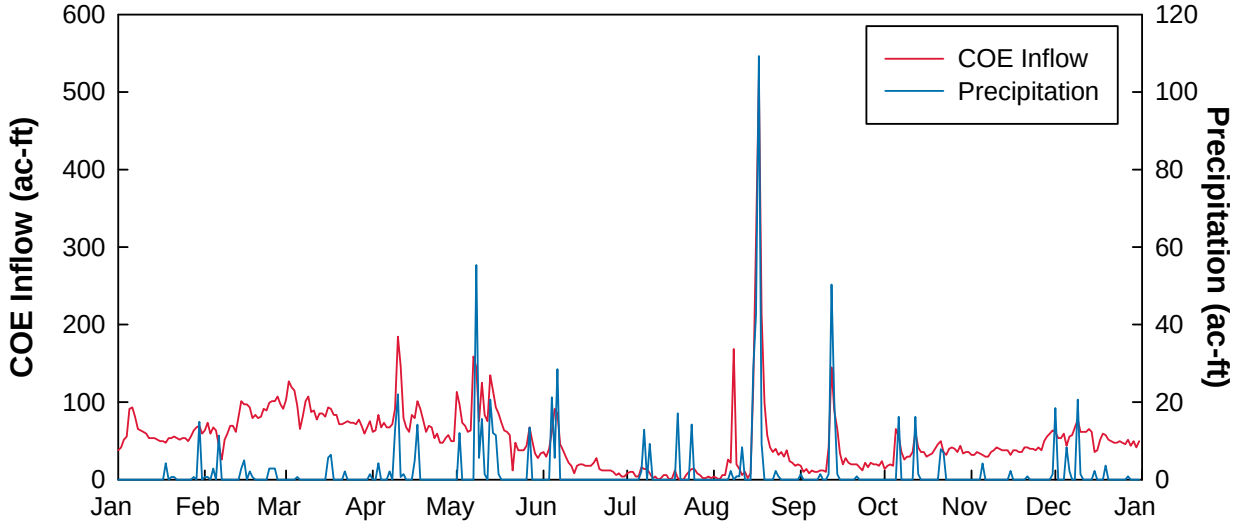
**Includes ungaged residual load.*

Figure 9-17. Long-Term Trends in Total Phosphorus Load (lbs/yr), Inflow (ac-ft/yr), and Standardized Phosphorus Load (lbs/ac-ft) from Cherry Creek Reservoir, 1992 to 2008



Inflow data, measured as the change in reservoir elevation by the COE, was influenced by storm flow events in May, June, and August 2008 (Figure 9-18). The total inflow for 2008 was 18,841 ac-ft which is slightly greater than the long-term median of 14,953 ac-ft/yr.

Figure 9-18. Comparison of Direct Precipitation on the Reservoir and Inflow for 2008



9.3.5 Precipitation

Total annual precipitation in 2008, as measured by the KAPA rain gage located at Centennial Airport approximately 4.3 miles due south of Cherry Creek Reservoir, was 11.2 inches (Figure 9-18). This value is less than the long-term median (1987-2008) of 16.6 inches.

Given the approximate surface area of Cherry Creek Reservoir (852 acres), and the long-term (1995-2005) median total phosphorus concentration (116 µg/L) for precipitation events, total phosphorus loading was estimated to be 250 pounds for 2008.

9.3.6 Outflow

The COE daily outflow and monthly total phosphorus concentrations from the outlet structure at the base of the dam near Interstate Highway I-225 were used to estimate the total phosphorus export of 4,828 lbs from the Reservoir via the outflow structure in 2008 (Table 9-7).

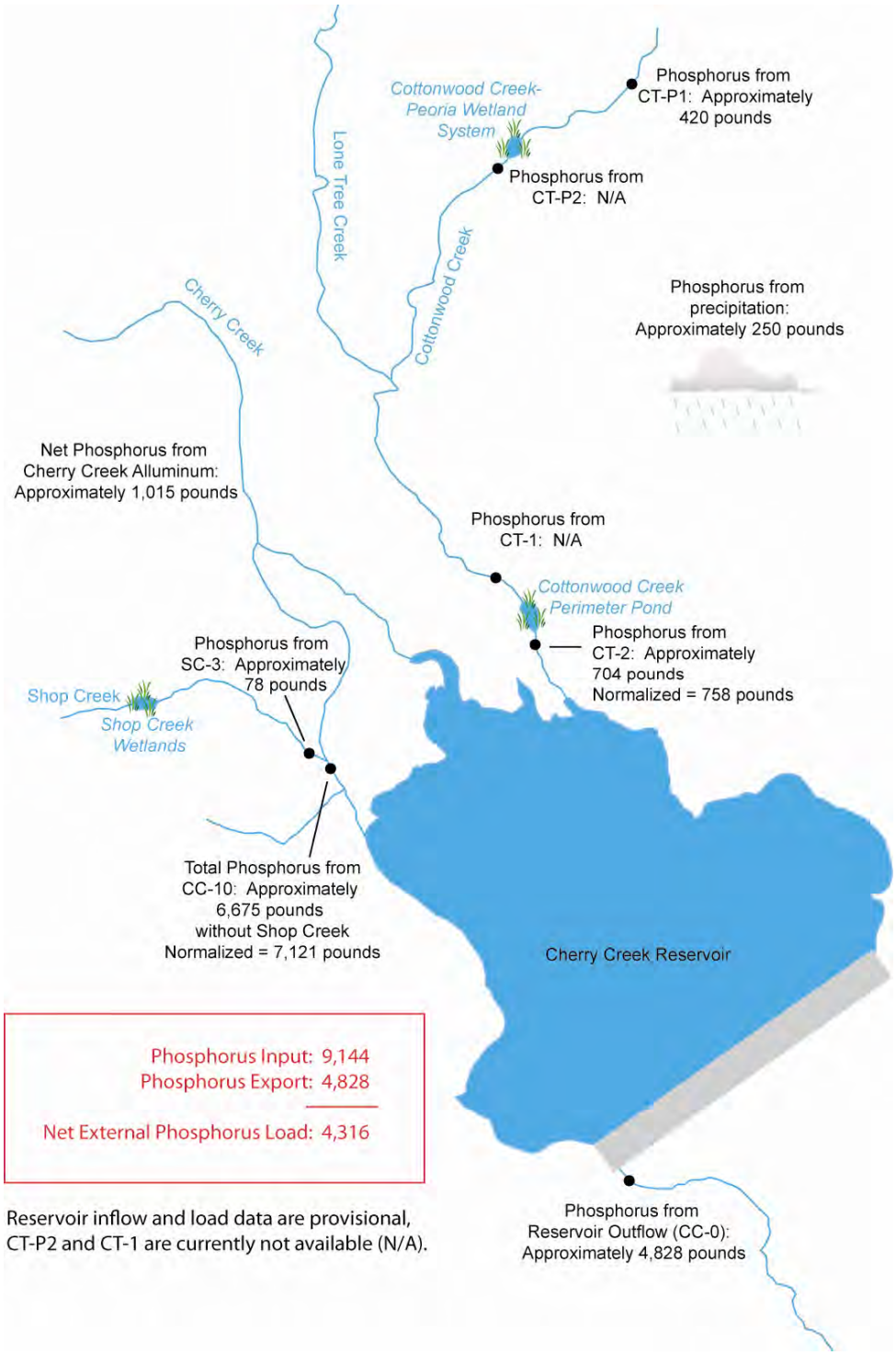
9.3.7 Alluvial Phosphorus

The alluvial phosphorus load for 2008 is 1,015 lbs. The 2008 load estimate utilizes an alluvial water budget value of 1,965 ac-ft/yr, which was normalized to the COE annual inflow, and a long-term median total dissolved phosphorus concentration from MW-9 of 190 μg/L.

9.3.8 Mass Balance Loadings for Phosphorus

In general, the phosphorus load budget for Cherry Creek Reservoir is comprised of phosphorus inflow (influent streams, precipitation, and alluvium) and Reservoir outflow. During 2008, phosphorus contribution from precipitation was an estimated 250 lbs, influent streams contributed 7,879 lbs, and alluvial inflow contributed 1,015 lbs (Figure 9-19) for a total load of 9,144 lbs. Outflow from the dam contained an estimated 4,828 lbs in 2008. After totaling the additions and losses, the net loading of phosphorus was estimated at 4,316 lbs during 2008 (Table 9-1). The 2008 flow-weighted phosphorus concentration of 178 μg/L represents one of the lowest observed concentrations entering the Reservoir (Table 9-1 and Figure 9-19).

Figure 9-19. Mass Balance Diagram of Phosphorus Loading in Cherry Creek Reservoir, 2008



9.4 Evaluation of PRFs

PRF effectiveness is gauged by monitoring the concentration of phosphorus and suspended solids and the phosphorus loading upstream and downstream of each facility. The effectiveness of the pollution reduction facilities constructed on Cottonwood Creek show mixed results in 2008, primarily due to the maintenance performed on both PRFs. The Cottonwood Creek-Peoria Pond was drained from January 17t to May 4, 2008 to facilitate the removal of accumulated sediment, while the Cottonwood Creek Reclamation Phase II project was conducted from March 26 to July 3, 2008. During these periods, the flow of water bypassed the ISCO stream flow monitoring gages, resulting in no available flow or load data for those periods.

9.4.1 Cottonwood Creek-Peoria Pond

The Cottonwood Creek-Peoria Pond structure came on line midway through 2002. As such, the values from 2002 represent less than a full calendar year (i.e., only July - December 2002). In 2008, the mean total phosphorus concentration both upstream and downstream of the PRF was different (Table 9-8), although the total suspended solids concentrations were similar. Following the maintenance on the PRF, it appeared to be very efficient in reducing phosphorus and slightly less efficient in removing suspended solids. The flow-weighted phosphorus concentration upstream of the PRF was 116 μg/L, while the flow-weighted concentration downstream of the system was 86 μg/L. The total phosphorus load downstream of the PRF system was reduced by 37 percent.

Table 9-8. Annual Historical (2002 to 2007) Total Phosphorus and Total Suspended Solids Concentrations Through the Cottonwood Creek-Peoria Wetlands System

Parameter	Year	Sampling Sites		Difference	Percent Reduction
		CT-P1	CT-P2		
Average Total Phosphorus Concentration (µg/L) (baseflow and storm samples combined)	2002	138	152	+ 14	(10)
	2003	101	92	- 9	9
	2004	142	123	- 19	13
	2005	92	101	+9	(9)
	2006	132	133	+1	(1)
	2007	179	125	-54	30
	2008	101	77	-24	24
	Mean	126	115	-12	8
Average Total Suspended Solids (mg/L)	2002	66	79	+ 13	(20)
	2003	31	34	+ 3	(10)
	2004	87	53	- 34	39
	2005	47	51	+4	(9)
	2006	38	47	+9	(24)
	2007	79	42	-37	47
	2008	37	35	-2	5
	Mean	55	49	-6	4
Loading of Total Phosphorus (lbs)	2002	142	89	-53	37
	2003	628	620	-8	1
	2004	839	897	+58	(7)
	2005	621	633	12	(2)
	2006	705	533	-172	24
	2007	1,106	732	-374	34
	2008	343	216	-127	37
	Mean	626	531	-95	18

9.4.2 Cottonwood Creek Perimeter Pond

During 2008, the mean concentration of total phosphorus in Cottonwood Creek Perimeter Pond increased from 65 to 76 µg/L after passing through the PRF system (Table 9-9). The mean concentration of total suspended solids also increased from 30 mg/L upstream to 56 mg/L downstream of the pond. In addition, the total phosphorus load increased downstream of the pond from 362 lbs to 454 lbs, although the flow-weighted phosphorus concentrations were very similar, 73 µg/L and 74 µg/L, respectively. An expected consequence of the Cottonwood Creek Reclamation project was the short-term loss in efficiency of the Perimeter Pond. This was evident in the phosphorus and suspended solids data collected upstream and downstream of the PRF in 2008. However, once the newly constructed Cottonwood Creek channel stabilizes, and the maintenance of the Perimeter Pond (i.e., sediment removal) is performed in 2009, the PRF is expected to function more efficiently.

Table 9-9. Annual Historical (1997 to 2007) Total Phosphorus and Total Suspended Solids Concentrations Through the Cottonwood Creek Stormwater Detention Pond

Parameter	Year	Sampling Sites		Difference	Percent Reduction
		CT-1	CT-2		
Annual Average Total Phosphorus Concentration (µg/L) (baseflow, storm samples combined)	1997	200	133	-67	34
	1998	289	210	-79	27
	1999	158	157	-1	1
	2000	187	149	-38	20
	2001	165	114	-51	31
	2002	146	143	-3	2
	2003	144	129	-15	10
	2004	212	151	-61	29
	2005	180	142	-38	21
	2006	170	161	-9	5
	2007	213	148	-65	31
	2008	65	76	11	(17)
	Mean	177	143	-35	16
Annual Average Total Suspended Solids (mg/L)	1997	207	87	-120	58
	1998	311	129	-182	59
	1999	267	68	-199	74
	2000	96	64	-32	33
	2001	79	43	-36	46
	2002	130	79	-51	39
	2003	84	62	-22	26
	2004	155	77	-78	50
	2005	126	66	-60	48
	2006	86	95	9	(9)
	2007	81	71	-10	12
	2008	30	56	26	(87)
	Mean	138	75	-63	29
Annual Loading of Total Phosphorus (lbs)	1997	2,359	614	-1745	74
	1998	1,556	1070	-486	31
	1999	1,140	984	-156	14
	2000	1,617	1057	-560	35
	2001	1,181	1212	31	(3)
	2002	636	801	165	(26)
	2003	1,356	864	-492	36
	2004	2,023	1433	-590	29
	2005	1,575	1725	150	(10)
	2006	1,924	1220	-704	37
	2007	2,244	1,854	-390	17
	2008	362	454	92	(25)
	Mean	1,498	1,107	-390	17

9.5 Historical Sampling of the PRFs on Shop Creek and Quincy Drainage

Historical sampling of the PRFs on Shop Creek and Quincy Drainage indicates efficient phosphorus removal in these streams. Shop Creek was monitored from 1990 to 2000 and revealed an average phosphorus load reduction of 173 lbs, equating to an average of 63 percent reduction in load. Quincy Drainage was even more efficient with 99 percent reduction in loads over the period of 1996 through 1999. The average phosphorus load reduction was 138 lbs.

9.6 Status of Water Quality

In 2008, the July through September mean chlorophyll *a* content in Cherry Creek Reservoir was 16.6 μg/L, which exceeded the standard of 15 μg/L. This standard has only been met four times in the past seventeen years, meaning non-attainment of the 15 μg/L nine-out-of-ten years chlorophyll a standard. The seasonal mean of total phosphorus (118 μg/L) exceeded the current goal of 40 μg/L. The 2008 annual phosphorus load was 9,144 lbs which met the phased TMAL of 14,270 lbs.

9.7 Progress Made

- The Authority completed annual water quality monitoring and analysis for the Reservoir, Watershed, alluvium, and selected PRFs in accordance with the Sampling, Analysis, and Quality Assurance Work Plan.
- The Cottonwood Creek-Peoria Pond PRF showed improvement in removing total phosphorus from the stream flows following the maintenance of the PRF in 2008. The flow-weighted phosphorus concentration was less downstream of the pond as compared to flow-weighted concentrations upstream of the system.
- The efficiency of the Cottonwood Creek Perimeter Pond PRF was affected by the Phase II reclamation project upstream of the pond, which appears to have resulted in greater sediment and phosphorus loads to the PRF during and post construction. This is a short-term negative effect on the PRF, and once the new channel stabilizes the PRF is expected to function more efficiently.
- The total phosphorus load to the Reservoir met the TMAL.
- There has been a statistically significant decrease in seasonal whole-reservoir chlorophyll *a* concentrations since 1999, with the 2008 seasonal mean concentration of 16.6 μg/L.

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10. IMPLEMENTING WATERSHED PLAN 2003 RECOMMENDATIONS

Recommendations and specific opportunities for improving water quality can be found in the Watershed Plan 2003. The Watershed Plan 2003 and recommendations were developed by an independent consultant under the direction of the Authority. The Board has adopted the Watershed Plan 2003 and will consider these recommendations. Listed below are the recommendations provided in the Watershed Plan 2003 and progress made during 2008.

- Consider various funding options to achieve capital budget increase of $2 million to $4 million annually.
  - The Board is focusing on meeting the 60 percent spending requirement for capital projects and does not currently need to increase revenues for capital projects.
- Implement the Cherry Creek Reservoir Watershed Plan 2003 as a coordinated management program.
  - Watershed Plan 2003 recommendations are incorporated into the Five-Year Capital Improvement Project Work Plan and assist in prioritizing and determining activities for completion.
- Fund, design, and construct high priority stream improvements.
  - The Authority included funds in the 2008 annual budget for potential stream corridor preservation partnering opportunities.
- Design and construct additional pollutant reduction facilities.
  - Began operation of the Reservoir destratification project.
  - Completed Phase II of the Cottonwood Creek Reclamation PRF.
  - Completed repairs on Cottonwood Creek Reclamation Phase I project.
  - Completed operation and maintenance to the existing PRFs,
- Work with land use agencies and the Water Quality Control Division to refine and strengthen regulated stormwater requirements and recommended changes to Section 72.7 of Control Regulation 72.
- Encourage local governments to provide developer incentives to preserve and enhance stream corridors.
  - Continue to review land use applications and provide land use agencies and developers with comments and recommendations consistent with the Authority's Requirements.
- Explore options to reduce septic system loading in Cherry Creek.
- Promote reuse of wastewater through land application.
- Conduct special studies to optimize water quality improvements.
- Develop and implement a comprehensive public involvement plan.
  - Continued support the Cherry Creek Stewardship Partners in implementing its significant efforts through the Education Initiative.
- Consider participation in several federally funded programs that support sustainable agriculture and habitat protection and restoration.
- Coordinate with other stormwater Phase I and II entities and efforts.
  - The Authority regularly interfaces with land use agencies and stormwater permittees to answer questions and provide guidance for enhanced BMPs.

Cherry Creek Reservoir did not meet the chlorophyll *a* standard in 2008, and the Reservoir did not meet the accompanying phosphorus concentration goal. The phosphorus loading to the Reservoir continues to be below the TMAL. The 2008 Reservoir data, as well as the long-term monitoring indicate the relation between chlorophyll *a* and phosphorus concentrations (or between phosphorus concentration and load) needs consideration. With the addition of six years of Reservoir data (since 2000), the Authority updated the Reservoir model to evaluate these relationships in the Reservoir, refine the TMAL, and evaluate the achievable load and concentration reductions in the Watershed.

The Authority's management strategies have focused on the Watershed, including the construction of PRFs that have shown to be effective in reducing phosphorus loads and concentrations. The Authority believes watershed management strategies are beneficial over the long term, but it has taken several years to see improvements to Reservoir water quality. The Authority completed construction of the Reservoir destratification system, and began operations for the 2008 growing season. This project is intended to help achieve continued improvements to Reservoir water quality in conjunction with the Authority's continued efforts to develop and implement watershed management strategies as a priority.

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ATTACHMENT A

Cherry Creek Stewardship Partners 2008 Annual Report

Cherry Creek Stewardship Partners

2008 Annual Report

"Providing a forum for promoting stewardship of the Cherry Creek Watershed" *January 2009*

2008 in Review: Partners Outreach in Action!

Audubon Raptor Walk, January 26th: *The Open Space Committee hosted this annual Denver Audubon Society field trip along the Cottonwood Creek riparian area.*

Metro Regional Science Fair, February 27 & 28: *The Education Committee provided judging & awarded prizes on behalf of the CCBWQA & SPLASH Group.*

Walk the Watershed @ the CC Valley Eco Park, March 22: *A new semi-annual Partners effort to engage basin residents in learning about the nature of Cherry Creek through an ecological assessment of the Park during the spring equinox.*

Colorado Science & Engineering Fair, CSU, April 10th and 11th: *The Partners emphasized the integration of watershed interests and science curriculum.*

17-Mile House Park Planting, April 12th: *Partners from Arapahoe & Douglas counties and Town of Parker joined Boy Scouts for a day of planting and learning.*

Science Fair Projects at CCBWQA Board, April 17th: *The winning science projects awarded a cash prize on behalf of the CCBWQA were presented to the Board.*

WEED Better Pull Together @ Tagawa Gardens, April 14th: *The Partners hosted a booth w/ info on how local residents can help in combating noxious weeds.*

CO Dept of Education Service Learning Symposium, May 2nd: *Hands-on training for local area teachers, highlighting field trips and stewardship opportunities.*

Southeast Denver Duck Drop, George Wallace Park, May 4th: *Another chance to get young and old involved in water resource concepts with this fun activity.*

13th Annual Aurora Water Festival, May 13th: *Partners actively participate in this well-attended outreach to students and educators regarding water issues.*

WEED Network Meeting, May 22nd: *The Partners hosted a meeting of state and local weed experts to further efforts at a regional approach to noxious weed controls.*

Troop 373 Inlet Stenciling Project, May: *The Partners & SPLASH participated in a Eagle Scout project to label inlets in Arapahoe County's 4-Square Mile area.*

5th Project WET Teacher Training & Service Learning Workshop, Aurora, June 10th: *Hands-on training for local area teachers, promoting the EdKit.*

Butterfly Extravaganza, June 21st: *Held at the Eco Park in Centennial, local volunteers searched for butterflies and other creatures to mark the summer solstice.*

Annual Teachers Workshop, July 1st, 8th, 15th, and 22nd: *The Partners hosted the teachers at several Cherry Creek locations to promote stormwater education.*

Lake Appreciation Day, July 25th: *Cottonwood Creek and CCBWQA hosted Americorps volunteers for a day of cleanup and 'health of the watershed' assessment.*

Maintenance Support, Cherry Creek, summer 2008: *The Partners Casey Davenhill planned, hosted and supervised several maintenance support activities with over 50 Americorps youth volunteers, re-building trails, monitoring riparian areas, pulling weeds, planting, you name it, they did it!*

4th Annual Run for Watershed, September 27th: *see article, page 2.*

10th Annual Watershed Conference, "*Leveraging Collective Expertise*", November 7th: *see article, page 2.*

Winter's Solstice, December 27th: *Another visit to the CC Valley Eco Park to round out the Partners 2008 habitat assessment.*

"Classroom Visits and Field Trips, 2008: *West Middle School, Cole Middle School, Slavens Elementary School, Grandview High and Castle View High School.*

"Boy Scout Troop 117 field projects, 2008: *Four Eagle projects with Troop 117 at Cherry Creek State Park and three 'working explorations' at 17-Mile House Park.*

Volunteers getting ready for Lake Appreciation Day efforts

Casey's Corner: "What Stewardship means to the Partners...

Participation on the Technical Advisory Committee (TAC) for the Cherry Creek Basin Water Quality Authority took on added importance in 2008 as 'Modeling' was finalized *(see Modeling Efforts, page 2)*. Now I don't think I'm giving anything away by saying that even the experts don't always agree. What I will say for sure is that meeting regulatory requirements is a primary motivator for concerted action to protect water quality in the Cherry Creek basin. As arguably the least 'technical' member of the TAC, I felt I could best serve by listening and trying to make the connection between the data and the decision making. Is the goal to achieve the 15 micrograms of *chlorophyll a* per liter of Cherry Creek reservoir water or is the goal a healthy watershed where people receive real value for their investment in water quality?

All the efforts of the Partners are aimed at increasing understanding and appreciation of the entire 385 square mile Cherry Creek watershed. The science and technology needed to protect water quality have prompted the direct investment of millions of dollars through the Basin Authority and its member agencies in an effort to protect resources under their care. Ultimately, it is the residents of the watershed who pay for its stewardship. By providing opportunities to 'go outside' and explore, the Partners aim is to bring area residents in touch with the treasure their investment is meant to protect *(see Working Committees, page 2)*. By supporting Partners' efforts to make science and community service opportunities available to local teachers and youth groups, our sponsors are sparking the imagination and creativity of area students and their parents. We need these kids to understand the complexities and appreciate the importance of resource management. And I need these kids to help me understand the Reservoir Model! Learning from each other…that sounds like our model for active watershed stewardship.

EdKit habitat assessment activity at Cherry Creek

Cherry Creek Stewardship Partners

Casey Davenhill, Watershed Coordinator
415 S. High Street
Denver, Colorado 80209 303-345-1675 (ph) 303-744-1752 (fax)
www.cherry-creek.org ***casey@cherry-creek.org***

The Cherry Creek Stewardship Partners mission is to provide a forum for promoting stewardship of the Cherry Creek watershed.

The *Partners* is an informal association of a broad range of stakeholders actively promoting effective stewardship of Cherry Creek and other local watersheds. The *Partners* bring together land use jurisdiction staff, state and federal resource management agencies, conservation, recreation, and historic preservation groups, the business community, and interested citizens. Please contact us if any of the Partners working groups are of interest.

Working Groups

Executive Committee – Administration and strategic planning.
Chair: Bob Toll, 720-874-6500
Education and Outreach Committee – Active in citizen outreach and education; host community meetings.
Chair: Darren Mollendor, 303-446-3588
Water Quality Committee – Promotes watershed sustainable approaches; assists the Cherry Creek Basin WQ Authority TAC.
Chair: Lanae Raymond, 303-858-8844
Open Space, Habitat and Trails Committee – Coordinates stewardship aspects of recreational trails, noxious weeds, and resource management; host volunteer days.
Chair: Toby Sprunk, 303-660-7334

2008 Conference

10th Annual Conference: ***Leveraging Collective Expertise for Stewardship***

Friday, November 7, 2008 @ the Wildlife Experience, @ Peoria and Lincoln

The Partners have solidified their role of providing a forum for stewardship opportunities by hosting an **annual conference** where participants have the opportunity to consider ways to coordinate and integrate projects and activities that affect water resources in the watershed. The focus for the conference in 2008 was the varied agencies at work in the basin. General sessions included:

- **Partners Investing in Good Planning and Science**: Efforts being utilized to further the planning and scientific expertise include UDFCD's ALERT flood warning program, the Basin Authority's Special Studies, DRCOG's 208 oversight, and CWCB's Chatfield Reservoir efforts.
- **Partners Maximizing Beneficial Uses of the Reservoir**: The Army Corps of Engineers shared a pictorial history of the dam and reservoir; the Basin Authority updated us on the reservoir de-stratification project; and State Parks shared their 'user experience' perspective.
- **Partners Strengthening the Recreation Fabric of Urban Life:** Presentations included the Parker Jordan Metro District and their efforts on a new trailhead; Wenk and Associates on efforts to combine shoreline stabilization with enhancing the fishing experience at the reservoir; and the State Division of Wildlife's analysis of the fishery, long term, past and present, and the effects of the aeration on the fishery.

All of this information & the wonderful atmosphere of the Wildlife Experience! We hope you can participate again in 2009, so join us **Wednesday, November 4th!**

Also at the conference, Annual Awards were presented by the Conference Committee to very worthwhile recipients, including **Jenny Dallman**, science teacher at Castle View High School (Educator Award), **Boy Scout Troop 117** (Stewardship Award), and the **City of Glendale** (Agency Award). In addition, the Partners took this chance to recognize the **2008 "Run for the Watershed" award winners** (*see below*). Also, **Paul Hindman, UDFCD Executive Director,** was recognized for his many years of 'demonstrating a pioneering sense of awareness and stewardship of land-use values' with the prestigious **Jane Silverstein Ries Foundation** award. Congratulations to all the award winners!

Thanks again to the Executive Committee who assisted with the conference planning, **Lanae Raymond**, Southeast Metro Stormwater Authority (SEMSWA) (conference development & content, poster exhibits and silent auction); **Paul Hindman**, UDFCD (content & insurance); **Bob Toll**, Arapahoe County Open Space (content & awards), **Casey Davenhill** (logistics, awards, & silent auction), and **Terry Baus**, Denver Public Works (content).

Cherry Creek "Run for the Watershed"

The Partners hosted their 4th Annual Cherry Creek **"Run for the Watershed" Race** through the beautiful Cherry Creek watershed. The relay race, 50 miles in length, traversed Douglas and Arapahoe counties, sprinting through Parker, Centennial, Greenwood Village, and Denver before rolling into Cherry Creek State Park for the finish. The Race Committee, led by **Bob Toll and Paul Hindman**, with logistics assistance from Casey Davenhill and Lanae Raymond, were thrilled with the enthusiasm of the 12 teams and over 150 participants. Volunteer-hosted exchange points added to the festive spirit, as did aid stations hosted by ACWWA, SEMSWA, and the SPLASH group.

All teams felt like they were winners at the end, but some were recognized with an award during the post-race festivities:

- Relay Winner: **Design Concepts**, *Kurt Munding, Captain*
- 2nd Place Relay: **Urban Drainage**, *Paul Hindman, Captain*
- 3rd Place Relay: **C/C of Denver**, *Alan Polansky, Captain*
- Fastest Finish: **CH2M Hill**, *Scott Yanigahara, Captain*
- Annual Traveling "Spirit Award": **Parker Boot Camp**, *Kimberly Thoman, Captain*

The race date in 2009 is **September 26th.** A flyer & entry form is provided in this newsletter and the race logistics brochure will be available spring 2009 to allow plenty of training time…. see you on the trails!

Contact: Bob @ rtoll@co.arapahoe.co.us

Cherry Creek Basin Authority Modeling Efforts

From mid 2006 through August, 2008, the Authority developed a Watershed Model to calculate total phosphorus loads and water yield from the watershed into the Reservoir, with the capability of predicting long-term trends in water yield (i.e.: runoff volume) and phosphorus loads as the result of changes in the watershed. Also, during the same time period, the Basin Authority retained Freshwater Research to update the Reservoir Model (originally completed in 2001) to incorporate 6-additional years of data, re-evaluate correlations between *chlorophyll a* and nutrients, and provide a scientific basis for recommending a new *chlorophyll a* standard (22 ug/l to replace 15 ug/l) and compliance schedule (four out of five years instead of nine out of ten years) for the Reservoir. The Reservoir Model can be used for different scenarios and sensitivity studies to evaluate future growth impacts and best management practices (BMP) effectiveness in the watershed.

The Watershed Model was developed in Microsoft Excel with Visual Basic programming to perform a majority of the calculations. The Model was developed in a collaborative manner by a modeling team comprised of six watershed consultants (GEI, Halepaska, Lytle Water Solutions, Brown and Caldwell, Max Grimes, and Bill Ruzzo). Also representatives from the State's Water Quality Control Division (WQCD), and local municipalities participated. During the development process, data and algorithms were evaluated by the modeling team to ensure that the hydraulic and physical processes that control fate & transport of phosphorus in the watershed were reasonably simulated. The purpose of the Watershed Model is to predict total phosphorus loading into the Reservoir under different land use scenarios, hydrologic conditions, and watershed management.

The process to revise the Control Regulations that determine the standard for Cherry Creek Reservoir will be ongoing through 2009, with the final standard set to take effect in January 2010. See www.cherrycreekbasin.com for complete details about the Basin Authority modeling efforts.

Cherry Creek Initiative

Cherry Creek , looking north towards the Reservoir

We all know Cherry Creek is one of the most recognizable and treasured natural assets in the south metro Denver area: Confluence Park, Cherry Creek Dam, 17-Mile House and Park, Prairie Canyon Ranch, and miles and miles of trails that wind through Douglas, Arapahoe and Denver counties and links these communities together. On September 25th, Arapahoe County issued a challenge to the other entities in the basin - $3 Million in challenge, to be exact, which would be used to help leverage new dollars for conservation in the Cherry Creek basin for future improvements, such as adding open space buffers and connecting trails in an effort to beautify and enhance Cherry Creek. These efforts will build upon the Cherry Creek Basin Open Space Conservation and Stewardship Plan, which was developed in 2002 and identifies priority conservation areas and outlines a land conservation strategy for one of the region's most rapidly developing areas.

Arapahoe County is hoping to capture the same enthusiasm and success of the South Platte Working Group, a coalition of 19 cities, towns and local organizations working to conserve land, clean up open space and improve connections to the South Platte River. Since 2006 the South Platte Working Group has secured more than $28 million in funding, including a Legacy grant from Great Outdoors Colorado; acquired several parcels; began a planning process and won the Denver Regional Council of Government's highest honor – a gold award – for their collaborative work to protect the South Platte. The Partners will have a strong role in this effort, so stay tuned and get ready for the challenge!

Cherry Creek Stewardship Partners

2008 Accomplishments

Eagle Scout Projects

2008 "Run for the Watershed" Relay Race

10th Annual Cherry Creek Conference

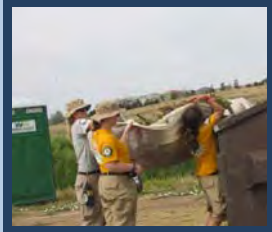
MS4 Permittee Assistance

Cherry Creek Stewardship Partners

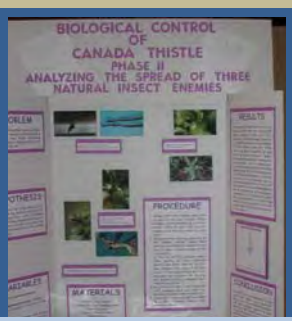
2008 Accomplishments

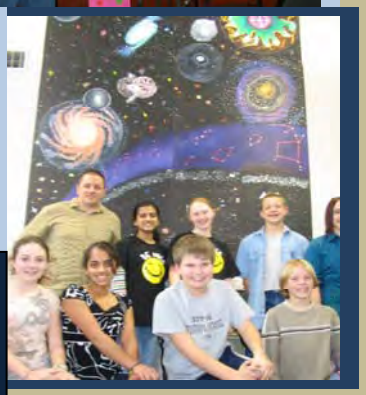
Biology & CAEE Teacher Workshops

Watershed Stewardship



Americorps and NCCC Youth Volunteers





2008 Youth Science Fairs

5th Annual
Cherry Creek "Run for the Watershed" Relay Race

September 26, 2009
7:00 am

Celebrating the splendor and diversity of the watershed, from the top of the basin, downhill to Cherry Creek State Park

50 Mile Relay Race

The **Annual Cherry Creek Watershed Relay Race** is approximately 50 miles in length, and brings your team from the top of the watershed to the reservoir at Cherry Creek State Park, running through Douglas and Arapahoe counties, and the cities and towns of Franktown, Parker, Centennial, Aurora, Greenwood Village and Denver. The race has 13 legs, with 3 reserved as walking legs.

Along the way, you will be running through some very special terrain, indicative of the varied ecosystems within a watershed. The beginning of the race will see you traversing the hills and forest at the top of the watershed. Soon you will be traveling downhill to Castlewood Canyon State Park, enjoying the beauty of Cherry Creek as you run through the west canyon of the park and on to the Cherry Creek Regional Trail through Parker, going off trail onto Jordan Road in Arapahoe County, Centennial and Aurora, until you reach Cherry Creek State Park at the southern Caley Avenue entrance. As a special treat, we will be celebrating National Public Lands Day and the Fall Equinox at two of the watershed's beautiful parks, with interactive learning opportunities for Exchange Point teammates, friends and volunteers.

Once in the park, you will head north on the internal park trail, exit the park at Dayton heading north to Greenwood Village's Village Green Park, continue on the trail through Denver as you parallel the Dam Road, and then you'll head south, back into the Park, run along the swim beach and finish at the Smoky Hill group picnic area.

Team size varies, according to the race experience level of your participants. Some 'elite' teams have only 5 or 6 members to cover the race's 13 segments, while other teams have a full complement of 13 participants. The majority of teams average around 9 or 10. The segments range from 3.2 to 6 miles for the running legs, and around 2 miles for the walking legs.

The main purpose of the relay is to encourage appreciation of the watershed's natural wonders, as well as providing a race experience in a "rally" format. The "rally" part of the watershed run rewards the team that travels the race route at "typical" times. In this race we are using a 9-minute mile average for runners and a 17-minute mile average for walkers. Each team is scored based on how closely to the "calculated typical" time you arrive at each segment Exchange Point. Each Exchange Point will have points awarded based on how close to the rally time. Awards will be given for cumulated points from all checkpoints. For those teams with a "need for speed", the fastest place team will also receive an award at the finish.

We also encourage teams to show their SPIRIT! Team creativity will be rewarded at the finish with a "spirit award" for the team that brought "something special" to the race. The winning team will be representative of the group with the most team pride and sense of fun and a proud recipient of a special *traveling trophy*. Judging criteria will include the variety of ways of 'showing your spirit', on the vehicle, in your costumes, singing at the staging areas, etc. Be creative and unique, celebrate the 'fun' of the race experience, and be inspirational to others. We look forward to you joining us for this wonderful experience in *your* watershed!

The Partners organization has been actively promoting effective stewardship of the Cherry Creek watershed since 1999, and this annual Relay Race is an exciting way to showcase the watershed. The Partners are excited to co-sponsor this opportunity to 'experience the Cherry Creek watershed up-close-and-personal' with the American Public Works Association (APWA). APWA provides training and education assistance to present and future public works employees.

2009 5th Annual Cherry Creek "Run for the Watershed" – September 26th

RELAY RACE ENTRY

$20/Team member **BEFORE August 15th**

(Registrations received after August 15th increases to $25/member; and registrations received after September 15th increases to $30/member)

The race is a total of 13 legs, ranging from 3.2 to 5.9 miles for the running legs and from 2.0 to 2.3 miles for the three mandatory walking legs. You can field an elite team of 5 total participants to complete the 13 legs or have up to 13 team members, each one doing a leg. Any way you do it, the experience is unique and rewarding!

Relay limited to first 20 teams registered. *The Team Captain identified below will be notified if your team is not one of first 20 teams registered, and your check returned.*

Specify total number of Commemorative gift for team members: _____

Team Captain to complete:

Team Name: _____

Entry Fee: # of team members X $20 = $ _____(check amount)

Entry Fee must be received by August 15th or registration fees increase as noted above.

Last Name: _____ First Name _____

_____

Street Address City State ZIP

Email _____ Phone _____

As Captain, you are responsible for communicating all relay race information to your team, including team safety requirements of safety vests, caution sign for vehicle(s), wireless phone and vehicle(s) first aid kit. Please assign a runner/walker to each leg as indicated on the back of this form. You are also required to attend a mandatory team meeting the week before the race. In addition, please communicate that all team members must sign in and sign a waiver prior to staring the relay; the content of the waiver will be as follows (Actual waiver at www.cherry-creek.org)

I, the person submitting this entry, am aware that participating in an event such as a 50 mile relay is a potentially hazardous activity, and that I (or my child, if I am signing as a parent or guardian) should not so participate unless physically able. I verify that I am (or my child is) medically fit to participate and will have sufficiently trained for the event prior to participation. I (and my child, if I am signing as a parent or guardian) agree to abide by the rules and decisions of any event officials relating to participation and assume all risks associated with participation in the event and any associated event or activities, including, but not limited to, falls, contact with other participants, effects of weather such as extreme cold, snow and ice, traffic and road conditions, all such risks being known and appreciated. In consideration of acceptance of the entry fee, and intending to be legally bound, I (and my child, if I am signing as a parent or guardian) and anyone entitled to act on my (or our) behalf(s), assume all risks associated with participation and waive any and all claims whatsoever against and fully release all race day volunteers, all event promoters and sponsors and their representatives and successors from all claims damages or liability of any kind arising from my (or my child's) participation in this event. I grant full permission to any and all of the foregoing to use my (and my child's) name or photographs, videotapes and other recordings of participation in this event without obligation or liability to me (or my child). I also understand that entry fees are not refundable. I have read this agreement carefully and understand it and certify my agreement by my signature below. Note: Runners under 18 years of age must have parent or guardian's signature below.

After Casey receives completed waiver forms, your team will be given a Team Number.

Send check, to be received by August 15th, to

Cherry Creek "Run for the Watershed" Team Relay
% Casey Davenhill
415 S. High Street
Denver, CO 80209

Please make checks payable to: Cherry Creek Stewardship Partners

Water Quality Committee

Members of the Water Quality Committee participated in the Cherry Creek Basin Water Quality Authority Technical Advisory Committee (TAC) efforts, including the modeling efforts (*see article previous page*), as well as joining the other Partners committees to bring the water quality message to the forefront during Open Space, Habitat & Trails Committee and Education Committee activities. Joint efforts undertaken by the TAC members and the Partners Water Quality Committee in 2008 include the following:

- **Metro Regional & Colorado State Science Fair, Teacher Training Workshop, and Colorado Department of Education Service Learning Symposium**: *the Partners and several TAC members judged science fairs and hosted science teachers at workshops and during field trips to local creeks, and for Project WET "Discover a Watershed" training.*
- **4th Annual 'Run for the Watershed**": *several TAC and WQ Committee members organized teams to participate in the 50 mile relay race (see article previous page).*
- **10th Annual Cherry Creek Watershed Conference**: *the Basin Authority was a featured agency during the conference, with several TAC members and technical consultants as featured speakers, including talks about the Reservoir aeration project; the proposed changes to Control Reg 72, and both the Reservoir and watershed modeling efforts (see article previous page).*
- **Cherry Creek Watershed Classroom and Field Trip Implementation Kit:** *the Partners continued to implement the **"EdKit",** approved by the Basin Authority for educational applications in the watershed, with assistance by several TAC members.*

The Basin Authority Board approved the Partners budget request for continued collaboration with the TAC in 2009 to deliver a practical water quality message to residents of the Cherry Creek watershed. The Basin Authority has been a funding partner since 2002, supporting the WQ Committee in spreading the water quality message.

The integration of the Partners activities with the **State MS4 WQ Permit holders**' "measurable goal" efforts continues to be a focus of the Water Quality Committee. In 2009, the Committee will take a 5-year look-back at the 2004 Smart Growth for WQ Report to see how we are doing on the specific recommendations, and what the Partners can do to incorporate water quality goals into the Cherry Creek Initiative effort (*see article previous page*).

Contact Lanae at lraymond@semswa.org

Open Space, Habitat & Trails Committee

Did someone say **'go outside'**? The Open Space Committee starts every year off with a bang. Thanks to **Doug at the Shooting Center** at Cherry Creek State Park, participants in the annual **Hawk Walk** had a place to park, attend to their indoor needs then carpool to the site of the **Cottonwood Creek Stabilization Project**. **Mary Burger and Mike Range** provided expert guidance to find and identify birds, mammals and plants while **Bill Ruzzo** described the work that has been done to restore the natural function of Cottonwood Creek and improve water quality in Cherry Creek reservoir. Nearly 20 hardy souls turned out on the last Saturday in January, as they have for the past three years, to make this a popular and enlightening event.

The Committee meets early in January each year to set their calendar for the coming year. Various stewardship activities are planned to emphasize cooperative planning and management of open space resources. **Cooperation and stewardship** are the cornerstones of Partners activities which include year-round monitoring of wildlife and plant life at **Cherry Creek Valley Ecological Park**, Cottonwood Creek and the **17-Mile/Norton Farms Heritage Area**. In conjunction with **Douglas County**, **Arapahoe County** and the **Town of Parker**, the Partners coordinated the second willow and shrub planting event at **17-Mile/Norton Farms Heritage Area** in April.

Pulling together was the theme of summer projects promoting cross-boundary cooperation for weed control. With heroic assistance from **Americorps and Summer of Service** volunteers, hundreds of thousands of thistle seed heads were removed in the Cherry Creek corridor, with a concerted effort to keep **Scotch thistle** from invading the restoration area along Cottonwood Creek. Nearly 150 teens, young adults and parents braved the July heat to complete this essential task before devouring watermelon and cooling off at Cherry Creek swim beach. Ongoing collaborations with the **Outdoor Stewardship Institute**, **Colorado Weed Management Association**, **Tagawa Gardens** and **REI** bring more valuable resources to Cherry Creek open spaces, habitat and trails.

Contact Casey at casey@cherry-creek.org

Open Space planting by Boy Scouts at CC

Dedicated Open Space Crew Leaders in Denver

Education Committee

The Education Committee, including partners from Denver, Aurora, and Arapahoe & Douglas counties, SPLASH and SEMSWA, as well as experienced science teachers and engineers, continued to emphasize science activities that highlighted water resources in 2008. Several science education activities were carried out at the **Metro Regional Science Fair, Colorado Science & Engineering Fair, the Colorado Department of Education Service Learning Symposium, Aurora Project WET, and the Partners annual Teacher Training Workshop.** These various classroom visits, field trips and symposia promote a richer 'hands-on' experience, highlighting the messages of 'stewardship', integrating watershed interests, use of best management practices (BMPs), and overall protection of our water resources.

In 2008, the committee continued to refine their **"EdKit"**, a 'Classroom and Field Trip Implementation' project tool to enhance school activities. The **"EdKit"** includes the components of a classroom presentation using a 3D watershed model, brochures & handouts to explain the watershed concept and non-point pollution. Volunteers facilitate a field trip to a local drainageway highlighting water quality concepts. The final activity supports either a physical, biological & chemical assessment of habitat or an inlet identification and labeling effort near the school's home campus as a way of completing the learning experience. **EdKit** activities in 2008 were requested by various **Boy Scout troops**, **West Middle School**, **Cherry Creek Challenge School**, **Grandview High School**, **Castle View High School**, **Slavens Elementary School**, **Cole Middle School**, the **Democratic National Committee**, and **World Water Monitoring Day** sponsors.

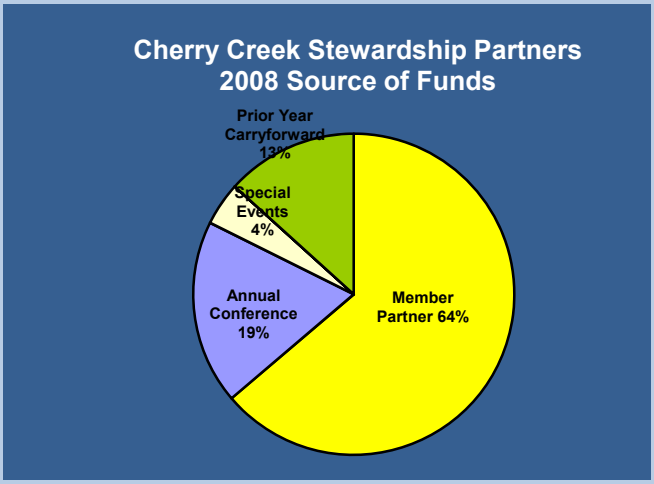
If you have participated in any of our tours, workshops, projects or mentoring opportunities this past year, we'll be contacting you for educational opportunities in 2009! If you have been meaning to put together a team for the **Run for the Watershed** (*see pages 5 & 6 for information and registration form*), volunteer as a Science Fair Judge, or come out to 'bother the butterflies' we hope you'll make your move in 2009!

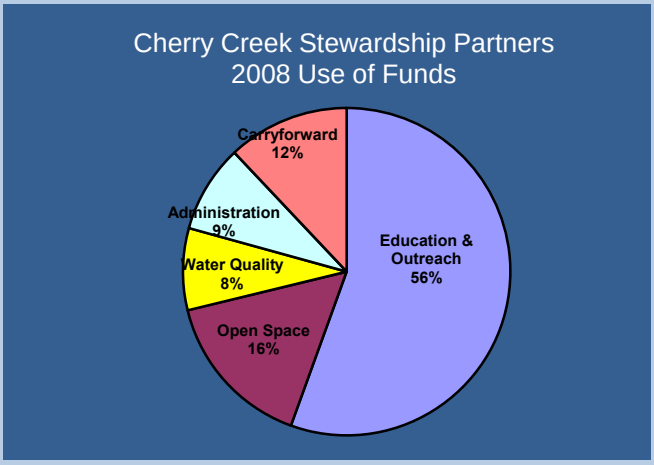
Contact Casey at casey@cherry-creek.org

The Partners EdKit activity at World Monitoring Day

Hands-on teacher training at the CC Valley Eco Park

Partners 2008 Financial Data





The Pie Charts to the left present relative income (Source of Funds) and expenditures (Use of Funds) for the various projects & programs of the Cherry Creek Stewardship Partners for 2008.

Our Work Plan is broken down into several main categories, including: Education and Outreach, Annual Conference, Open Space, Water Quality and Administration (detailed below). We continue to receive financial support from our member partners, including the Cherry Creek Basin Water Quality Authority, as well as the many land use agencies in the watershed. In 2008, the CBWQA provided $17,000 of our member funds, with the remaining $31,150 of operating funds provided by MS4's, interested corporations, special districts, and others. We will continue to seek funds from our members, and State and Federal grants, as we continue our mission of providing a forum for watershed information, stewardship education and regional collaboration. During 2008, the Partners changed their fiduciary sponsor from the Colorado Watershed Network to the Greenway Foundation. We thank the CWN for their past support, and look forward to working with Greenway Foundation in 2009 and the years to come.

For more information on any of our programs you may check our website, www.cherry-creek.org or contact Casey Davenhill at casey@cherry-creek.org.

SOURCE OF FUNDS		USE OF FUNDS	
Member Contributions	$48,150*	Education & Outreach	$41,925
Annual Conference	$14,016	Open Space	$11,831
Special Events	$3,290	Water Quality	$6,105
Carry-over	$10,036	Administrative	$6,546
		Carry forward	$9,085
*CCBWQA contributed $17,000			
Total	$75,492	Total	$75,492

Partners Assist MS4's in Education

In 2008, the Partners assisted the 11 regulated Phase I and Phase II MS4 communities that have ties to the Cherry Creek & South Platte watersheds, including Denver, Aurora, Glendale, Littleton, Greenwood Village, Centennial, Parker, Castle Rock, as well as the counties of Arapahoe and Douglas, and Cherry Creek State Park. Efforts ranged from hosting public events for education and public participation purposes, like the **Annual Conference**, the **Run for the Watershed**, and the **Aurora Water Festival**, to implementing educational programming for area schools and civic groups, like the **Science Fairs, Project WET**, **Biology Teachers Workshop**, and in-school efforts using the Partners **"EdKit"**. The Partners goal for 2009 is to continue field projects that incorporate education, public participation and service, and integrates all the permit control programs, specifically stream restoration projects and hands-on construction of post-construction BMPs in the watershed.

Contact Casey @ 303-345-1675

Drainageway habitat assessment EdKit activity

Student volunteers at a Denver trail building project

Join us….

We invite you to join us as the Partners continue to provide stewardship opportunities for all manner of organization, agency, business or citizen. Visit our website, www.cherry-creek.org, and join us at our next Forum, Conference or Volunteer Day. We do need your financial support and have identified levels of support as follows:

- Community Group/Nonprofits: $100 - $500
- Special Districts/Other: $350 - $500
- Corporations: $500 - $1,000
- Groups with Educational Mandate: $500 - $2,000
- MS4 Permittees: $2,000 - $5,000
- Conference support: $150 - $3,000 (depending on activity sponsored)

If any of the activities in this Annual Report interest you, give Casey a call or email her at casey@cherry-creek.org. We look forward to working with you!

Cherry Creek Stewardship Partners

2008 Annual Report

"Providing a forum for promoting stewardship of the Cherry Creek Watershed"

January 2009

CHERRY CREEK BASIN
WATER QUALITY AUTHORITY

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ANNUAL REPORT

ON ACTIVITIES