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ANNUAL REPORT
ON ACTIVITIES

Cherry Creek Basin
Water Quality Authority

March 31, 2010



2009 Annual Report on Activities

Cherry Creek Basin **Water Quality Authority**

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CONTROL REGULATION 72 REPORTING REQUIREMENTS

This report is being submitted to both the Colorado Water Quality Control Commission (Commission) and the Water Quality Control Division (Division) on or before March 31, 2010, in fulfillment of the reporting requirements of Regulation No. 72 – Cherry Creek Reservoir Control Regulation (Reg. 72). The following list shows where the reporting requirements of the Cherry Creek Reservoir Control Regulation can be found in this report. Reporting information includes both the requirements of the newly revised Regulation No. 72, effective January 1, 2010, as well as several superseded reporting requirements from the previous version of Regulation 72 (e.g., compliance with previous Wasteload Allocations), as they were in effect throughout 2009. These reporting requirements that are no longer effective after January 1, 2010, are shown below in parentheses. They will be included one last time in this year’s annual report, and will likely be discontinued in next year’s report.

Control Regulation (effective 01/01/10) Reporting Requirement and Section Number	Section of Annual Report
Point Source Controls (§72.9(1)(a)).....	4
Phosphorus concentrations (and annual loads).....	4.1
(Monthly phosphorus loads)	4.2
Permit violations	4.3
Approved site applications	4.4
Effectiveness in reducing nutrient concentrations	4.5
(Wasteload Allocations).....	4.6
(Trading Program, including TMAL reductions from Trading Program)	4.7
(Temporary transfers, reserve pool allocations, and semi-urban area transfers)	4.8
(Actions taken pursuant to previously-approved TMAL)	4.9
Regulated Stormwater Controls (§72.9(1)(b)).....	5
Sediment and erosion control permit, inspection, and enforcement actions	5.1
Construction BMPs inspection and enforcement actions	5.2
Permanent BMPs construction, inspection, and maintenance actions.....	5.3
Flood control facilities retrofitting, inspection, and maintenance actions	5.4
Effectiveness in reducing phosphorus concentration.....	5.5
Funding of nonpoint source control projects	5.6
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Public information and education actions.....	5.8
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Updated list of PRFs implemented (§72.3).....	6.1
Floodplain preservation/conservation easements	6.2
Effectiveness in reducing phosphorus concentration.....	6.3
Funding of PRFs	6.4
Monitoring of PRFs.....	6.5
Riparian and Wetlands Protection (§72.9(1)(d)).....	7
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LIST OF ACRONYMS AND ABBREVIATIONS

ac-ft	Acre-feet
ACWWA	Arapahoe County Water and Wastewater Authority
Authority	Cherry Creek Basin Water Quality Authority
BMP	Best Management Practice
DESC	Drainage, Erosion, and Sediment Control
CDOT	Colorado Department of Transportation
CIP	Capital Improvement Projects
COE	U.S. Army Corps of Engineers
Commission	Colorado Water Quality Control Commission
CSU	Colorado State University
Regulation 61	Regulation No. 61 – Colorado Discharge Permit System Regulations
Regulation 72	Regulation No. 72 – Cherry Creek Reservoir Control Regulation
Division	Colorado Water Quality Control Division
DRCOG	Denver Regional Council of Governments
EPA	U.S. Environmental Protection Agency
GESC	Grading, Erosion, and Sediment Control
lbs/yr	Pounds/year
µg/l	Micrograms per liter
mg/l	Milligrams per liter
MEP	Maximum Extent Practicable
MS4	Municipal Separate Storm Sewer Systems
O&M	Operations and Maintenance
Partners	Cherry Creek Stewardship Partners
PRF	Pollutant Reduction Facility
SEMSWA	Southeast Metro Stormwater Authority
SRP	Soluble Reactive Phosphorus
TAC	Authority's Technical Advisory Committee
TMAL	Total Maximum Annual Load
TMDL	Total Maximum Daily Load
UDFCD	Urban Drainage and Flood Control District

2009 ANNUAL REPORT ON ACTIVITIES

EXECUTIVE SUMMARY

The purpose of the 2009 Annual Report on Activities is to provide a status of the Cherry Creek Reservoir water quality and review progress made by the Cherry Creek Basin Water Quality Authority (Authority) towards achieving water quality standards in 2009. The following objectives guide the development of the Annual Report:

- Document the steps taken in 2009 to perform required tasks,
- Meet Regulation No. 72 – Cherry Creek Reservoir Control Regulation reporting requirements,
- Present the results of monitoring activities,
- Review the effectiveness of watershed management strategies, and
- Provide an Executive Summary that can act as a stand-alone abbreviated report of 2009 activities and progress.

The mission of the Authority is to *“improve, protect, and preserve the water quality of Cherry Creek and Cherry Creek Reservoir, and to achieve and maintain state water quality standards for the reservoir and related watershed”*. Beneficial uses for which the Cherry Creek Reservoir has been assigned to protect include: (1) aquatic life; (2) primary contact 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, and implementing the phased Total Maximum Annual Load (TMAL) for phosphorus entering Cherry Creek Reservoir¹. 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 Regulation 72 to update the TMAL, and
- Identifying additional strategies for meeting reservoir water quality standards and goals in the foreseeable future.

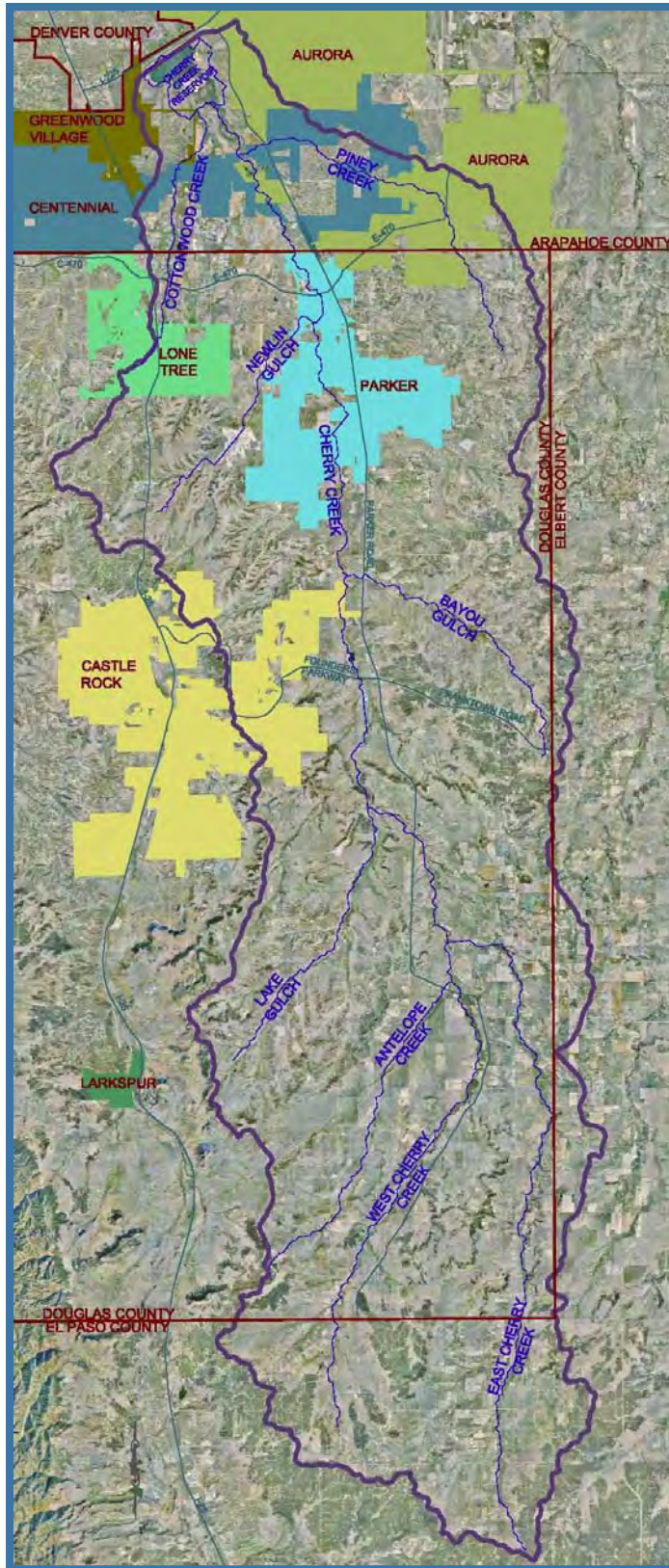
Status of Water Quality

In 2009, the Authority continued to implement the routine annual water quality monitoring program in the Cherry Creek Reservoir and 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, 2009 was the third year of a multiple year special monitoring program within the Cherry Creek Reservoir to measure changes due to the Reservoir Destratification project in operation since 2008.

¹ Control Regulation No. 72 was modified in 2009 effective January 1, 2010 which eliminated the TMAL requirement and changed the watershed management goal from a load-based to a concentration-based approach.

Figure ES-1. Cherry Creek Reservoir Watershed Map



2009 Water Quality Summary

- The seasonal mean chlorophyll *a* of 13.2 µg/l was less than the previous 15 µg/l reservoir standard, but the standard had not been met as required in 9 out of 10-years.
- The new seasonal mean chlorophyll *a* standard of 18.0 µg/l, with an exceedence frequency of once every five years, has been met for the past five years, from 2005 through 2009, with no exceedences. The new standard became effective in January 2010.
- A seasonal mean total phosphorus concentration of 98 µg/l exceeded the previous reservoir goal of 40 µg/l. The new Control Regulation (effective January 2010) does not include an explicit phosphorus goal within the reservoir.
- The annual total phosphorus load of 18,938 pounds to the reservoir was greater than the previous TMAL of 14,270 lbs/year. The new Control Regulation does not include a TMAL.
- The flow-weighted total phosphorus concentration was 0.234 mg/l, which is greater than the new (non-regulatory) concentration-based goal of 0.200 mg/l for all sources of inflow. The higher concentration was due in large part to the numerous storm events that occurred in 2009.
- The Cottonwood-Peoria Pond PRF demonstrated a phosphorus load reduction effectiveness of 28%.
- The Cottonwood Creek Perimeter Pond PRF showed a phosphorus reduction of 8 percent. The Cottonwood Creek Reclamation project was completed in 2009, substantially decreasing the amount of erosion and phosphorus contributions in this reach.
- Historical sampling of the Shop Creek and Quincy Drainage PRFs indicate an average annual phosphorus reduction of 63% or 173 pounds (1990-2000) and 99% or 138 pounds (1996-1999), respectively.

Long-Term Water Quality Summary

The seasonal average (July through September) mean chlorophyll *a* values only met the previous 15 µ/l seasonal limit four times in the past 18 years (in 1993, 2006, 2007, and 2009). However, because this level had to be met in 9 out of every 10 years, the standard itself was not met ever.

The new chlorophyll *a* standard is 18 µ/l total phosphorus as a mean seasonal average (July through September), to be met 4 out of every 5 years. This new standard, effective as of January 1, 2010, was met for the past five years, with every year less than 18 µg/l). Since 1999 there has been a steady decline in the seasonal mean chlorophyll *a* concentration.

Table ES-1 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.

Table ES-1 Water Quality (July–September Average Concentration) and Total Phosphorus Load Data for Cherry Creek Reservoir, 1992 – 2009

Year	Chlorophyll <i>a</i> (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	14.8	62	826	3,114	5,581	196	2,186
1994	15.4	59	1,144	3,785	6,998	199	2,730
1995	15.6	48	913	5,736	11,788	179	4,302
1996	18.2	62	944	4,425	7,654	213	3,102
1997	22.0	96	1,120	5,659	10,391	200	4,060
1998	26.5	89	880	13,222	20,902	234	9,311
1999	28.6	81	753	17,672	27,604	235	10,913
2000	25.1	81	802	13,788	18,611	272	9,362
2001	26.1	87	741	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	8,857	18,841	178	4,029
2009	13.2	98	1236	18,938	29,736	234	9,003
Mean	19.3	85	928	9,369	15,857	210	5,627
Median	17.8	87	914	8,916	16,078	207	4,352

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.

The Authority's watershed management strategies have been focused on reducing nutrient loading, through structural and non-structural management practices. 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 revised seasonal mean chlorophyll *a* standard has been met since 2005 (based on the chlorophyll *a* standard adopted in 2009). 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 Water Quality Control Commission's new approach as adopted during the March 2009 rulemaking hearing. Key changes to the regulation are summarized below:

- Adopted new chlorophyll *a* standard of 18 µ/l (seasonal mean, July-September, for upper 3 meters of water column, with an exceedence frequency of once every 5 years)
- Established concentration-based management approach
- Removed all TMAL-related components from the regulation
- Removed the phosphorus goal of 40 µg/l
- Established a discharge effluent limit of 0.20 mg/l total phosphorus for drinking water treatment plants
- Established a 3-tiered stormwater system of controls required for development and redevelopment

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. After two years of monitoring, the data provides evidence that the aeration system does destratify the reservoir, although it required approximately 6 days to mix the water column after a summer storm event. The monitoring also provides evidence that the aeration system may not improve dissolved oxygen levels at the bottom of the reservoir.

Overview of Progress Made

Although the Cherry Creek Reservoir did meet the chlorophyll *a* requirements for the reservoir in 2009, the Authority continues to take initiative towards meeting standards through planning, implementation, and evaluation actions.

- Planning – Recommendations of the Watershed Plan 2003 continue to guide the Authority's Work Plan.
- PRF Implementation – The Authority continued to make progress in the design, construction, and maintenance of PRFs by developing a 5-year Capital Improvement Plan and funding a number of PRFs in 2009.
- Phased TMAL Progress - The Authority completed the special studies and modeling necessary to support future watershed management goals and objectives. The results and conclusions from these special studies were included in the Authority's Prehearing Statement for the March 2009 Standards Hearing.
- Education – The Authority coordinated with the Cherry Creek Stewardship Partners to implement more education and public outreach programs (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.

Progress Made in Specific Management Programs

Listed below are specific watershed management programs that the Authority implemented or continued in 2009 to improve watershed health and water quality, along with the associated progress made through each program.

Wastewater Facility Controls

- All wastewater treatment plants were in compliance in 2009 with their required phosphorus limits and conditions, with the exception of one slight reported exceedence which was due to contaminated sample preservative.

- The total annual phosphorus pounds discharged in the basin from the wastewater discharges was in all cases less than the dischargers' total annual wasteload allocations.

Nonpoint and Regulated Stormwater Source Controls

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

- The Authority has seen improvement in the incorporation of stormwater quality facilities into development plans over the years due to raised awareness and proactive efforts of the land use agencies. The Authority reviewed 97 land use and development applications for nonpoint and regulated stormwater pollutant source impacts. Of the 97 applications it reviewed, the Authority took no exception or no exception with contingencies for 73 percent of the applications.
- The Authority completed the second year of operation of the Reservoir Destratification system for in-lake management, completed construction of Cottonwood Creek Reclamation Phase II, began final design of additional reservoir shoreline stabilization measures, and completed repairs to existing PRFs along the east shoreline of the reservoir.
- The Authority has continued to work closely with land use agencies and the Division. This effort resulted in revisions to Control Regulation No. 72 at 72.7, Stormwater Permit Requirements, which implemented a three-tiered stormwater system for development and redevelopment providing more regulatory flexibility while maintaining water quality protection.

Trading Program

- No new trade projects were proposed in 2009.

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 Authority leveraged resources by supporting the Cherry Creek Stewardship 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 with 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.

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 to complete all the special investigations and programs required for the phased TMAL.

Water Quality Monitoring

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

- The Cottonwood Creek treatment system, consisting of the Perimeter Road Pond (aka, Cottonwood Wetlands Pond), Phase I and II creek reclamation, and the Peoria Pond PRFs, continued to show improvement in removing total phosphorus from the stream flows and reducing phosphorus concentrations to levels below background.
- The total phosphorus load to the reservoir was greater than the historical TMAL, but is largely attributed to the extremely wet year experienced by the reservoir.
- There has been a statistically significant decrease in seasonal whole reservoir chlorophyll *a* concentrations since 1999, with the 2009 seasonal mean concentration of 13.2 µg/l.
- Monitoring results suggest stratification of the reservoir has 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 has slightly decreased (see Section 8 Water Quality Monitoring).
- The flow-weighted, external phosphorus concentration discharged into the reservoir was 234 µg/l.

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 “*improve, protect, and preserve the water quality of Cherry Creek and Cherry Creek Reservoir, and to achieve and maintain state water quality standards for the reservoir and related watershed.*” These actions are components of a plan directed toward meeting water quality standards and enhancing environmental health in the Cherry Creek basin.

The 2009 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 previously set. With data collected from 2000-2007, 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. As the result of the special studies and other information brought forth during the March 2009 hearing, the Commission made the following rulings:

- The current reservoir chlorophyll *a* standard was not attainable and, therefore, adopted a 18 µg/l chlorophyll *a* standard with an exceedence frequency of 1 out of 5 years. (Control Regulation No. 38, Basis and Purpose, p.197).
- Removal of all TMAL-related components of Control Regulation No. 72. As necessary, the Commission will direct the Division and the Authority to work with EPA in developing a separate TMAL document for the Reservoir (Control Regulation No. 72, Basis and Purpose, p. 49).
- Establishment of a concentration-based watershed management approach for phosphorus control in the watershed. (Control Regulation No. 72 Basis and Purpose, p. 48).

The Authority’s management strategies continue to have strong focus on the watershed controls, including the construction of PRFs that have shown to be effective in reducing phosphorus loads and concentrations. The Authority believes watershed management strategies have taken years to see a measurable improvement to reservoir water quality, but these strategies are beneficial over the long term. The Authority completed the

second year of 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 by mixing and destratifying the reservoir. 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.



2009 ANNUAL REPORT ON ACTIVITIES

1. PURPOSE OF THE ANNUAL REPORT

The purpose of the Annual Report is to show progress made by the Cherry Creek Basin Water Quality Authority (Authority) in implementing activities necessary to reduce the inflow total phosphorus concentrations to Cherry Creek Reservoir. These activities are prescribed by the Colorado Water Quality Control Commission (Commission) in its Regulation No. 72, also known as the Cherry Creek Reservoir Control Regulation. The regulation describes various required activities and minimum levels of controls that must be implemented for point sources (e.g., wastewater treatment plants), regulated stormwater, and nonpoint sources (e.g., nonregulated stormwater runoff).



The activities discussed in the Annual Report are components of an overall plan for protecting the health of the watershed, and include the following:

- Monitoring water quality,
- Measuring flow-weighted phosphorus concentrations in inflows to the Cherry Creek Reservoir,
- Implementing point, nonpoint source, and regulated stormwater controls and programs,
- Completing special studies to update the total maximum annual load (TMAL), and
- Evaluating additional strategies for meeting water quality standards and goals for Cherry Creek Reservoir.



The following objectives guide the development of the Annual Report.

OBJECTIVE 1 – Document the Activities Taken

OBJECTIVE 2 – Meet Control Regulation 72 Reporting Requirements

OBJECTIVE 3 – Present the Results of Monitoring Activities

OBJECTIVE 4 – Provide a Framework for a Review of Strategies

OBJECTIVE 5 – Provide a Summary Report of Activities and Progress Made

2009 ANNUAL REPORT ON ACTIVITIES

2. THE AUTHORITY

The mission of the Authority is to “improve, protect, and preserve the water quality of Cherry Creek and Cherry Creek Reservoir, and to achieve and maintain state water quality standards for the Reservoir and related watershed” and, as such, is designated as a 208 Management Agency. From this mission, the Authority has developed water quality management strategies to minimize point, nonpoint, and regulated stormwater pollutant sources by implementing specific programs and monitoring water quality to evaluate progress. These strategies create an effective water quality management approach.



OUR VISION

Integrate watershed goals for:

- *Community development*
- *Water supply*
- *Recreation*
- *Wildlife habitat*
- *Open space*

with the Authority’s water quality mission.

This section provides information on the Authority’s history, members of the Authority, 2009 annual budget and funding sources, and reference materials.

2.1 History

The Authority was formally created in 1988 by the Colorado Legislature to preserve water quality within the Cherry Creek Reservoir watershed. A summary of the Authority’s history pertinent to regulations is shown below. In March 2009, the Commission held a rulemaking hearing to adopt changes to Cherry Creek Reservoir Control Regulation 72. Final action was taken August 10, 2009; the changes became effective January 1, 2010. These changes are summarized in the chart below.

2010...New water quality standards and Control Regulation effective January 1, 2010

2009.. Commission adopted Authority-recommended changes to water quality standards and Control Regulation 72. New reservoir standard established as seasonal mean chlorophyll *a* $\leq 18 \mu\text{g/l}$ measured in the upper 3 meters of the water column for the months of July through September, with an exceedence frequency of once every 5 years. Changes to Regulation 72 include removal of all TMAL-related components, establishment of concentration-based management approach, establishment of discharge effluent limit of 0.20 mg/l total phosphorus for drinking water treatment plant discharges, and establishment of a 3-tiered stormwater system for development and redevelopment.

2004 .. Authority and Water Quality Control Division (Division) recommended changes to Control Regulation 72 to Commission in September 2004 triennial hearing; Control Regulation 72 revised, effective on December 30, 2004

2003... Watershed Plan 2003 created by Authority

2001 ...Commission adopted a new Control Regulation as a phased TMAL; total phosphorus load of 14,270 pounds for the reservoir, pending future studies; new legislation reconstituted the Authority

2000 .. Watershed Plan 2000 developed by Authority; existing standards re-evaluated at Commission triennial review; new chlorophyll *a* standard of $15 \mu\text{g/l}$ (July through September mean) to be met in nine out of ten years, with total phosphorus goal of $40 \mu\text{g/l}$ (July through September mean)

1988... General Assembly statutorily created and empowered the Authority

1987 ...Colorado Legislature's Water and Water Quality Subcommittee conducted hearings on legislation to create a water quality management agency

1985... Commission established limits: $35 \mu\text{g/l}$ in-reservoir total phosphorus standard to maintain chlorophyll *a* concentration of $15 \mu\text{g/l}$ (both defined as a July-September seasonal mean); local governments, private interests, and government agencies developed a total maximum daily load (TMDL) of 14,270 pounds total phosphorus annual load; TMDL presented in the Cherry Creek Basin Water Quality Management Master Plan and approved by the Commission and EPA Region 8, portions of Master Plan adopted as the Regulations for Control of Water Quality in Cherry Creek Reservoir (Section 4.2.0, 5 C.C.R. 3.8.11), effective December 30, 1985 Intergovernmental Agreement created to form the Cherry Creek Basin Water Quality Authority.

1982... DRCOG conducts Clean Lakes Study of Cherry Creek Reservoir; phosphorus identified as the major nutrient causing algal productivity, potentially leading to eutrophication of the reservoir and negative impacts to beneficial uses.

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 statutory changes adopted in 2001 by the Colorado Legislature as SB 01-006.

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	18

Table 2-2. Authority TAC Members	
Entities Represented	Number of Members
County (Arapahoe/Southeast Metro Stormwater Authority ² (SEMSWA), Douglas)	2
Municipality (Aurora, Castle Rock, Centennial, Foxfield, Greenwood Village, Lone Tree, Parker, Castle Pines North)	8
Special districts	1
Board-appointed	2
Other	5
Total members of TAC	18

¹ The Castle Pines North and Foxfield seats are currently vacant.

² SEMSWA was formed by an Intergovernmental Agreement among Centennial, Arapahoe County, Arapahoe County Water and Wastewater Authority, East Cherry Creek Valley Water and Sanitation District, and Inverness Water and Sanitation District.

2.3 Financial Matters

The Authority receives funding for its activities primarily from property taxes, Cherry Creek State 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 and miscellaneous sources, such as reimbursed expenses and interest earnings.

The Authority's budget for the 2009 calendar year was approximately \$1,779,000 in revenue and approximately \$779,000 in expenditures. Expenditures and revenues are not necessarily matched each calendar year because implementation and timing of project costs for the capital improvement program can vary significantly from year to year. 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 remaining 40 percent is allocated towards monitoring, special studies, planning documents, technical reports or memoranda, and administrative costs.

2.4 Reference Documents

The Authority generated documents that serve as references for the status of water quality in Cherry Creek Reservoir, guidelines and educational material on water quality best management practices (BMPs), technical sources on various aspects of water quality, and watershed planning and management strategies (see Table 2-3).

Table 2-3. 2009 Reference Documents	
2009 Annual Report of Activities by the Cherry Creek Basin Water Quality Authority	Update on activities completed by the Authority in 2009.
2009 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.
2009 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.
2009 Five-Year Capital Improvement Projects Plan	Summary of potential pollutant reduction facilities.
December 7, 2009 Monthly CIP Status Report to Board	Summary of 2009 progress on capital improvement projects. (generated monthly)
Cherry Creek Reservoir 2009 Annual Aquatic Biological and Nutrient Monitoring Study	Characterization of potential relationships between nutrient loading and reservoir productivity.
Cherry Creek Stewardship Partners 2009 Annual Report	Update on activities completed by the Partners in 2009.
Summary of Information Binder for Authority Board Members	Summary reference information on Authority mission, guiding documents, projects, and budget.
Prehearing and Rebuttal Statements for March 2009 Standards Hearing	Documentation as the proponent of proposed changes to the Classification and Numeric Standards (Regulation No. 38) and the Cherry Creek Reservoir Control Regulation (Regulation No. 72).
Summary of Activities to Comply with Phased TMAL Requirements	William P. Ruzzo, PE, LLC. January 2009. (prepared for March 2009 Rulemaking Hearing)

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3. DESCRIPTION OF CHERRY CREEK RESERVOIR WATERSHED

Originally built for flood control, Cherry Creek Reservoir is owned and operated by the U.S. Army Corps of Engineers (COE). The reservoir, with a surface area of approximately 852 acres, and surrounding land (3,346-acres) were leased to the State of Colorado for use as the Cherry Creek State Recreation Area in 1959. The park almost immediately received extensive recreational use, a pattern that has continued to the present day. Recently reported figures show the park had 1.44 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.

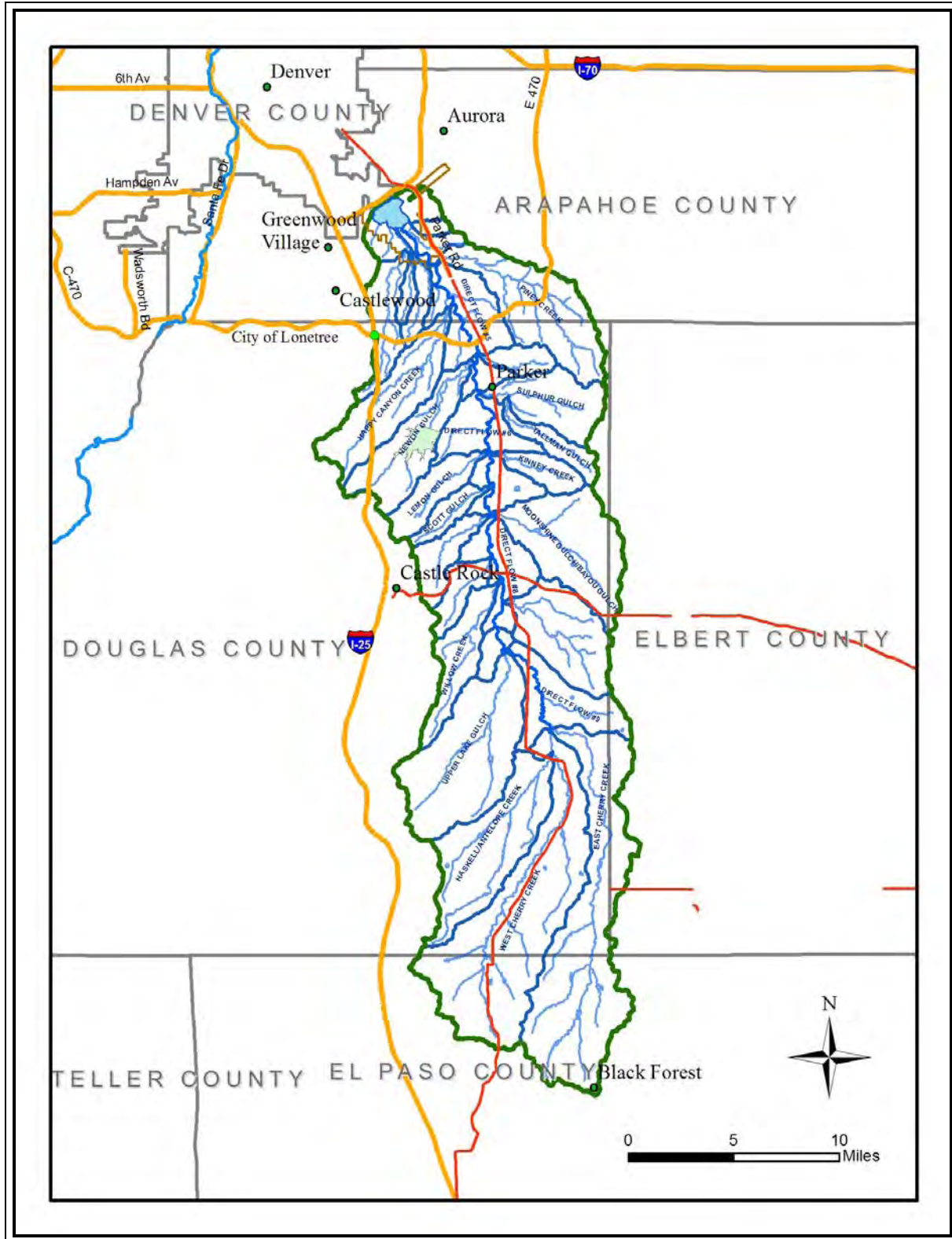


Cherry Creek Reservoir was designed for flood control management and evolved into a terminal water storage facility, intended to hold runoff water that would then be discharged to maintain an acceptable downstream flow and a predetermined lake level. The reservoir, along with subsurface flows from below the dam, have 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 five 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 beneficial uses of the reservoir include warm water class 1 aquatic life, existing primary contact recreation, water supply, and agriculture.

Figure 3-1. Cherry Creek Reservoir Watershed



2009 ANNUAL REPORT ON ACTIVITIES

4. POINT SOURCE CONTROLS

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. Several point source dischargers within the Cherry Creek Reservoir watershed provide centralized wastewater treatment service. Two point source dischargers are located outside the watershed, but may land-apply reuse water as irrigation within the watershed; only one discharged within the watershed in 2009.

Wastewater and industrial process wastewater sources are limited in the amounts of phosphorus they can discharge to the Cherry Creek Reservoir watershed. The changes in 2009 to Regulation 72 place the emphasis on phosphorus concentration-based limits for point source dischargers. Under the old regulation, dischargers also had a maximum annual poundage limit for phosphorus as well; however, the new regulation removed all references to total maximum allowable load components. For the 2009 report, information on both compliance with the old wasteload allocations as well as the phosphorus concentration limits are listed in Table 4-1 below; this will continue until TMAL limits are removed from the dischargers' permits.

4.1 Phosphorus Concentrations and Annual Loads

Colorado Discharge Permit System permits require dischargers to monitor and quantify the concentration and total pounds of phosphorus discharged. Tables 4-1 present the phosphorus allocations and annual loads, as well as the concentration-based limits and actual maximum reported concentrations, for the wastewater dischargers in 2009. The previous Regulation 72 assigned annual phosphorus load allocations among the wastewater and industrial facilities as shown in Table 4-1.

Note that under the previous Regulation 72, discharge limits were as follows:

- for wastewater facilities and industrial process wastewater sources with direct discharges: ≤ 0.05 mg/l total phosphorus concentration as a 30-day average;
- for dischargers using land-application and relying on a return flow factor: 30-day flow-weighted average phosphorus concentration ≤ 0.05 mg/l total phosphorus divided by the land application return flow factor; and
- for dischargers using land application and relying on lysimeters: ≤ 1.0 mg/l total phosphorus concentration in effluent being applied to the land.

Under the new Regulation 72, effective January 1, 2010, the new discharge limits will be:

- for wastewater facilities and industrial process wastewater sources with direct discharges: ≤ 0.05 mg/l total phosphorus as a 30-day average, unless a 90-day average is approved by the WQCD at the request of the discharger;
- for drinking water treatment facilities: ≤ 0.2 mg/l total phosphorus concentration as a 30-day average, unless a 90-day average is approved by the WQCD at the request of the discharger;
- for dischargers using land-application and relying on a return flow factor: 30-day flow-weighted average phosphorus concentration ≤ 0.05 mg/l total phosphorus divided by the land application return flow factor; and
- for dischargers using land application and relying on lysimeters: ≤ 1.0 mg/l total phosphorus concentration as a 30-day flow weighted average in effluent being applied to the land, unless a 90-day averaging period is approved by the WQCD at the request of the discharger.

Table 4-1. Cherry Creek Reservoir Watershed Point Source Allocation and 2009 Point Source Phosphorus Annual Contribution

Facility	Allocation (pounds)	2009 Phosphorus (pounds) ¹	30-day avg. Phosphorus Limit (mg/l)	Maximum Reported 30-day avg. Concentration (mg/l)	Phosphorus Permit Limit Violation? (yes/no)
Arapahoe County Water and Wastewater Authority/Cottonwood Water & Sanitation District ²	402	159	0.05	0.052	Yes (see discussion below)
Pinery Water and Sanitation District	304	67	0.05	0.048	no
Inverness Water and Sanitation District ²	129	0	1.0 ⁵	No discharge	no
Parker Water and Sanitation District ³	593	208	0.05 (Outfall 001A) 0.33 (Outfall 001B) ⁷	0.040 (001A) No discharge (001B)	no
Meridian Water and Sanitation District	114	0	1.0 ⁵	0 ⁶	no
Stonegate Village Metropolitan District	161	26	0.25 (Outfall 001A) ⁷ 0.05 (Outfall 002A)	0.029 (001A) 0.020 (002A)	no
Plum Creek Wastewater Authority ⁴	25	10	0.05	0.043	no

1 The 2009 phosphorus pounds are from the discharger-submitted Discharge Monitoring Reports, rounded to the nearest pound.

2 Inverness's permit was terminated in 2009.

3 In 2005, the Authority Board approved an allocation from the semi-urban area of 60 pounds for Parker Water & Sanitation District.

4 In 2004, phosphorus pounds were transferred from the semi-urban area allocation to the Plum Creek Wastewater Authority for land application.

5 Limit is lysimeter-based, calculated per Control Regulation 72.

6 Lysimeters reported as being "dry".

7 Limit calculated based on land application factor, per Control Regulation 72.

Arapahoe County Water and Wastewater Authority reported a 30-day average total phosphorus exceedence of 0.052 mg/l in January 2009. This is only slightly larger than its limit of 0.05 mg/l. ACCWA conducted a sampling study and concluded that the preservative used to hold the phosphorus samples was contaminated, and caused the exceedence.

4.2 Monthly Phosphorus Concentrations

Table 4-2 below summarizes the cumulative annual pounds of phosphorus contributed by each wastewater treatment plant. The data were taken from the monthly Discharge Monitoring Reports submitted to the Water Quality Control Division by the dischargers. It can be seen that all dischargers were well below their allowed total maximum annual load in 2009. Of the total allowed allocation of 1728 pounds of phosphorus per year for these 7 wastewater treatment plants combined, only 469 pounds were discharged in 2009.

Table 4-2. 2009 Point Source Phosphorus Monthly Contribution

Month	Discharges to Cherry Creek						Discharges to Lone Tree Creek
	Parker Water & Sanitation District (cumulative lbs/yr)	Pinery Water & Sanitation District (cumulative lbs/yr)	Stonegate Village Metropolitan District (cumulative lbs/yr)	Inverness Water & Sanitation District (cumulative lbs/yr)	Plum Creek Wastewater Authority ¹ (cumulative lbs/yr)	Meridian Water & Sanitation District (cumulative lbs/yr)	Arapahoe County Water & Wastewater Authority (cumulative lbs/yr)
Jan.	24.82	7.09	2.34	0	0	0	25.8
Feb.	44.88	10.91	5.14	0	0.05	0	42.8
March	61.71	19.25	6.76	0	1.09	0	52.3
April	75.53	24.57	7.26	0	1.27	0	62.1
May	90.12	30.38	8.24	0	2.38	0	72.0
June	108.05	35.12	9.80	0	3.36	0	79.9
July	124.32	39.08	12.43	0	4.44	0	90.6
Aug.	137.53	43.74	15.96	0	7.43	0	101.0
Sept.	147.89	48.49	20.67	0	8.96	0	113.3
Oct.	165.52	54.51	22.71	0	9.48	0	127.0
Nov.	187.05	60.25	24.38	0	9.61	0	145.3
Dec.	207.57	67.34	25.93	0	9.64	0	158.5
TMAL	593	304	161	129	25	114	402

¹ The Plum Creek Wastewater Authority discharges in the Cherry Creek Reservoir watershed are through reuse irrigation.

4.3 Permit Compliance

Control Regulation 72 requires that the Annual Report also identify wastewater facility permit violations with regard to phosphorus concentration limits and annual phosphorus loads. In 2009, there was one permit violation reported for phosphorus. As noted above, ACWWA reported a 30-day average total phosphorus exceedence of 0.052 mg/l in January 2009 (vs. its permit limit 0.05 mg/l). ACCWA conducted a sampling study and concluded that the preservative used to hold the phosphorus samples was contaminated, and caused the exceedence. Based on extensive research, ACCWA concluded that the contaminated preservative caused erroneous test results when in fact the results should have demonstrated that ACCWA was meeting its permit limits in January 2009.²

4.4 Approved Site Applications

As the designated regional water quality management agency for the Cherry Creek Reservoir watershed, the Authority reviews applications for site location approval for 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. As required by Regulation 72, the Authority must report on approved site applications annually.

² February 26, 2009 letter from Arapahoe County Water and Wastewater Authority to Colorado Department of Public Health and Environment, Water Quality Control Division

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

- Cherry Creek Control Regulation 72;
- 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 (DRCOG), January 2003) and “Lift Station Report Guidance and Checklist” (DRCOG, October 2000); and
- 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 regulation.

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. In 2009, the Authority provided comments to applicants on two site application requests. The first was for the Lagae Ranch subdivision in the Town of Castle Pines North. The Authority Board approved the site application subject to the addition of differential flow monitoring. The second application was from the Cherry Creek State Park Shooting Center. The Authority Board conditionally approved the site application, contingent upon several items being addressed. Specifically the Authority required additional information and follow-up in the following areas: data on the flow meter; details on the valving; data on the alarms; data on backup power; pump sizing calculations and pump redundancy; pump data, pump curves, and cycling calculations, for both now and the future; forcemain sizing calculations; ventilation HVAC data; sump sizing calculations; and by-pass details for the flow meter.

4.5 Effectiveness in Reducing Nutrient Concentrations

The control requirements placed on the point source dischargers described above are found to have been effective in reducing or controlling nutrient concentrations to the watershed and reservoir. Inspection of the flow-weighted concentrations listed in Table 8-1 show that the 18 year median concentration is 0.207 mg/l with two of the last five years being below the concentration goal of 0.20 mg/l referenced during the 2009 Regulation No. 72 hearing. In its August 10, 2009 Statement of Basis and Purpose for Regulation 72, the Water Quality Control Commission specifically concluded the following: “Watershed and reservoir modeling results have shown that, although population growth and surface flows have increased in the basin, the total phosphorus concentration in the inflow to the reservoir has remained relatively constant. These results provide a basis for the Commission to conclude that point and nonpoint source controls for total phosphorus (point source treatment facilities, PRFs [Pollutant Reduction Facilities], 208 agency processes,

and permitted MS4 [Municipal Separate Storm Sewer System] activities) are successfully reducing total phosphorus concentrations in stormwater and surface water flows to the reservoir.” (§72.27)

It is also noted that the required effluent limits for total phosphorus concentrations discharging from wastewater facilities and industrial process wastewater sources (i.e., for most dischargers, less than 0.05 mg/l total phosphorus concentration as a 30-day average) are less than the flow-weighted total phosphorus concentrations currently entering the reservoir. Actual concentrations discharged were well below the 0.05 mg/l limits.

Specific accomplishments for 2009 included:

- Wastewater facility discharges did not exceed annual permitted wasteload allocations in 2009. One minor effluent phosphorus concentration exceedence was reported in 2009; however, it was determined to be due to contamination of the sample preservative.
- The total annual phosphorus pounds discharged in the basin from the wastewater discharges was less than the total annual wasteload allocation.
- Two site application reviews were completed and forwarded to the applicants with specific requirements for project improvements to help meet the watershed goals.

4.6 Wasteload Allocations

The previous Control Regulation 72 allocated among the point sources their share of the Total Maximum Annual Load of phosphorus that could enter the reservoir. These wasteload allocations were assigned to wastewater facilities, industrial process wastewater sources, and developing areas. However, in 2009 the Commission removed all TMAL-related components from Regulation 72. Because these changes were not effective until January 1, 2010, information on wastewater treatment plant compliance with the assigned wasteload allocations for 2009 is still included in Table 4-1.

4.7 Trading Program, Including TMAL Reductions from Trading Program

The Authority initiated the Cherry Creek Reservoir watershed phosphorus trading program in 1997. The trading program allowed 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 could also sell or lease phosphorus credits through the Reserve Pool.

The goal of the Trading Program, which allowed phosphorus trading from the Phosphorus Bank, was to encourage and facilitate the construction of nonpoint source control projects and retrofit of existing stormwater facilities with water quality enhancements that were not in the original design. Watershed-based trading was used as a successful water quality management strategy that could provide net reductions to the phosphorus TMAL, as well as provide additional environmental benefits in the Cherry Creek Reservoir watershed.

The Authority did not receive any new trade project applications in 2009. In addition, changes to Control Regulation No. 72 effective January 1, 2010, suspended the trading program.

4.8 Temporary Transfers, Reserve Pool Allocations, and Semi-Urban Area Transfers

Under the previous Regulation 72, the Authority was authorized to implement and maintain the sale or lease of phosphorus pounds from the Reserve Pool. The Reserve Pool included 216 pounds of phosphorus credits from projects already constructed by the Authority (and approved by the Commission) and could be sold by

the Authority to allocatees in the watershed. The Reserve Pool phosphorus credits were 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 were available for transfer and could be purchased or leased from the Authority at a price established by the Authority. Pounds sold or leased from the Reserve Pool were 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 2009.

Control Regulation 72 also allowed the temporary transfer of the unused portion of a phosphorus wasteload allocation from an existing discharger to another facility. Both the transferring and receiving facilities had to agree upon the temporary transfer.

There were no temporary transfers in 2009.

4.9 Actions Taken Pursuant to Previously-Approved TMAL

The previous Control Regulation 72, as adopted by the Commission in 2001, included 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.”

The previous Control Regulation 72 identified 13 specific activities to provide reasonable progress in attaining water quality standards and support revisions to the TMAL. Since 2001, the Authority worked to complete the studies and gain a better understanding of the watershed and the reservoir in preparation for the March 2009 Rulemaking Hearing. A more comprehensive review of these activities can be found in the Authority’s Summary of Activities to Comply with Phased TMAL Requirements³, which was submitted to the Commission as part of the Authority’s Prehearing Statement for the March 2009 Rulemaking Hearing.

As the result of the special studies and other information brought forth during the March 2009 hearing, the Commission took the following actions:

- Based on a finding that the 15 µg/l reservoir chlorophyll *a* standard was not attainable, adopted an 18 µg/l chlorophyll *a* standard with an attainment period of four out of 5 years. (Control Regulation No. 38, Statement of Basis and Purpose (SOBP) (§38.72), p.197).
- Removed all TMAL-related components of Control Regulation No. 72. As necessary, the Commission will direct the Division and the Authority to work with EPA in developing a separate TMAL document for the reservoir (Control Regulation No. 72, SOBP (§72.27), p. 49).
- Established a concentration-based watershed management approach for phosphorus control in the watershed. (Control Regulation No. 72, Statement of Basis and Purpose (§72.27), p. 48).
- Recognized that the appropriate designated projects conducted to support Phase I of the TMAL had been completed and therefore struck those requirements from the regulation.

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

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5. REGULATED STORMWATER SOURCE CONTROLS

Regulated stormwater is stormwater runoff that discharges to state waters (including the reservoir, streams, and groundwater) from regulated entities, which include commercial and industrial facilities, and from municipal separate storm sewer systems. Municipal Separate Storm Sewer Systems, or MS4s, are essentially storm sewer systems that are owned or operated by a state, city, town, county, district, or association having jurisdiction over the disposal of stormwater, sewage, or industrial wastes.

Regulated stormwater sources are subject to the Colorado Discharge Permit System Regulations (Regulation 61). Larger sources were originally regulated under the U.S. Environmental Protection Agency's (EPA) Stormwater Phase I Rule, which covered entities with populations over 100,000 and other significant dischargers. The City of Aurora and Colorado Department of Transportation (CDOT) were the only Cherry Creek Basin entities that were included under Phase I.

Regulation 61
Requirements

In 1999, the Stormwater Phase II Rule expanded the Phase I Rule to include several of the land use agencies that are part of the Authority. The Phase II Rule requires small MS4s to, at a minimum, adopt best management practices, or BMPs, for six minimum control measures, implement them to the maximum extent practicable (MEP), 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 required by Control Regulation 72. The six minimum requirements are:

- Public education and outreach
- Public involvement/participation
- Illicit connections and discharge detection and elimination
- Construction site stormwater runoff control
- Post-construction stormwater management in development/redevelopment
- Pollution prevention/good housekeeping for municipal operations

More detailed information on implementation for each Phase I and Phase II permittee can be found in the Stormwater Annual Reports that all MS4s are required to submit to the Division every year by March 10th.

Regulation 72
Requirements

The Cherry Creek Reservoir Control Regulation also spells out specific requirements that are to be applied to regulated stormwater discharges. The Authority recommended changes to Regulation 72 at the March 2009 hearing, which resulted in the revised Regulation No. 72 which became effective January 1, 2010. Relative to regulated stormwater and non-point source controls, there were several substantive changes to Regulation No. 72:

- New definitions were included to correspond with the recent revisions to Regulation 61. These definitions are intended to clarify the distinction in the application of PRFs and BMPs for various categories of sources. References to load were replaced with concentration.
- Other substantive revisions to the stormwater permit requirements revolve around the post-construction development and redevelopment requirements outlined in Regulation 61 and stream preservation area considerations. For post-construction development and redevelopment, a three-tiered approach to stormwater management BMPs was adopted to coincide with the requirements found in Regulation 61, while specifically addressing concerns within the basin. Also excluded were certain limited activities identified as insignificant contributors to water quality degradation.
- Over the last eight years, the Authority and permittees determined that there were certain types of land disturbances that would not result in water quality degradation and that greater flexibility in BMP selection or requirements was needed to preserve the integrity of the stream preservation area. Thus, the Commission identified specific activities where a land disturbance in a stream preservation area would not be detrimental to water quality, such as construction of a BMP in accordance with this regulation.

As the result of changes to the regulation, the Authority began updating its Stormwater Requirements⁴ and replacing them with CR72.7 Guidance Document⁵ to address the new regulatory requirements.

5.1 Sediment and Erosion Control Permits

Regulation 72 requires that, prior to commencement of certain land-disturbance activities, an Erosion and Sediment Control Plan must be submitted to and approved by the local MS4. All the land use agencies require a Grading Erosion and Sediment Control (GESC) Permit or a GESC Plan be submitted and approved prior to the start of any new land-disturbance activity. Land-disturbance activities include clearing, grading, or excavation of land; construction, expansion, or alteration of a residential, commercial, or industrial site or development; and construction of public improvements and facilities (e.g., roads, airports, and schools). Erosion and sediment control requirements during construction for each agency under the stormwater Phase II requirements are complimentary to the programs required under Regulation 72.

5.2 Construction BMPs

In 2000, the Authority adopted requirements related to construction activities in the Cherry Creek Reservoir watershed entitled the “Cherry Creek Reservoir Watershed Stormwater Quality Requirements”. These requirements recommend implementation of substantive BMP measures to control the quality of stormwater runoff from land disturbances on private and public property. The requirements were 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. All the land use agencies also maintain design standards for construction BMPs to limit the amount of sediment that enters the watershed during the construction of projects within the basin.

The numbers of construction sites covered by the different entities’ construction site runoff control programs in 2009 are summarized in Table 5-1 below. Inspection and enforcement actions for both construction sites and post-construction permanent BMPs are also included in Table 5-1, as well as the number of inspection and enforcement actions conducted in 2009 by the MS4s for construction sites.

⁴ CCBWQA February 16, 2000. *Cherry Creek Reservoir Watershed Stormwater Quality Requirements*.

⁵ CCBWQA - *Control Regulation 5 CCR 1002-72 Stormwater Permit Requirements Guidance Document*. Draft November 2009.

5.3 Permanent BMPs

The Cherry Creek Reservoir Watershed Stormwater Quality Requirements described above also include requirements for post-construction control of stormwater quality. All regulated new development and redevelopment projects must submit a post-construction BMP Plan to the MS4 for review and approval prior to commencing land-disturbance activities. Each of the land use agencies maintains design standards for permanent BMPs that remove sediment from stormwater runoff prior to the runoff being released into the watershed. Plans for permanent BMPs are reviewed and must be approved by the local land use agency prior to the start of construction on a project.

The number of water quality-control BMPs (or sites with permanent BMPs), number of inspections, and number of enforcement actions for post-construction activities are summarized for each MS4 in Table 5-1.

- **BMP:** a stormwater quality measure required under the regulated stormwater program for new and redevelopment
- **PRF:** a stormwater quality measure, such as stream stabilization, detention, wetlands, or other measure implemented to address nonpoint stormwater sources from existing and future land disturbances



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

Land Use Agency ^{1,2}	Construction Sites	Construction BMPs		Permanent BMPs		
	Total Sites	Number of Inspections	Number of Enforcement Actions	Number of BMPs (or BMP Sites) Constructed	Number of Inspections	Number of Enforcement Actions
Arapahoe County	34 in Basin	559 in Basin	10 in Basin	3 in Basin	5 in Basin	0 in Basin
Douglas County	305	1876	718	151	42	0
City of Aurora	20	53	8	1 in Basin	3 in Basin	0 in Basin
City of Centennial/SEMSWA ³	33 in Basin	559 in Basin	15 in Basin	7 in Basin	8 in Basin	6 in Basin
City of Greenwood Village	119	Full Level Inspections: 153 Reconnaissance Indicator Inspections: 5,881	Stop Work Orders: 1 Written Notices: 62 Verbal Notices: 109 # of Sites Where Inspections Were Withheld: 2	12 Sites Implemented in 2009; however, 191 Sites Since Full Implementation of Program	Number of Site Inspections: 238	0
City of Lone Tree	3 in Basin	6 in Basin	1 in Basin	0 in Basin	0 in Basin	0 in Basin
City of Castle Pines North	10	36	0	7	13	0
Town of Castle Rock	GESC ⁸ : 101 DESC ⁹ : 463	GESC ⁸ : 1096 DESC ⁹ : 1113	GESC ⁸ : 415 DESC ⁹ : 282	10	404	0
Town of Parker	39 ⁴	Full Level Inspections: 84 Additional Inspections: 563 ⁵	Notices of Intent to Issue Stop Work Order: 15 Stop Work Orders: 5	262	262	n/a ⁶
CDOT	3 in Basin	22 in Basin	0 in Basin	10 in Basin	1 in Basin	1 in Basin

¹ Some of 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 unless otherwise noted.

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

³ The Southeast Metro Storm Water Authority (SEMSWA) is the MS4 permittee for the City of Centennial and is a member of the TAC.

⁴ This number applies to all construction sites that were active for any amount of time during 2009. This number also includes minor construction projects (i.e. utility projects, etc.) that do not necessitate "full level" inspections.

⁵ This number represents an estimate; refers to indicators, complaint investigation, follow-up & post-precipitation inspections

⁶ The Town of Parker performs regular inspections and executes the necessary maintenance of all permanent BMPs within the Town. As a result, enforcement actions are unnecessary.

⁸ GESC = Grading, erosion, and sediment control (permitting/inspection process for land-disturbing activities)

⁹ DESC = Drainage, erosion, and sediment control (permitting/inspection process for detached, single-family residential construction)

5.4 Flood Control Facilities Retrofitting, Inspection, and Maintenance Actions

An annual inspection of pollutant reduction facilities was conducted on Tuesday, October 20, 2009 by the Authority, Cherry Creek State Park, and the Army Corps of Engineers. The purpose of the inspection was to assess whether PRFs are functioning as designed and to identify routine, restorative, and rehabilitative

maintenance requirements. The TAC uses the inspection report to provide recommendations to the Board for the following fiscal year budgeting of maintenance activities.

This year's inspection was conducted subsequent to improvements made to PRFs as part of the 2008 PRF Maintenance Program, which was completed in April 2009, and the Cottonwood Creek Phase II Stream Reclamation project, which was completed July 2009. Conclusions of the 2009 annual inspection are:

1. All PRFs are performing as designed, but some routine, restorative, and rehabilitation maintenance activities are recommended and are planned for 2010.
2. The projected total operations and maintenance (O&M) cost as the result of this inspection is \$ 274,500, as compared to the last inspection, which was \$222,000.
 - a. The largest expenditure is rehabilitation of the Cottonwood Perimeter Road wetlands projected to be up to \$266,000 based on 2009 preliminary design.
 - b. The remaining maintenance projection is \$8,500 for minor restorative and rehabilitative maintenance work for East Boat Ramp (\$5,500) and Tower Loop (\$3,000).

5.5 Effectiveness in Reducing Phosphorus Concentrations

At the March 2009 rulemaking hearing, the Commission concluded that point, nonpoint source, and regulated stormwater controls for total phosphorus (including the permitted MS4 activities) are successfully reducing total phosphorus concentrations in stormwater and surface water flows to the reservoir. This is supported by monitoring being conducted both upstream and downstream of the PRFs, which effectively measures the cumulative benefits of BMP implementation in the upstream watershed. This data confirms that the BMPs and other controls placed on regulated stormwater continue to be effective. Watershed and reservoir modeling results have shown that, although population growth and surface flows have increased in the basin, the total phosphorus concentration in the inflow to the reservoir has remained relatively constant.

In addition to the controls required by Regulation 72 for regulated stormwater sources, the Authority also ensures implementation of effective BMPs through other activities. The Authority serves as a referral agency in the land use application process for several 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. Table 5-2 provides a review of the number of land use and development applications that the Authority has reviewed annually since March 1997 and Table 5-3 provides a summary of 2009 referrals by land use agency.

Table 5-2. 1997 - 2009 Land Use and Development Applications Reviewed by Authority

Year	# of Applications
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
2009	97
Total	2054

Table 5-3. 2009 Land Use and Development Application Referrals by Entity

Referring Agency	# of Applications
Arapahoe County	6
Douglas County	23
City of Aurora	13
City of Centennial	14
Town of Castle Pines North	5
Greenwood Village	1
Town of Castle Rock	4
Town of Parker	27
Town of Foxfield	1
SEMSWA	1
Colorado Department of Transportation	2
Total	97

The Authority's review of applications for land use changes 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 has resulted 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.

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.

In addition, the Authority is actively participating in Urban Drainage and Flood Control District's (UDFCD), efforts to revise the Urban Storm Drainage Criteria Manual Volume 3 Best Management Practices. This process is considering, among other items, updates to extended detention basins, grass swales and buffers, porous landscape detention (bioretention), and proprietary BMP requirements. The Authority will continue to participate in the Volume 3 revision process through 2010.

5.6 Funding of Regulated Stormwater Projects

For new and redevelopment construction projects within the jurisdictional boundaries of the land use agencies, the developer or land owner is held responsible for planning, construction, operation, and maintenance of BMPs. The developer must also make any necessary repairs to BMPs immediately after a defect or need for repair is discovered. For permanent BMPs, the Post-Construction BMP Plan required is to address the design, construction, and long-term operation and maintenance. The plan must contain procedures for maintenance and inspections to ensure the continued effectiveness of the permanent BMPs, as well as commitments from the responsible agency or owner to maintain the BMPs. The plan must also contain provisions for dedication by easement or other legal means of access of operation, maintenance, and inspection.

5.7 Monitoring of Regulated Stormwater Projects

At the March 2009 rulemaking hearing, the Commission found that it was necessary for the Authority to continue to monitor and maintain all nonpoint source runoff PRFs for total phosphorus concentration controls. (PRF monitoring is further discussed in Chapter 6.) The Commission also concluded that individual monitoring of BMPs need not occur because PRF monitoring upstream and downstream of the project effectively measure the cumulative benefits of BMP implementation in the upstream watershed.

5.8 Public Information and Education Actions

All entities have public education and outreach programs such as;

- Coordination with other entities (Authority, Phase II Co-op Workgroup, Cherry Creek Stewardship Partners, UDFCD);
- Distribution of issue-specific fact sheets and brochures to residents and commercial entities;
- Participation on school programs (e.g., project WET and graduate students' programs);
- Educational projects such as willow planting, channel repairs and stabilization with scout troops; and
- Web sites, hot lines, surveys, public service announcements.

The majority of the land use agencies also maintain links on their websites for general information about what community members can do to help maintain stormwater quality.

The Authority has increased its participation in community-based programs that engage local citizens in volunteer service projects designed to educate participants. Working with the Cherry Creek Stewardship Partners (Partners) to deliver the message that Open Space is the BMP for water quality, activities are designed to highlight the value of riparian buffers, floodplain management, and household water pollution prevention. Regular and periodic site visits to constructed BMP's, offered to neighborhood groups, give the public a better understanding of the function of these innovative projects, and provide consulting engineers the opportunity to evaluate and adapt maintenance as needed.

Volunteer service projects include water quality and habitat monitoring, storm drain stenciling, delivery of brochures and fact sheets, development of recreational guides, maintenance and review of websites, participation at public events, support for classroom and field trips at local schools, teacher training workshops open to home schoolers, and promoting tributary signage to increase public awareness of local water resources.

Education and outreach includes sponsorship of the Denver Metro Regional Science and Engineering Fair, the Colorado Science and Engineering Fair, an Annual Teacher Training Workshop, and Water Quality Programs for local businesses, school, church, neighborhood, and youth groups.

The Authority has been a supportive participant in the effort to create and update the Cherry Creek Basin Water Stewardship and Education Initiative. This document is a compilation of the Public Education and Outreach and Public Participation/Involvement minimum control measures identified by key stakeholders in the Cherry Creek watershed which forms the basis for the multiple year workplan of the Partners. With support from the Authority, as well as all the other MS4 permittees in the Cherry Creek watershed, the Partners provide a forum to continue the development and implementation of a public information and outreach program that meets the regulatory requirements of Regulation 72 and the objectives identified in the Cherry Creek Basin Watershed Plan (2003).

A representative of the Partners is a voting member of the TAC which is instrumental in determining the appropriate BMPs and measurable goals for public education and outreach.

The Authority recognizes the benefit of utilizing locally adapted educational materials and existing programs created by resource experts. Preferred programs include: Project WET, Colorado Foundation for Agriculture, Natural Resource Conservation Service, U.S. Geological Survey, CSU Extension Service, Colorado Division of Wildlife, Colorado State Parks, and local natural resource programs.

By providing opportunities for service projects, field trips, and tours to individuals and organizations both within and outside of the Authority's regulatory boundaries, partnership activities reach a variety of audiences, age ranges, and interests. Interested parties with urban ties and rural roots have the opportunity to explore a range of opportunities provided through the educational and recreational network of the Partners, Cherry Creek Regional Trail Providers, Colorado Front Range Trail, and others.



The Authority participates in regularly scheduled and well-attended activities open to the public that provide unique opportunities for land use agencies and the public to interact. Community service activities that are hosted by and have the participation of elected officials, land-use agency staff, and consultants give citizens the benefit of project expertise and encourage pride of ownership and knowledgeable assessment of BMPs and PRFs. Examples include the TAC meetings, and ongoing activities with Americorps and Summer of Service, Colorado State Parks, Volunteers for Outdoor Colorado, REI, Cherry Creek Working Group, and various Boy Scout and Girl Scout troops.

Volunteer water quality monitoring is encouraged by providing volunteer instructors to local business, school, and community groups. The Authority refers to CSU Extension Service materials, Colorado River Watch, uses and provides LaMotte Water and Soil testing kits as part of its educational program coordinated through the Partners.

In an effort to protect water quality, Cherry Creek Reservoir, Cherry Creek and its tributaries have been the subject of regulation and monitoring for over 18 years. Geologists, hydrologists, engineers and chemists have compiled data to create both a reservoir and a watershed model in an effort to understand how a prairie stream reacts to development, changes in hydrology and reclamation efforts. Local residents and wildlife specialists have compiled lists of animal activity and dazzling photographs sharing their knowledge with other budding naturalists. Cherry Creek has proven to be an extraordinary outdoor classroom.

Partners 2009 Activities:

The Partners' model for education and outreach is based on a continuum which starts with AWARENESS – where are we, what is around us and why is it here; which hopefully sparks a quest for KNOWLEDGE – what goes on along this complex and fascinating prairie stream which has provided sustenance and guidance to generations of human travelers, what are the birds, mammals and insects that share this environment; and leads to STEWARDSHIP – shared responsibility for making our communities more compatible with the natural surroundings, adopting non-structural solutions that engage more brain than brawn.

In 2009 the Partners continued to take it outside with area teachers and students, the Scouting community, Americorps and Summer of Service, the Cherry Creek Working Group, University of Colorado at Denver Landscape Architecture and Ecology students, Friends of 17-Mile House, and many others. The Partners will continue to add value to the volunteer experience by providing guided exploration as a part of all its service-learning projects. Specifically, the Partners are working to develop qualitative habitat assessment protocols which will allow citizen scientists to collect and share data based on their observations of Cherry Creek. Partners and volunteers will be building a knowledge base to share with their neighbors.

In addition to the activities of the Open Space Committee (January bird watching along Cottonwood Creek, year-round monitoring of wildlife at Cherry Creek Valley Eco Park and service learning projects at the many Open Space Parks in Douglas, Arapahoe and Denver counties, and the Run for the Watershed) major planning efforts are underway with the Cherry Creek Working Group and the Arapahoe County Open Space Group.

In the upper part of the Cherry Creek watershed, the efforts of Douglas County Open Space & Natural Resources staff have resulted in the acquisition and conservation of the 771 acre Palmer Divide Ranch protecting 1.6 miles of West Cherry Creek. Douglas County residents have invested over \$11 million in the Cherry Creek corridor.

Additionally, the Partners recognized the Parker Jordan Metropolitan District's purchase of 80 acres along Cherry Creek in Centennial with a Stewardship Award celebrating the acquisition of this extraordinary riparian area at the 2009 Cherry Creek Annual Conference.

The Partners' participation in the Metro Regional Science and Engineering Fair in February of each year provides encouragement to students and teachers to explore water issues through interaction with the students at the Fair and the presentation of Award certificates along with a small cash prize. The Authority, ACWWA, SPLASH, Arapahoe County, and Parker Jordan Metro District are the named sponsors



of these awards which are given to individual students and to the school that has shown a particular focus on water-related issues. The teachers receiving that recognition have been extremely appreciative and the energy around the Science Fair is a great way to start the Education year.

A common education and public participation goal of the Partners is to engage the agricultural community in the water quality conversation. To acknowledge the important role of farming and ranching in Colorado's economy and because there is a sense that many of us are disconnected from our agrarian 'roots' we chose the theme of agriculture for our 2009 Teacher Training Workshop Cultivate Your Inner Farmer. Working with existing resources provided by Project WET, the Aurora Water Quality Understanding & Awareness facility (AWQUA Lounge), the Colorado Foundation for Agriculture, River Watch, 17-Mile Farm Park, Prairie Canyon Ranch and the Natural Resource Conservation Service 18 teachers from Longmont to Larkspur experience two full days of exploring and learning in the Cherry Creek watershed.

A new Partner was welcomed this year, CU School of Landscape Architecture Charlie Chase. His graduate and undergraduate students are enjoying Cherry Creek's outdoor classroom practicing their site assessment, planning and design skills at various locations in the basin. Right now they are incorporating the concept of range management to improve traffic flow and ease some of the pressure on Cherry Creek that comes from intensive human and animal use of the off-leash area at Cherry Creek State Park.



2009 ANNUAL REPORT ON ACTIVITIES

6. NONPOINT SOURCE STORMWATER CONTROLS

Nonpoint source stormwater controls consist of Pollution Reduction Facilities, or PRFs, which are Best Management Practices constructed by the Authority. These stormwater quality measures, such as stream stabilization, detention, wetlands, and other measures, are implemented to address nonpoint stormwater sources from existing and future land disturbances. PRFs are different from the BMPs that are implemented by local land use agencies (i.e., MS4s) under the regulated stormwater program that was discussed in Section 5 above. The difference between PRFs and BMPs was recognized in the new Regulation 72 through the addition of several new definitions intended to clarify this distinction.

6.1 Updated List of PRFs Implemented

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 2009. To meet this requirement, the Authority conducts a multi-year Capital Improvement Project (CIP) planning process (currently five-year projections are made) to identify and 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.



CHERRY CREEK BASIN WATER QUALITY AUTHORITY

2009 Capital Project Status Report (December 7, 2009)

- 1. Cottonwood Creek Stream Reclamation – Phase II**
 - a. Description: Completion of stream reclamation project awarded in 2008.
 - b. Status: All construction work completed as of April 2009. One year warranty remains on vegetation planted in 2009. Final punch list items are finished and Engineer certified completion. Board approved Muller's request for extras due to continued delay in contractor performance. All claims have been settled.
 - c. Action Items: Authority made final payment at November Board meeting.

- 2. Cottonwood Wetlands (aka Perimeter Road Pond).**
 - a. Description: Maintenance design to remove cumulated sediment and restore water quality function.
 - b. Status: On indefinite hold due to discovery of clay pigeons on site, which may require site characterization and disposal at certified land fill. Meeting with USACE and State Parks determined responsibility lies with State Parks. Parks has allocated funds for 2010 to remove clay pigeons from the excavation area of the project. Investigations suggest that clay pigeons do not have to be removed, but if so, they must be disposed off-site.
 - c. Action Items: Work plan and IGA in progress.

- 3. Cottonwood Creek Stream Reclamation at Easter Avenue**
 - a. Description: Co-funding for construction of stream reclamation project with SEMSWA.
 - b. Status: Board approved revised IGA for partial funding on May 21, 2009. SEMSWA signed IGA on June 24, 2009. Bidding will begin when all easements are finalized.
 - c. Action Items: Authority to monitor bidding and construction.

- 4. Cherry Creek Stream Reclamation at Eco-Park**
 - a. Description: Co-funding for design of stream reclamation project with SEMSWA
 - b. Status: TAC commented on draft terms and conditions for IGA on July 2, 2009.
 - c. Action Items: Authority pursuing IGA with SEMSWA.

- 5. Cherry Creek Stream Reclamation at 12-Mile Park**
 - a. Description: Preliminary design of stream reclamation by Authority.
 - b. Status: Draft scope, schedule, and budget in progress.
 - c. Action Items: Authorized proceeding with RFP process at December TAC.

- 6. Cherry Creek Stream Reclamation at Vermillion Creek**
 - a. Description: Co-funding for design of stream stabilization project with Parker Jordan Metro District.
 - b. Status: Waiting for IGA request from Parker Jordan Metro District (PJMD). Inspected creek damage on 9/28/09.
 - c. Action Items: Monitor design work by PJMD consultant.

- 7. Reservoir Shoreline Stabilization at Mountain Loop**
 - a. Description: Final design of improvements based on preliminary design in 2008.
 - b. Status: Board approved award at June 18, 2009 meeting. TAC rejected scope modifications. Contract signed. Surveying completed, design underway.
 - c. Action Items: Monitor design work by MEC.

8. McMurdo Gulch Stream Reclamation

- a. Description: Co-funding for design of stream stabilization project with Castle Rock
- b. Status: IGA approvals pending. Design work initiated by Castle Rock and Authority providing oversight and guidance.
- c. Action Items: IGA approved at the November Board meeting.

9. Stream Corridor Preservation

- a. Description: Co-funding of property acquisition of stream buffers
- b. Status: Waiting for opportunity.
- c. Action Items: None

10. Cottonwood Creek Stream Reclamation –Weed Control

- a. Description: Weed control at Phase I and Phase II
- b. Status: Cherry Creek State Park contracted with VMI for weed control. Spring weed control in Phase I and II and east shore line PRFs have been completed and invoiced. Board approved CCSP request for funding of prairie dog management equipment.
- c. Action Items: Board approved RG Construction bid for silt fence removal in November.

11. Reservoir Destratification

- a. Description: Routine O&M, system evaluation, and minor upgrades.
- b. Status-Compressor: Routine O&M, system evaluation, and upgrades in progress. 8000 hour inspection performed June 26, 2009. Additional modifications to ventilation in compressor building to control heat have been made. Authority receiving daily reports on compressor power status by email. Cleaning of compressor plenum chamber completed. TAC report presented to Board on October 15 and was reviewed by Board at October and November meetings. Additional overheating shut-down occurred on November 7, 2009 and system would not restart. Inspection by Power Service Company determined that the unloader valve solenoid wiring was burned and that the electronic controls malfunctioned, both of which were repaired.
- c. Status-Aerators: Inspection, cleaning, and repairs of aerators completed September 2, 2009 at an estimated cost of \$10,200, which is within the 2009 budget.
- d. Action Items: System shut-down for the winter on 11-25-09. Relocate unloader discharge after shutdown due to high equipment temperatures.

12. 2008 PRF Maintenance Program

- a. Description: Repairs of PRF's constructed along east shoreline of reservoir.
- b. Status: All construction work completed as of May 2009. Authority made final payment. Project closed.

13. Cherry Creek at Shop Creek Trail

- a. Note: Board added this project to CIP list and awarded design to Brown and Caldwell on June 18, 2009.
- b. Description: Prepare Stream Stabilization Plan for 2,000 feet of Cherry Creek between Wetlands and Shop Creek trails.
- c. Status: Final contract with Brown and Caldwell signed and preliminary design work in progress. Emergency protection of two major water lines by City of Aurora is complete. Data collection and evaluation phase of work in progress. Conceptual design completed.
- d. Action items: Monitor design work by B&C.

6.2 Floodplain Preservation/Conservation Easements

The Commission recognizes protection of floodplain, riparian corridor, and other environmentally sensitive lands through public acquisition or conservation easement and restoration of the same lands for nutrient control through erosion control, revegetation, or other means, as nonpoint source nutrient controls. The Authority and local governments may collaborate with other entities in pursuing easements, ownerships, and rights to protect the streams, riparian corridors, tributaries, and wetlands in the Cherry Creek watershed.

In 2002 and 2003, the Authority was a funding partner in the acquisition of 21.5-acres of land at the confluence of Piney Creek and Cherry Creek whose shape resembled a bowtie and was hence called the bowtie property. The purchase was a joint effort between the City of Centennial, Arapahoe County, the Urban Drainage & Flood Control District, and the Authority and preserved the channel and riparian corridor of Piney Creek from future development, and returned an existing developed area into open space park.

Since the acquisition of the bowtie property, the Authority's annual budget has included funds allocated to stream preservation as a place holder should opportunities arise during the year to participate in other acquisition or conservation projects.

6.3 Effectiveness in Reducing Phosphorus Concentration

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 very promising results, now that about three miles of the stream system has been stabilized using the "treatment train" approach. The final phase was completion of Cottonwood Creek Phase II in 2008. This treatment train includes the Cottonwood Creek-Peoria Pond upstream of Peoria Street, 2.2 miles of Cottonwood Creek Stream Reclamation, and the Cottonwood Wetlands Pond downstream of West Lake View Road. The mean annual, flow-weighted total phosphorus



concentration at the upstream end of the treatment train for 2009 was 0.134 mg/l and at the downstream end was 0.074 mg/l. These phosphorus concentrations are below 0.19 mg/l, which is considered be watershed background conditions⁶ and below the Authority-established flow-weighted concentration goal of 0.20 mg/l for all external flow sources to the reservoir.

The Cottonwood Creek-Peoria Pond structure came on line midway through 2002. In 2009, the mean total phosphorus concentration showed a 28 percent decrease downstream of the pond. Total suspended solids also showed a substantial decrease of 42 percent downstream of the PRF.

Following the maintenance on the PRF in 2008, it appeared to continue to be very efficient in reducing phosphorus and suspended solids.

⁶ CCBWQA January 4, 2009. *Summary of Activities to Comply with Phased TMLAL Requirements.*

In 2008, the Cottonwood Creek Reclamation Project was completed. The channel was relocated to its historic location, and the amount of erosion in this reach was substantially reduced by widening the channel and dissipating the flow energy through this reach. This channel stabilization and reclamation project appears to have greatly reduced the amount of phosphorus in flows through this reach. During the past two years, the flow-weighted phosphorus concentration at this site has been reduced by approximately 60 percent as compared to the previous 10 years. In 2009, the Cottonwood Creek Wetlands Pond PRF reduced the phosphorus concentration by 8 percent. The effectiveness of the wetlands pond appears to have been diminished over the past few years, and is currently undergoing final design to rehabilitate the PRF.

In addition, the Authority has made progress in 2009 in meeting the requirements of Regulation 72 for control of nonpoint and regulated stormwater source pollution in the following ways.

- Completed all the special studies identified in Regulation No. 72, providing data and analyses that was brought forward at the March 2009 Rulemaking Hearing allowing the Commission to adopt revisions to the water quality standard for chlorophyll *a* in the reservoir. Specifically, the Commission has changed the seasonal chlorophyll *a* standard from 15 µg/l to 18 µg/l to be attained four out of five years.
- Monitored development activities in the watershed for compliance with stormwater quality requirements by providing review comments to local governments on land use change applications.
- Identified and constructed PRFs in the watershed to reduce phosphorus concentrations entering Cherry Creek Reservoir.

6.4 Funding of PRFs

The Authority funds the PRFs. As noted above, the 5-year CIP identifies various cost components for the PRFs, including 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.

6.5 Monitoring of PRFs

The Authority contracted in 2009 with GEI Consultants to implement its annual Phosphorus Reduction Facilities monitoring program. Monitoring is conducted on Cottonwood Creek at sites above and below both the Peoria Pond PRF and the Perimeter Pond PRF. GEI has not monitored the Shop Creek and Quincy Drainage PRFs for effectiveness since 2000. This monitoring is discussed further in Section 8.4.



CHERRY CREEK BASIN WATER QUALITY AUTHORITY
TABLE 6-1 - SUMMARY OF RECOMMENDED POLLUTANT REDUCTION FACILITIES
 2010 - 2014 BUDGET PROJECTIONS (1000\$)

September 23, 2009

Project No.	Project Title	Project Budget						Previous Expend. Note 11	Residual PRF Costs	Proposed 2010 Budget					Proposed 2011 Budget	Proposed 2012 Budget	Proposed 2013 Budget	Proposed 2014 Budget
		Capital ¹	Land	Water	Total	O&M	Authority Portion			Design ⁶	Capital	Land	Water	Total				
CCB-13.3	Cottonwood Creek Stream Reclamation at Easter Avenue ³	\$ 1,350	\$ -	\$ -	\$ 1,350	\$ 1	25%	\$ 338	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
CCB-5.7	Cherry Creek Stream Reclamation at Eco-Park	\$ 532	\$ -	\$ -	\$ 532	\$ 1	29%	\$ -	\$ 154	\$ 59	\$ 95	\$ -	\$ -	\$ 154	\$ -	\$ -	\$ -	\$ -
CCB-5.10	Cherry Creek Stream Reclamation at Vermillion Creek	\$ 1,323	\$ -	\$ -	\$ 1,323	\$ 2	28%	\$ -	\$ 370	\$ 56	\$ -	\$ -	\$ -	\$ 56	\$ 315	\$ -	\$ -	\$ -
CCB-5.9	Cherry Creek Stream Reclamation at 12-Mile Park (CCSP)	\$ 300	\$ -	\$ -	\$ 300	\$ 1	100%	\$ 1	\$ 299	\$ 90	\$ -	\$ -	\$ -	\$ 90	\$ 209	\$ -	\$ -	\$ -
CCB-16	Stream Corridor Preservation ²	\$ -	\$ 500	\$ -	\$ 500	\$ -	100%	\$ -	\$ 500	\$ -	\$ -	\$ 100	\$ -	\$ 100	\$ 100	\$ 100	\$ 100	\$ 100
CCB-7.1	McMurdo Gulch Stream Reclamation ⁵	\$ 890	\$ -	\$ -	\$ 890	\$ 2	48%	\$ -	\$ 430	\$ 215	\$ -	\$ -	\$ -	\$ 215	\$ -	\$ -	\$ -	\$ -
CCB-5.4	Cherry Creek Stream Reclamation at Mainstreet (Parker) ¹⁷	\$ 1,776	\$ -	\$ -	\$ 1,776	\$ 1	11%	\$ -	\$ 200	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 200	\$ -	\$ -	\$ -
CCB-5.6	Cherry Creek Stream Reclamation at Lincoln Avenue (Parker) ¹⁷	\$ 1,447	\$ -	\$ -	\$ 1,447	\$ 1	21%	\$ -	\$ 304	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 304	\$ -	\$ -
CCB-5.11	Cherry Creek Stream Reclamation at Norton Open Space ¹⁷	\$ 329	\$ -	\$ -	\$ 329	\$ 1	46%	\$ -	\$ 151	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 151	\$ -	\$ -
CCB-18	ISDS Sewer Service ¹⁸	\$ 350	\$ -	\$ -	\$ 350	\$ -	100%	\$ -	\$ 350	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 100	\$ -	\$ 250	\$ -
CCB-5.8	Cherry Creek Stream Reclamation 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-5.13	Cherry Creek Stream Reclamation at Shop Creek Trail	\$ 200	\$ -	\$ -	\$ 200	\$ 1	100%	\$ 39	\$ 161	\$ -	\$ 161	\$ -	\$ -	\$ 161	\$ -	\$ -	\$ -	\$ -
CCB-12.1	Bowtie Phase I ⁹	\$ 616	\$ 450	\$ -	\$ 1,066	\$ 6	100%	\$ -	\$ 1,066	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 50	\$ 500	\$ 516
CCB-17.2	Reservoir Shoreline Stabilization Mountain Loop Trail	\$ 786	\$ -	\$ -	\$ 786	\$ 1	100%	\$ -	\$ 786	\$ 65	\$ -	\$ -	\$ -	\$ 65	\$ 721	\$ -	\$ -	\$ -
	SUB-TOTALS	\$ 12,772	\$ 1,000	\$ -	\$ 13,772	\$ 109		\$ 448	\$ 5,322	\$ 485	\$ 256	\$ 100	\$ -	\$ 841	\$ 1,645	\$ 1,145	\$ 850	\$ 616
	OPERATIONS AND MAINTENANCE																	
	<i>Rehabilitation Categories</i>																	
OM-1	Restore Cottonwood Perimeter Road	\$ 296	\$ -	\$ -	\$ -	\$ 296	100%	\$ 30	\$ 266	\$ 43	\$ 223	\$ -	\$ -	\$ 266	\$ -	\$ -	\$ -	\$ -
OM-8	Cottonwood/Peoria sediment removal ¹⁴	\$ 24	\$ -	\$ -	\$ -	\$ 24	25%	\$ -	\$ 6	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 24	\$ -	\$ -	\$ 24
	SUB-TOTALS	\$ 320				\$ 320		\$ 30	\$ 272	\$ 43	\$ 223	\$ -	\$ -	\$ 266	\$ 24	\$ -	\$ -	\$ 24
	<i>Restorative Categories</i>																	
OM-14	PRF weed control in CCSP ⁷	\$ -	\$ -	\$ -	\$ -	\$ 46	100%	\$ -	\$ 46	\$ -	\$ -	\$ -	\$ 46	\$ 46	\$ -	\$ -	\$ -	\$ 10
OM-6	Interpretive Signage restore	\$ -	\$ -	\$ -	\$ -	\$ -	50%	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 15	\$ -	\$ -	\$ -
	SUB-TOTALS	\$ -				\$ 46		\$ -	\$ 46	\$ -	\$ -	\$ -	\$ 46	\$ 46	\$ 15	\$ -	\$ -	\$ 10
	<i>Routine Categories</i>																	

CHERRY CREEK BASIN WATER QUALITY AUTHORITY
**TABLE 6-1 - SUMMARY OF RECOMMENDED POLLUTANT REDUCTION FACILITIES
 2010 - 2014 BUDGET PROJECTIONS (1000\$)**

September 23, 2009

Project No.	Project Title	Project Budget						Previous Expend. Note 11	Residual PRF Costs	Proposed 2010 Budget					Proposed 2011 Budget Total	Proposed 2012 Budget Total	Proposed 2013 Budget Total	Proposed 2014 Budget Total
		Capital ¹	Land	Water	Total	O&M	Authority Portion			Design ⁶	Capital	Land	Water	Total				
OM-7	Reservoir Destratification	\$ -	\$ -	\$ -	\$ -	\$ -	100%	\$ -	\$ -	\$ -	\$ 53	\$ -	\$ -	\$ 53	\$ 53	\$ 53	\$ 53	\$ 53
OM-15	PRF Emergency Repairs	\$ 15					100%	\$ -	\$ -	\$ -	\$ 15	\$ -	\$ -	\$ 15	\$ 15	\$ 15	\$ 15	\$ 15
	SUB-TOTALS	\$ -	\$ -	\$ -	\$ -	\$ -		\$ -	\$ -	\$ -	\$ 53	\$ -	\$ -	\$ 68	\$ 68	\$ 68	\$ 68	\$ 68
	SUB-TOTAL O&M	\$ 320	\$ -	\$ -	\$ -	\$ 366		\$ 30	\$ 318	\$ 43	\$ 276	\$ -	\$ 46	\$ 380	\$ 107	\$ 68	\$ 68	\$ 102
	GRAND TOTAL	\$ 13,092	\$ 1,000	\$ -	\$ 13,772	\$ 475		\$ 478	\$ 5,640	\$ 528	\$ 532	\$ 100	\$ 46	\$ 1,221	\$ 1,752	\$ 1,213	\$ 918	\$ 718

NOTES:

- 1 Includes engineering, administration, and contingency
- 2 Specific project not identified. Budget based on available funds. Cost of land/water purchase unknown. \$100k used as "place holder".
- 3 IGA with SEMSWA for construction funding signed in 2009
- 4 Total CIP = \$4,278M. Budget for stream reclamation portion of project partnering with local government after u/s Cherry Creek stabilization measures in place
- 5 IGA with Castle Rock for design/construction funding anticipated in 2010
- 6 Includes technical feasibility, design, construction observation and administrative costs
- 7 Authority 100% responsible for weed control in CCSP up to 5-years from project completion. Thereafter, Authority equally shares cost w/CCSP.
- 11 Accumulative expenditures for the project, based on previous years accounting and estimate of current year expenses
- 14 Assume Authority provides 25% of funds, with remaining under UDFCD cost sharing with SEMSWA for O&M
- 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

Following is a summary of nonpoint source projects that have been implemented in the basin by the Authority to date.

Detention with Wetlands:

- Shop Creek – completed 1991
- Cottonwood Wetlands – completed 1996
- Cottonwood/Peoria Pond – completed 2001

Detention with Infiltration:

- Quincy Drainage – completed 1995

Shoreline Stabilization:

- East Shade Shelter – completed 1996
- East Boat Ramp – completed 1996
- East Shoreline Extension – completed 1999
- Tower Loop – completed 1999
- Dixon Grove – completed 1999

Preservation of Stream Corridor:

- Bowtie Property Acquisition – completed 2003

Stream Stabilization:

- Cottonwood Creek Reclamation Phase I – completed 2004
- Cottonwood Creek Reclamation Phase II – completed 2008

Protection of Reservoir Water Quality:

- Reservoir Destratification (mixing to control algae) – completed 2007

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7. RIPARIAN AND WETLANDS PROTECTION

7.1 Protection, Enhancement, and Restoration Actions

The protection of floodplain, riparian corridor, and other environmentally sensitive lands through public acquisition or conservation easement and restoration of the same lands for nutrient control through erosion control, revegetation or other means, is recognized in Regulation 72 as another method to control nonpoint source nutrients. Despite the difficulty in quantifying the amount of phosphorus reductions from these actions, it is clear that such activities will assist in preventing future nutrient contributions to the reservoir. In addition, floodplain, wetlands, and riparian corridor restoration will provide recreational and aesthetic value to the watershed. The Authority and local governments are encouraged to voluntarily collaborate with other entities in pursuing easements, ownerships, and rights to protect the streams, riparian corridors, tributaries, and wetlands in the Cherry Creek watershed. However, the Commission also has recognized the difficulty in quantifying the amount of phosphorus loading reduction from these actions.

7.2 Stream Reclamation

Since 2001, the Authority has stressed stream reclamation as the preferred approach to channel and stream stabilization. Channel or stream reclamation means additional measures or enhancements to channel or stream stabilization that typically includes riparian and floodplain vegetation planting or enhancements and a channel cross section that results in more frequent connection and flooding of the overbank area. Riparian vegetation promotes filtration of fine particles with attached nutrients, and over-bank flooding promotes additional filtration and to some extent infiltration, which both reduce nutrient loads and concentrations. Therefore, the benefits from stream reclamation include the reduction in sediment and nutrient (i.e.: phosphorus) transport from the main channel, but also reduction in nutrient loads from riparian vegetation and more frequent floodplain inundation. Channel and stream reclamation also recognizes that urban development in the watershed has significantly altered the hydrologic regime which affects requirements for design of stream reclamation projects.

The Authority recently completed 2.2 miles of reclamation on Cottonwood Creek within Cherry Creek State Park and is participating as a funding partner and review agency for design and construction of other projects such as: McMurdo Gulch, Cherry Creek at Eco Park, Cherry Creek at Vermillion, and Cherry Creek at 12-Mile Park. Also refer to section 6.2, Floodplain Preservation/Conservation Easements for additional discussion related to riparian and wetlands protection.

7.3 Public Education and Information

As part of the Authority's water quality management approach, and consistent with the public information and educational activities required by Regulation 72, the Authority is committed to implementing 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 the reservoir.

Coordinated Education Initiative

The Authority has provided staff and funding to support the Cherry Creek Stewardship 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.

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 Regulation 72 and the objectives identified in Cherry Creek Basin Watershed Plan 2003.

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

Cherry Creek
Stewardship
Partners

In 2009, the Authority provided \$22,500 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 the watershed's recreational opportunities, such as the 2005 through 2009 "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 MS4 entities, the State Park, and the Authority, to more efficiently implement collaborative education and outreach activities. For more information on the Partners' activities in 2009 go to their website: (www.cherry-creek.org).

The Authority website also provides information and education on water quality issues within Cherry Creek Reservoir watershed and also as a storehouse of documents generated by, and related to, the Authority. The website can be found at www.cherrycreekbasin.org. The Authority is currently working to update the website to improve its functionality.

2009 Authority Accomplishments

Highlights in 2009 of the Authority's public information and education efforts include:

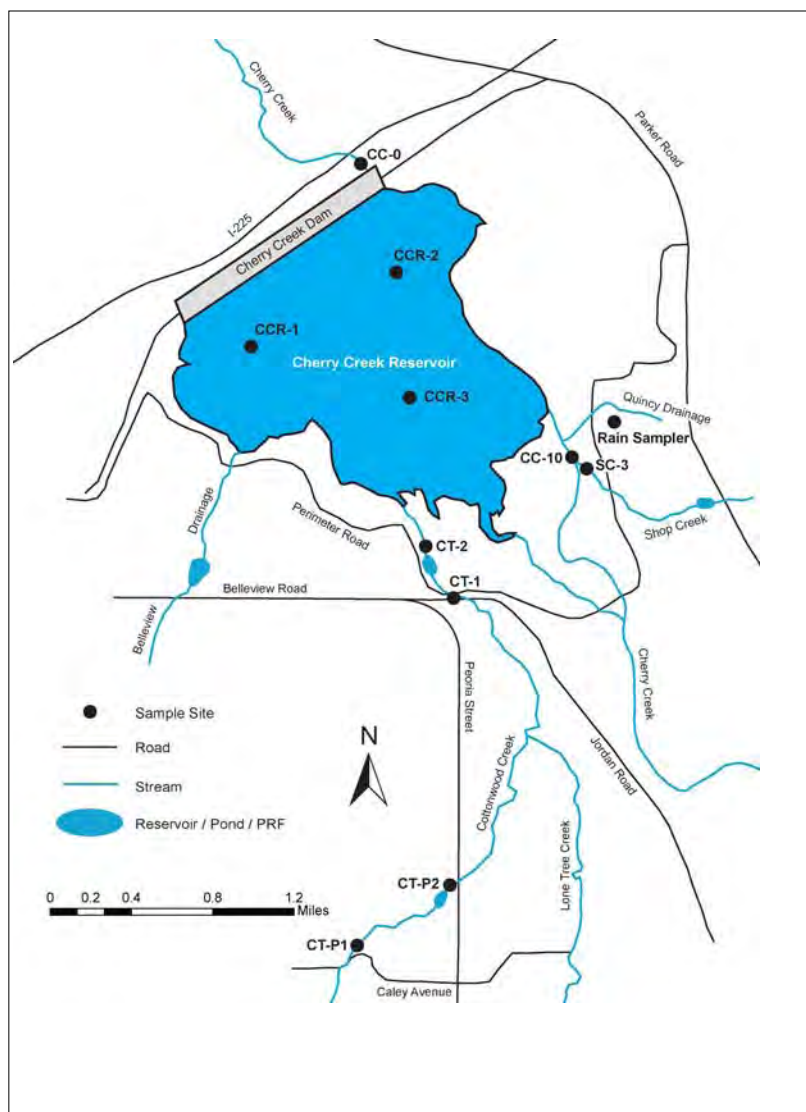
- The Authority leveraged resources by supporting the Partners and coordinating with other entities to implement the Education Initiative, a comprehensive and coordinated education strategy and action plan;
- The Authority continued the use of its website in cooperation with the Partners to facilitate 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; and
- The Partners facilitated broad community involvement and benefited long-term environmental stewardship from side-to-side outreach efforts.

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8. WATER QUALITY MONITORING - RESERVOIR AND WATERSHED CHARACTERISTICS AND STATUS OF WATER QUALITY COMPLIANCE

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

Figure 8-1. Sampling Sites on Cherry Creek Reservoir and Selected Streams

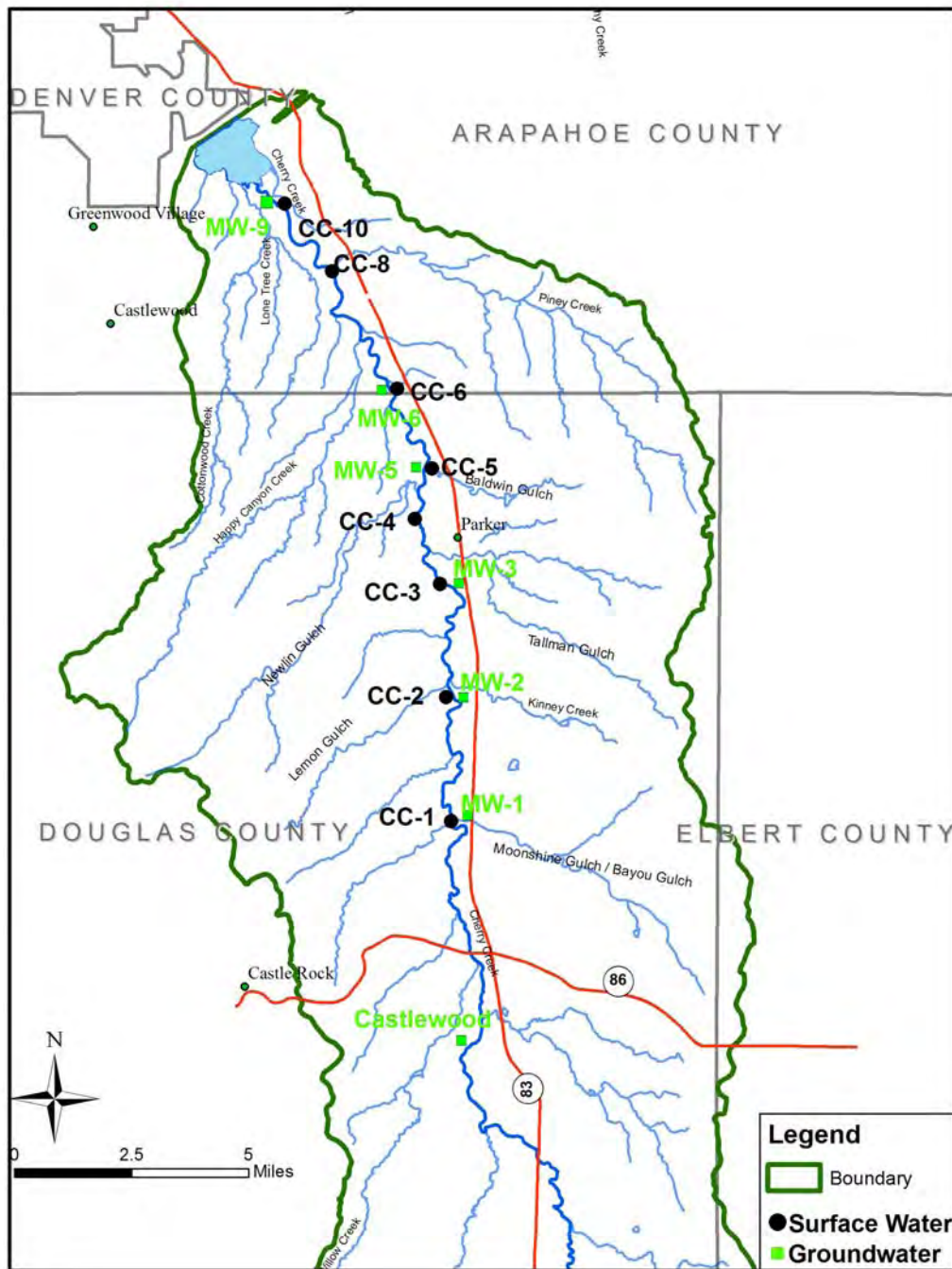


The Authority conducted reservoir and tributary sampling at ten sites in 2009, including three sites in Cherry Creek Reservoir, six sites on tributary streams, and one site on Cherry Creek downstream of the Reservoir (Figure 8-1). The Authority conducts sampling at sites upstream and downstream of the Cottonwood Creek-Peoria Pond and the Cottonwood Creek Perimeter Pond (aka, Cottonwood Wetlands Pond) to evaluate the effectiveness of these PRFs. This sampling also evaluates the effectiveness of the Cottonwood Creek Stream Reclamation project completed in 2009 since samples are obtained upstream and downstream of the project.

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 8-2). Complete data reports are provided in the Cherry Creek Reservoir 2009 Annual Aquatic Biological-Nutrient Monitoring Study and Cottonwood Creek Phosphorus Reduction Facility Monitoring Report prepared by GEI Consultants, Inc. (2009

Annual Monitoring Report), and the 2009 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 2009 Annual Monitoring Report.

Figure 8-2. Surface Water and Alluvial Groundwater Sampling Sites in the Watershed



In 2009, the July through September mean chlorophyll *a* content in Cherry Creek Reservoir was 13.2 $\mu\text{g}/\text{l}$, which met the new seasonal standard of 18 $\mu\text{g}/\text{l}$, and in terms of compliance, the reservoir has achieved the new standard for the 5 previous years. The 2009 flow-weighted phosphorous concentration of 234 $\mu\text{g}/\text{l}$ exceeded the goal of 200 $\mu\text{g}/\text{l}$, which was due in large part to the numerous storm events that occurred in 2009. In terms of annual inflow to the reservoir, 2009 ranked number 1 out of 18 years of inflow data with 29,736 acre-feet of water entering the reservoir.

The storm events in early July contributed to low dissolved oxygen conditions and low chlorophyll *a* observed during the 14 July 2009 sampling event. The storm events increased the suspended sediment load to the reservoir, increasing the oxygen demand at this time, while decreasing the ability of algae to photosynthesize. Dissolved oxygen concentrations at the surface of the Reservoir were slightly above 5 mg/l, although the average water column (0 to 6m) concentration was 4.25 mg/l. This average concentration is less than the table value standard of 5 mg/l for Class 1 warm water lakes and reservoirs. The average water column dissolved oxygen concentrations achieved the standard during the other Reservoir sampling events. Chlorophyll *a* concentrations right after the 14 July 2009 event were approximately 1 µg/l.

8.1 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 18 years of monitoring, as presented in the 2009 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.

8.1.1 Chlorophyll *a*

- Whole-lake chlorophyll *a* concentrations varied greatly throughout 2009, ranging from 1.1 µg/l in mid-July to 25.6 µg/l in late-September. The annual mean chlorophyll *a* concentration was 13.3 µg/l.
- The 2009 seasonal mean chlorophyll *a* concentration was 13.2 µg/l, which is less than the July-September seasonal mean chlorophyll *a* standard of 18 µg/l (Table 8-1). While the seasonal mean chlorophyll *a* concentration has varied greatly over the long term (1992-2009), there has been a significant decreasing trend ($p < 0.001$) in summer mean chlorophyll *a* concentration since 1999.



Table 8-1. Water Quality (July–September Average Concentration) and Total Phosphorus Load Data for Cherry Creek Reservoir, 1992 – 2009

Year	Chlorophyll <i>a</i> (µg/l)	Total Phosphorus (µg/l)	Total Nitrogen (µg/l)	Annual Phosphorus Load (lbs/yr)	Annual Inflow (ac-ft/yr)	Flow-weighted Phosphorus Concentration (µg/l)
1992	17.4	66	970	5,364	9,210	214
1993	14.8	62	826	3,114	5,851	196
1994	15.4	59	1,144	3,785	6,998	199
1995	15.6	48	913	5,736	11,788	179
1996	18.2	62	944	4,425	7,654	213
1997	22.0	96	1,120	5,659	10,391	200
1998	26.5	89	880	13,322	20,902	234
1999	28.6	81	753	17,672	27,604	235
2000	25.1	81	802	13,788	18,611	272
2001	26.1	87	741	9,099	17,246	194
2002	18.8	74	858	3,525	7,511	173
2003	25.8	90	1,121	9,390	14,953	231
2004	18.4	102	977	8,974	17,203	192
2005	17.1	116	990	10,725	18,534	213
2006	14.7	87	914	6,492	12,799	187
2007	12.6	118	716	19,772	29,586	246
2008	16.6	118	800	8,857	18,841	178
2009	13.2	98	1,236	18,938	29,736	234
Mean	19.3	85	928	9,369	15,857	210
Median	17.8	87	914	8,916	16,078	207

8.1.2 Phosphorus

- Whole-lake total phosphorus concentrations ranged from 51 µg/l in mid-March to 153 µg/l in mid-July, with an annual average of 83 µg/l.
- The 2009 July to September seasonal mean total phosphorus concentration was 98 µg/l. The seasonal mean total phosphorus concentration has varied greatly over the years, with the 2009 mean total phosphorus concentration being greater than the long-term median of 87 µg/l.

8.1.3 Nitrogen

- Whole-lake total nitrogen concentrations ranged from 619 µg/l in mid-June to 2,199 µg/l in mid-March. The 2009 annual mean total nitrogen concentration was 1,204 µg/l.
- The 2009 seasonal mean total nitrogen concentration was 1,236 µg/l, which was greater than the long-term median value of 914 µg/l.

8.1.4 Flow-Weighted Phosphorus Concentrations

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

- The 2009 flow-weighted phosphorous concentration is 234 µg/l, which is greater than the 200 mg/l flow-weighted phosphorous goal.

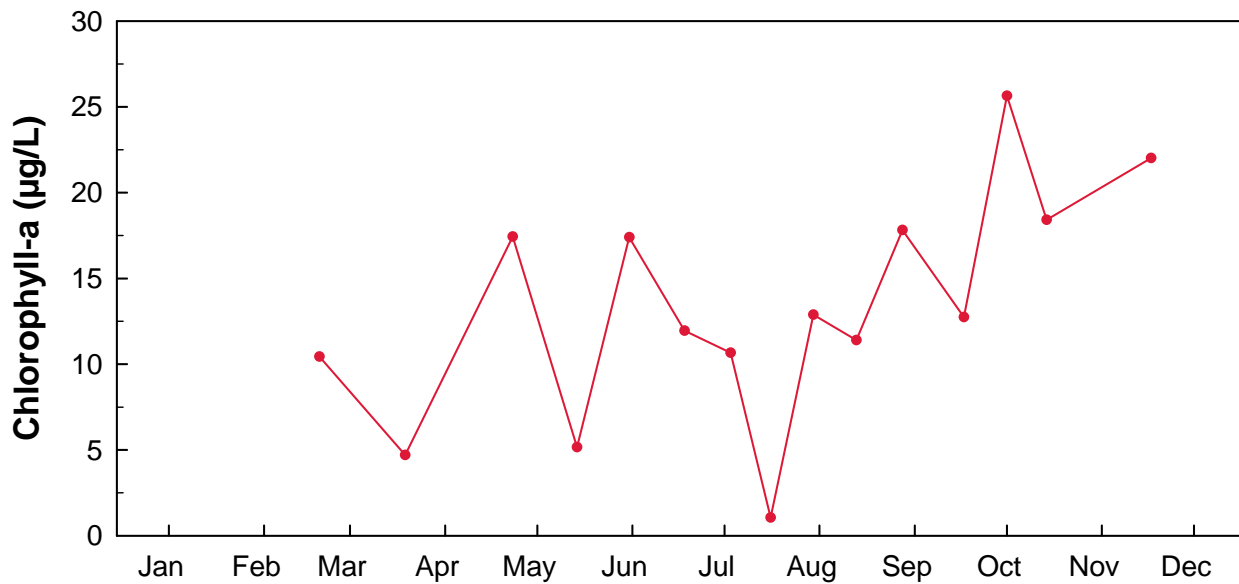
8.2 Cherry Creek Reservoir - Summary of 2009 Data

Presented below is a summary of 2009 water quality data for selected parameters. This information is also summarized in the 2009 Reservoir Monitoring Report (GEI 2009).

8.2.1 Chlorophyll *a*

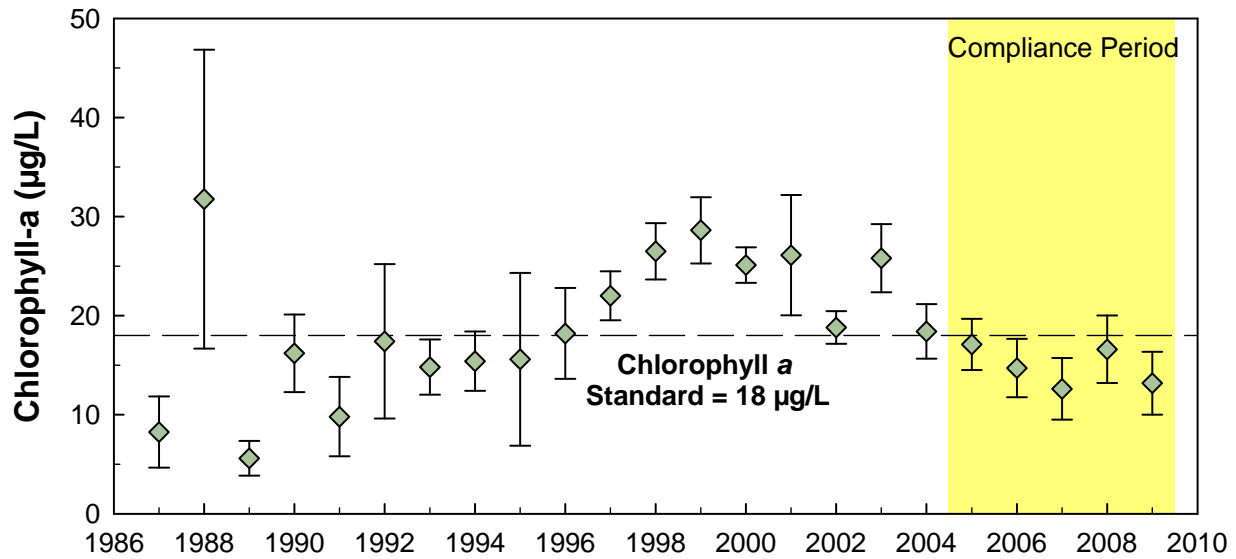
The annual pattern of chlorophyll *a* concentrations is quite variable with chlorophyll *a* less than 18 $\mu\text{g}/\text{l}$ throughout most of the year, except during late September to November. During the fall and winter diatoms typically dominate the algal community and the chlorophyll *a* levels increase due to their increased light capturing abilities (Figure 8-3). The seasonal mean chlorophyll *a* level of 13.2 $\mu\text{g}/\text{l}$ is relatively low for the reservoir, and was influenced by large storm event in early July that greatly reduced the clarity of the water column due to the substantial suspended sediment influx, which then reduced algal photosynthesis and chlorophyll *a*.

Figure 8-3. Concentration of Chlorophyll *a* ($\mu\text{g}/\text{l}$) in Cherry Creek Reservoir, 2009



The long-term chlorophyll *a* record shows considerable variability within and among the seasons, though with the revised 2009 standard, the reservoir is in compliance with the new chlorophyll *a* standard. The new chlorophyll *a* standard of 18 $\mu\text{g}/\text{l}$ was met in 2009. Since 1987, there has been no significant trend in the July through September mean concentration of chlorophyll *a* in Cherry Creek Reservoir (Figure 8-4). However, since 1999 there has been a steady decline in the seasonal mean chlorophyll *a* concentration.

Figure 8-4. Seasonal Mean (July to September) Chlorophyll *a* Concentrations Measured in Cherry Creek Reservoir, 1987 to 2009

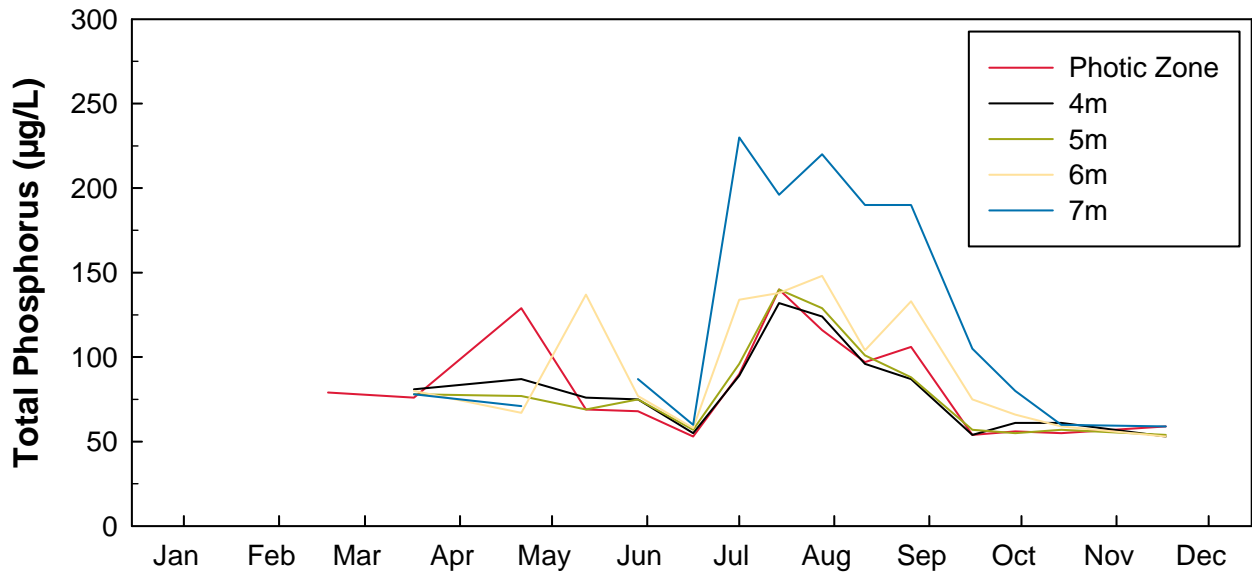


Note: Error bars represent a 95 percent confidence interval around each mean.

8.2.2 Phosphorus

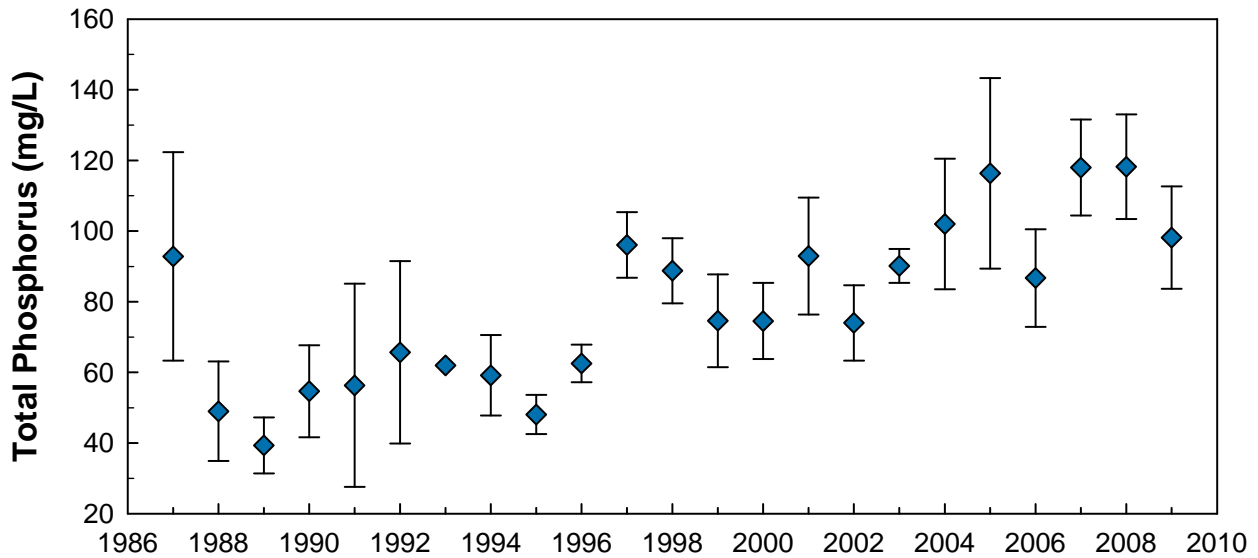
Nutrient profile samples collected in 2009 showed a well-mixed reservoir throughout the year. There were periods of nutrient release from bottom sediments from June through September as evidenced by increasing total phosphorus concentrations as compared with concentrations observed during the spring and late fall periods (Figure 8-5). The period of internal phosphorous loading shows a substantial increase in phosphorus at the 7 m depth, and a pattern of more consistent concentrations among the upper layers, though also elevated. This consistency within the upper layers is due to the diffusion of phosphorus between the 6 and 7 m layers, and the eventual circulation within the upper layers resulting from the aeration system. In terms of nutrient concentrations, the aeration system appears to create a well-mixed layer from the surface down to approximately 6 m, which is slightly above the aerator heads (approximately 0.75 m above the sediment). During the June to September period the total dissolved phosphorus fraction in the 7-meter water layer accounted for approximately 40 to 70 percent of the total phosphorus content, also supporting evidence that phosphorus was being released from the sediment during that time.

Figure 8-5. Total Phosphorus Concentrations Measured in Cherry Creek Reservoir, 2009



Routine monitoring data collected since 1987 indicate an increasing trend ($p < 0.01$) in the summer mean concentration of total phosphorus (Figure 8-6). In 2009, the summer mean concentration of total phosphorus was 98 µg/l, which is considerably greater than the long-term (1987-2009) median value of 87 µg/l.

Figure 8-6. Seasonal Mean (July to September) Total Phosphorus Concentrations (µg/l) Measured in Cherry Creek Reservoir, 1987-2009



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

8.2.3 Transparency

Lake transparency values (as measured by Secchi depth) in 2009 ranged between 0.35 m in mid-April to 2.63 m in mid-May. The seasonal mean Secchi depth was 1.09 m, which is similar to the long-term mean value of 1.07 m. [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.]

8.2.4 Temperature and Dissolved Oxygen

Analysis of past Cherry Creek Reservoir temperature profiles indicates that stratification occurs when there is a $>2^{\circ}\text{C}$ 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 8-7 and Figure 8-8). Temperature loggers were deployed on May 13, 2009, when the reservoir typically begins to show evidence of variation in water temperature. The reservoir only showed signs of brief thermal stratification approximately 8 days in late June and 4 days in early July. Between those events, a storm event in early July destratified the reservoir for approximately 6 days.

During the stratification periods in late-June and early July, the deeper water layers of the reservoir began to exhibit low dissolved oxygen concentrations ($<5\text{mg/l}$). 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. Notably, the dissolved oxygen data collect in September, with a recently purchased new probe, is considered inaccurate because the manufacturer recalled the probe.

Figure 8-7. Temperature ($^{\circ}\text{C}$) Profiles Recorded During Continuous Monitoring at Site CCR 2 in 2009
(highlighted areas represent thermal stratification and duration)

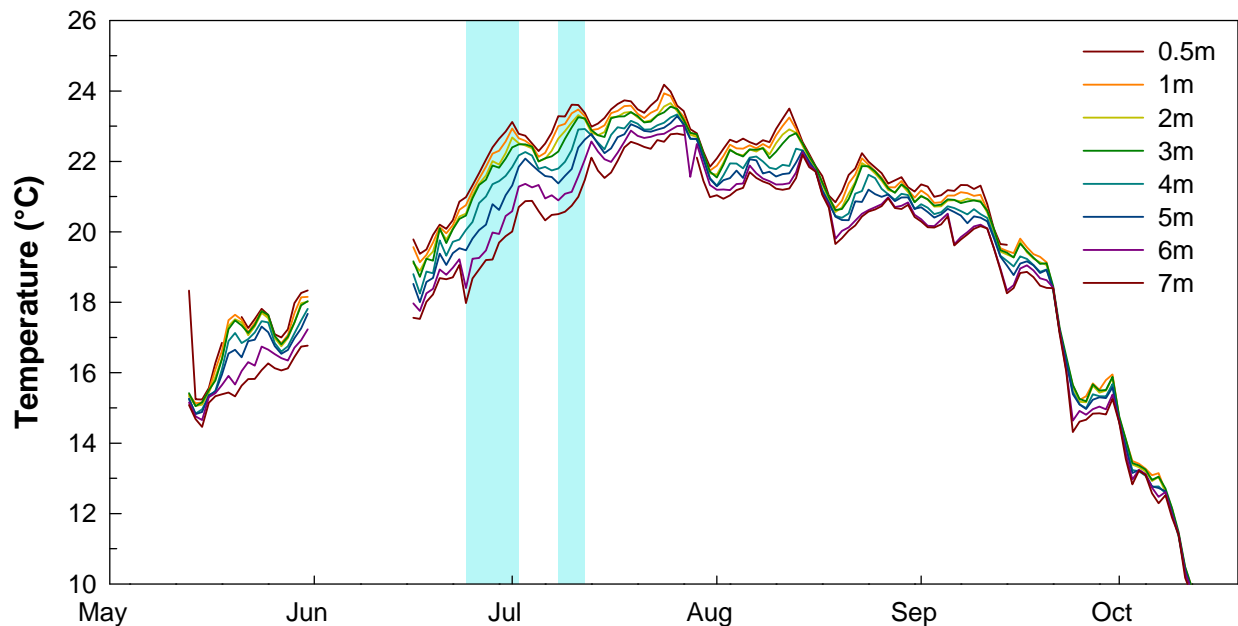
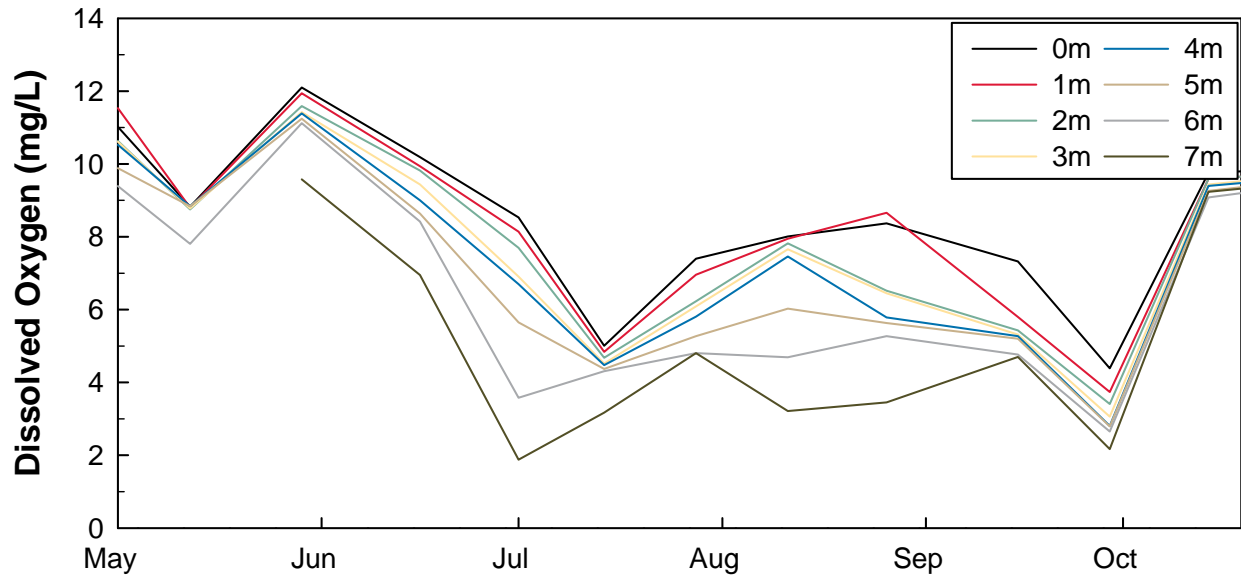


Figure 8-8. Dissolved Oxygen (mg/l) Profiles Recorded During Routine Monitoring at Site CCR 2 in 2009



8.3 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 8-2 shows the list of water quality monitoring sites for the Cherry Creek mainstem. Sites shown in gray were not sampled during the 2009 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 8-2. 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 WQ sampling location; abandoned in 2000 due to dev't.)
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)

8.3.1 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 (1994-2009). Figure 8-9 and Figure 8-10 present annual average alluvial SRP concentrations.
- The SRP concentrations in Cherry Creek range from <0.02 to 0.37 mg/l, with a median of 0.16 mg/l (1994-2009). Figure 8-11 and Figure 8-12 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 sites. (Table 8-3).

Table 8-3. Summary of Soluble Reactive Phosphorus Temporal Trend Analysis

Site	Type	Trend	Slope (mg/l per year)
Castlewood	Upstream surface water	Yes, decreasing	-0.003
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 8-4.

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

Table 8-4. 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

99 percent confidence level to determine spatial differences. Non-detect values were set equal to the detection limit.

Figure 8-9. Average SRP Concentrations in Cherry Creek Groundwater as a Function of Location

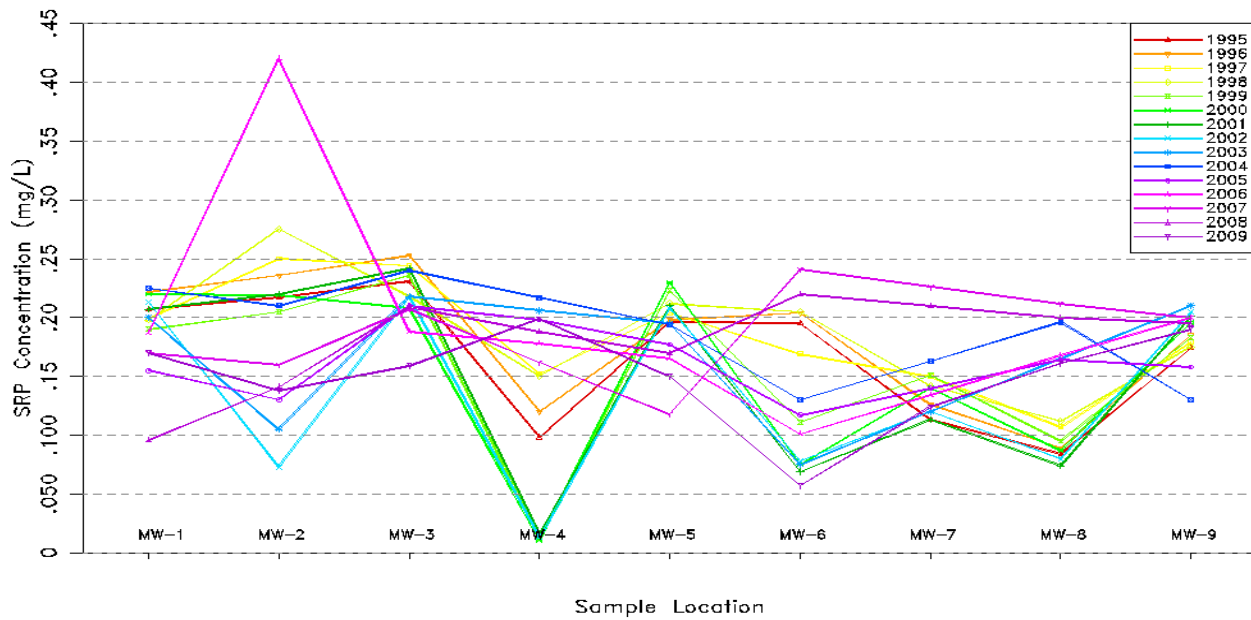


Figure 8-10. Average SRP Concentrations in Cherry Creek Groundwater as a Function of Time

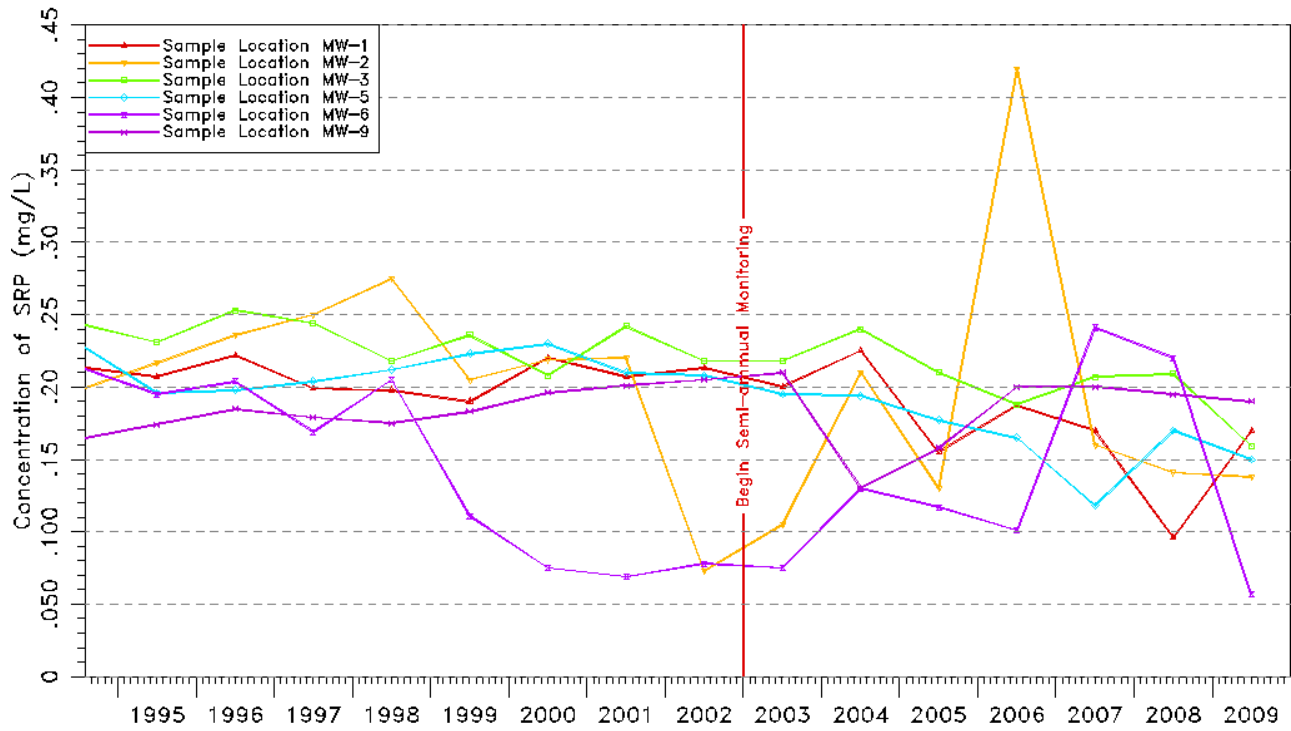


Figure 8-11. Average SRP Concentrations in Cherry Creek Surface Water as a Function of Location

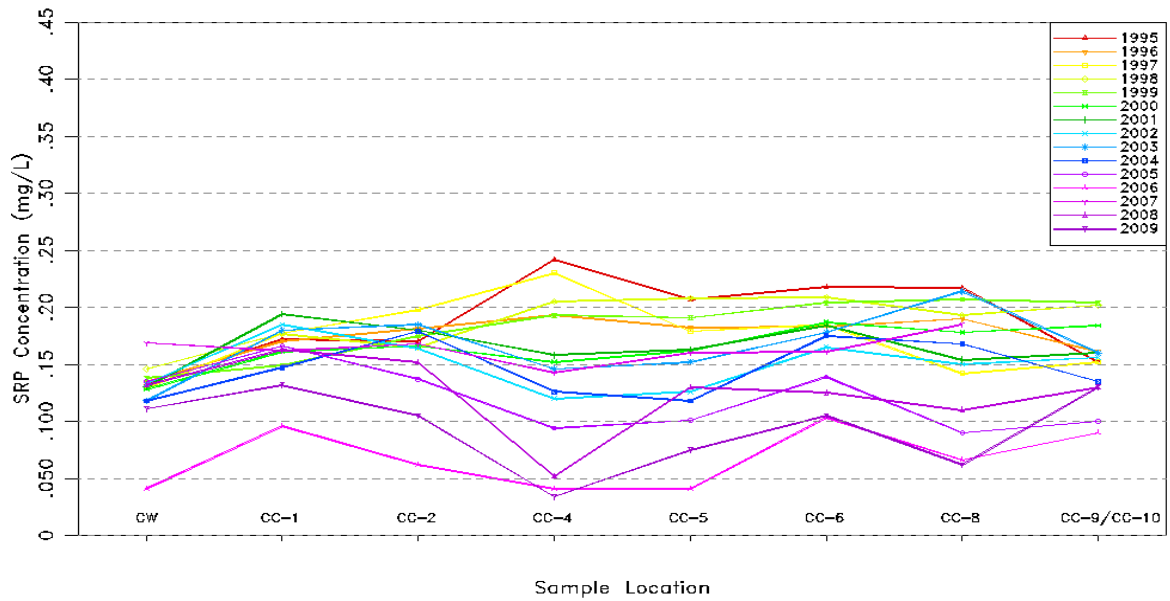
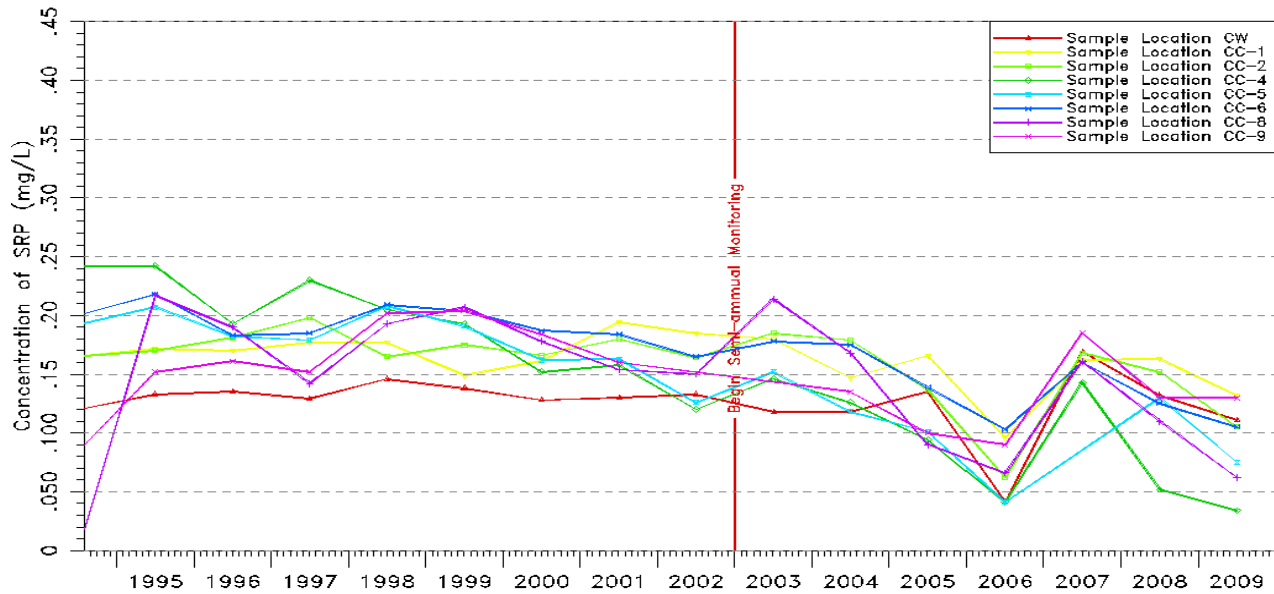


Figure 8-12. Average SRP Concentrations in Cherry Creek Surface Water as a Function of Time



8.3.2 Nitrate

- The nitrate concentrations in the underlying alluvial aquifer range from <math><0.1</math> to 12.10 mg/l, with a median of 0.80 mg/l (1994-2009). Figure 8-13 and Figure 8-14 present annual average alluvial nitrate concentrations.
- The nitrate concentrations in Cherry Creek range from <math><0.01</math> to 16.7 mg/l (maximum from 2006) with a median of 0.16 mg/l (1994-2009). Figure 8-15 and Figure 8-16 present annual average surface water nitrate concentrations.
- As shown on Figure 8-13, there are fluctuations in nitrate concentration between sampling sites. This is not expected as 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 8-5).

Table 8-5. 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 8-6.

Table 8-6. 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 8-13. Average Nitrate Concentrations in Cherry Creek Groundwater as a Function of Location

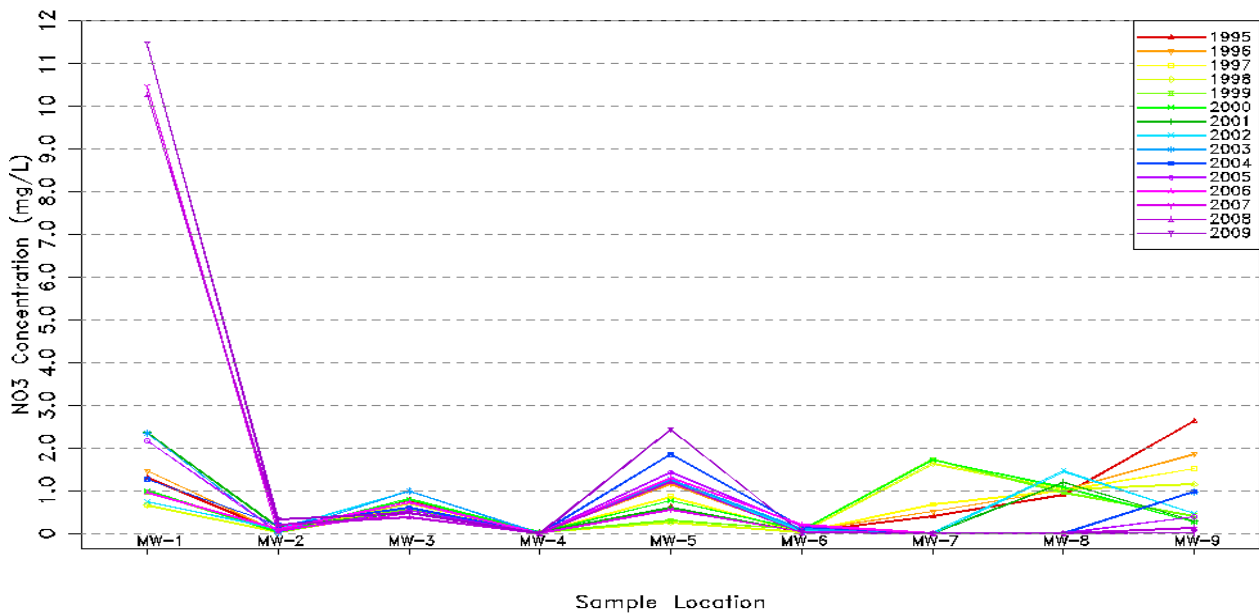


Figure 8-14. Average Nitrate Concentrations in Cherry Creek Groundwater as a Function of Time

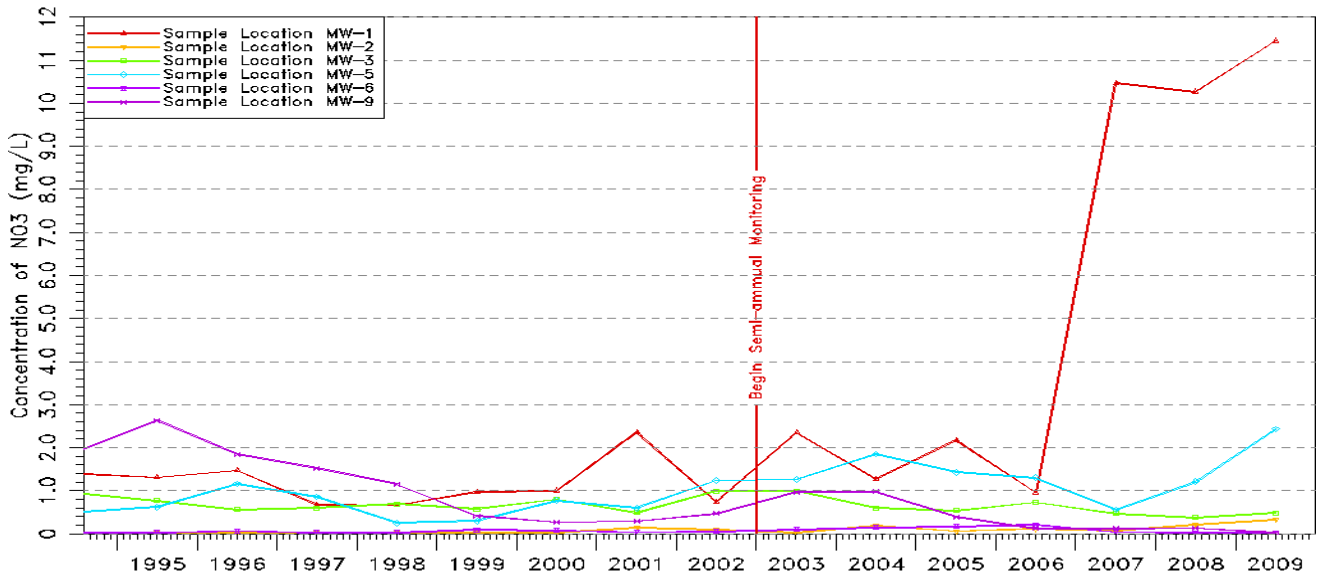


Figure 8-15. Average Nitrate Concentrations in Cherry Creek Surface Water as a Function of Location

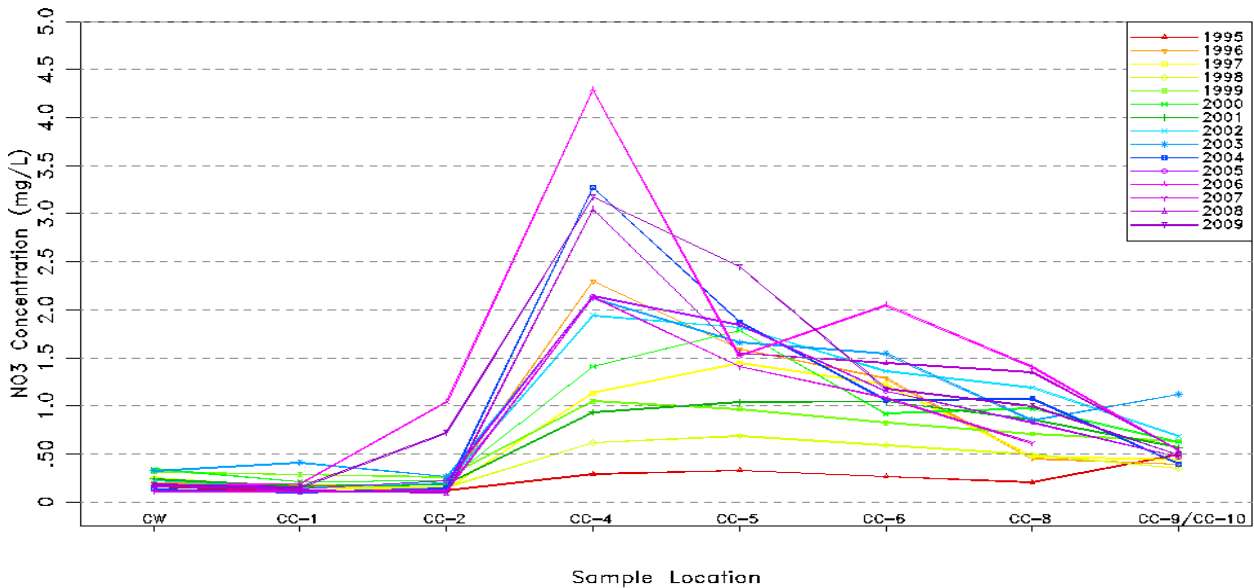
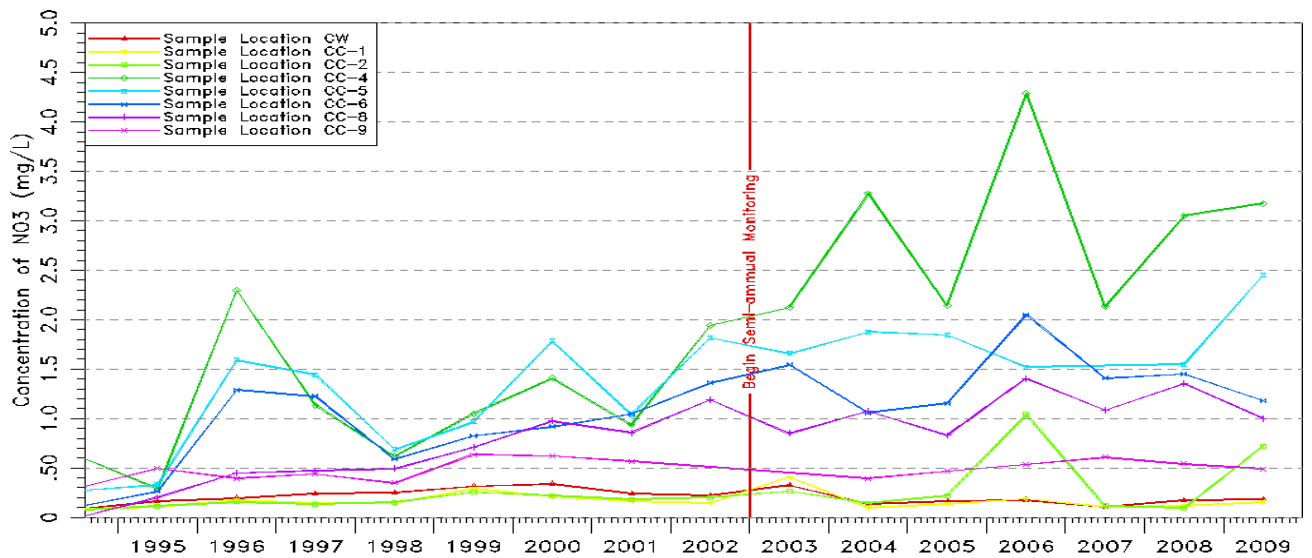


Figure 8-16. Average Nitrate Concentrations in Cherry Creek Surface Water as a Function of Time



8.3.3 Nutrient Loads and Flow-Weighted Concentrations

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).

External sources of nutrients include inflow from streams and precipitation, which carry nutrients from soil erosion, agricultural and municipal runoff, treated wastewater, and airborne particulates. Phosphorus loading was determined for several primary sources in 2009, including the tributary streams Cottonwood Creek, Cherry Creek, and Shop Creek, as well as from precipitation and alluvium, as summarized below.

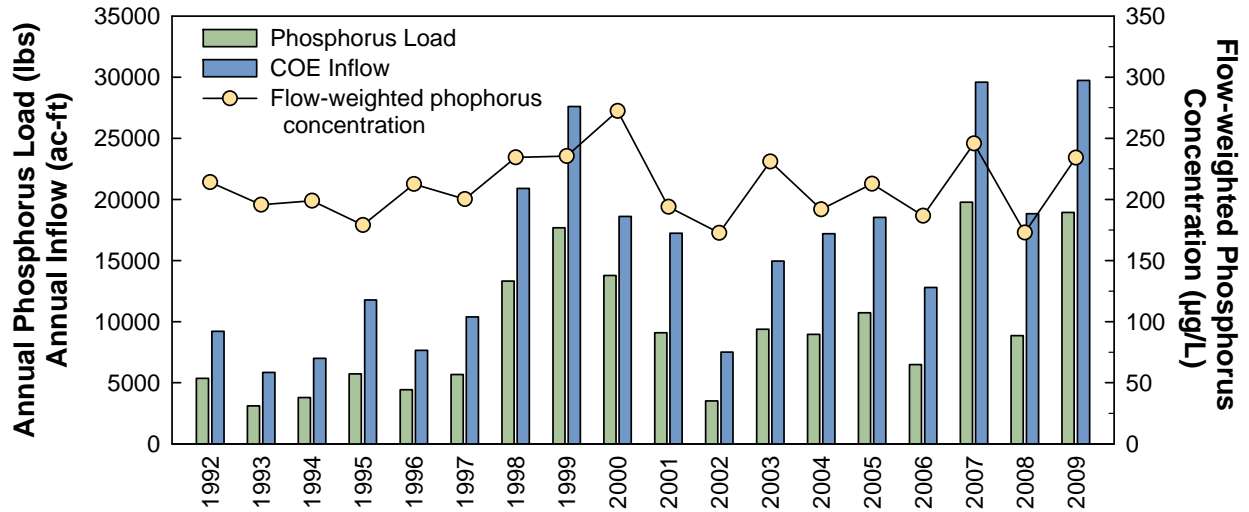
8.3.4 Inflowing Streams

Total phosphorus loading to the reservoir from surface flows of Cherry Creek and Cottonwood Creek was estimated at 17,354 lbs in 2009 (Table 8-7). The annual flow-weighted phosphorus concentration from surface flows of Cherry Creek and Cottonwood Creek was 292 $\mu\text{g/l}$ and 75 $\mu\text{g/l}$, respectively, with an external flow-weighted phosphorus concentration for all sources of 234 $\mu\text{g/l}$, which is greater the long-term median value of 200 $\mu\text{g/l}$ (Figure 8-17).

Table 8-7. Normalized Phosphorus Loads, Exports, and Flow-Weighted Phosphorus Concentrations for Cherry Creek Reservoir, 1992 to 2009						
Data Source	Loads and Exports			Flow-weighted Concentrations		
	Cherry Creek Load (lbs/yr)	Cottonwood Creek Load (lbs/yr)	Total External Load (lbs/yr)	Cherry Creek Flow-weighted (µg/L)	Cottonwood Creek Flow-weighted (µg/L)	External Flow-weighted (µg/L)
1992	3,142	408	5,364	264	179	214
1993	1,524	179	3,114	251	155	196
1994	2,437	164	3,785	250	90	199
1995	2,251	1,402	5,736	189	202	179
1996	2,467	599	4,425	238	339	213
1997	3,110	884	5,659	261	162	200
1998	9,963	1,633	13,322	275	172	234
1999	11,788	1,314	17,672	267	132	235
2000	10,714	1,644	13,788	348	150	272
2001	5,642	1,820	9,099	239	136	194
2002	1,815	505	3,525	227	98	173
2003	6,337	974	9,390	284	138	231
2004	5,710	1,753	8,974	225	146	192
2005	7,843	1,502	10,725	261	126	213
2006	3,813	1,272	6,492	230	133	187
2007	16,142	2,133	19,772	277	159	246
2008	6,814	778	9,144	204	76	173
2009	16,187	1,167	18,938	292	75	234
Mean	5,971	1,116	8,823	252	153	210
Median	5,642	1,272	8,974	251	146	207

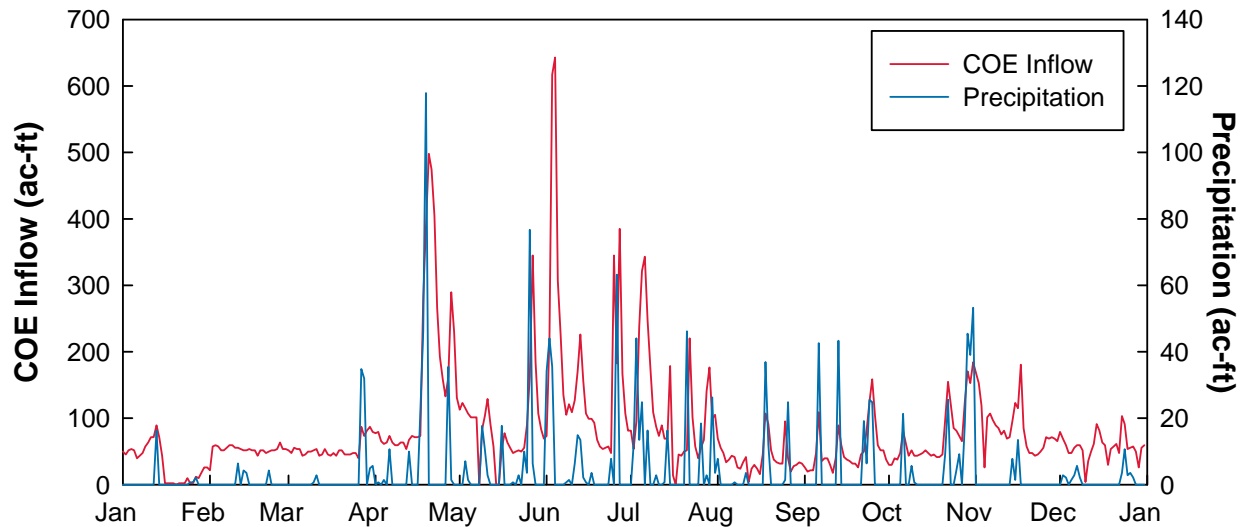
*Includes unengaged residual load.

Figure 8-17. 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 2009



Inflow data, measured as the change in reservoir elevation by the COE, was influenced by storm flow events in 2009 (Figure 8-18). The total inflow for 2009 was 29,736 acre-feet, which is the highest inflow in the past 18 years of monitoring, and nearly double the long-term mean of 15,857 acre-feet per year.

Figure 8-18. Comparison of Direct Precipitation on the Reservoir and Inflow for 2009



8.3.5 Precipitation

Total annual precipitation in 2009, as measured by the KAPA rain gage located at Centennial Airport approximately 4.3 miles due south of Cherry Creek Reservoir, was 21.44 inches (Figure 8-18). This value is greater than the long-term median (1987-2009) 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 480 pounds for 2009.

8.3.6 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 9,935 lbs from the reservoir via the outflow structure in 2009 (Table 8-7).

8.3.7 Alluvial Phosphorus

The alluvial phosphorus load for 2009 is 1,033 lbs. The 2009 load estimate utilizes an alluvial water budget value of 2,000 ac-ft/yr and a long-term median total dissolved phosphorus concentration from MW-9 of 190 µg/l.

8.3.8 Phosphorus Mass Balance

In general, the phosphorus load budget for Cherry Creek Reservoir is comprised of phosphorus inflow (influent streams, precipitation, and alluvium) and reservoir outflow. During 2009, phosphorus contribution from precipitation was an estimated 480 lbs, influent streams contributed 17,354 lbs., and alluvial inflow contributed 1,033 lbs (Figure 8-19) for a total load of 18,938 lbs. Outflow from the dam contained an estimated 9,935 lbs in 2009. After totaling the additions and losses, the net loading of phosphorus was estimated at 9,003 lbs during 2009 (Table 8-1). The 2009 flow-weighted phosphorus concentration for all sources of total phosphorus is 234 µg/l. (Table 8-1 and Figure 8-19).

8.4 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. Evaluation of the effectiveness of the Cottonwood Creek - Peoria Wetland Pond PRF in 2009 was hindered slightly due to the channel reconfiguration at Site CT-P1 which is the upstream monitoring station for this PRF. Flows during a portion of April were rerouted during construction which affected stream level data collection.

8.4.1 Cottonwood Creek-Peoria Pond

The Cottonwood Creek-Peoria wetland pond 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 2009, the flow-weighted phosphorus concentration upstream of the PRF was 134 µg/l, while the flow-weighted concentration downstream of the system was 97 µg/l (Table 8-8). This represents a 28 percent decrease in total phosphorus concentrations downstream of the PRF. Total suspended solids also showed a substantial decrease downstream of the PRF, being reduced by 42 percent. This PRF underwent sediment removal maintenance in 2008, and continues to be very efficient in reducing phosphorus and sediment from Cottonwood flows.

Figure 8-19. Mass Balance Diagram of Phosphorus Loading in Cherry Creek Reservoir, 2009

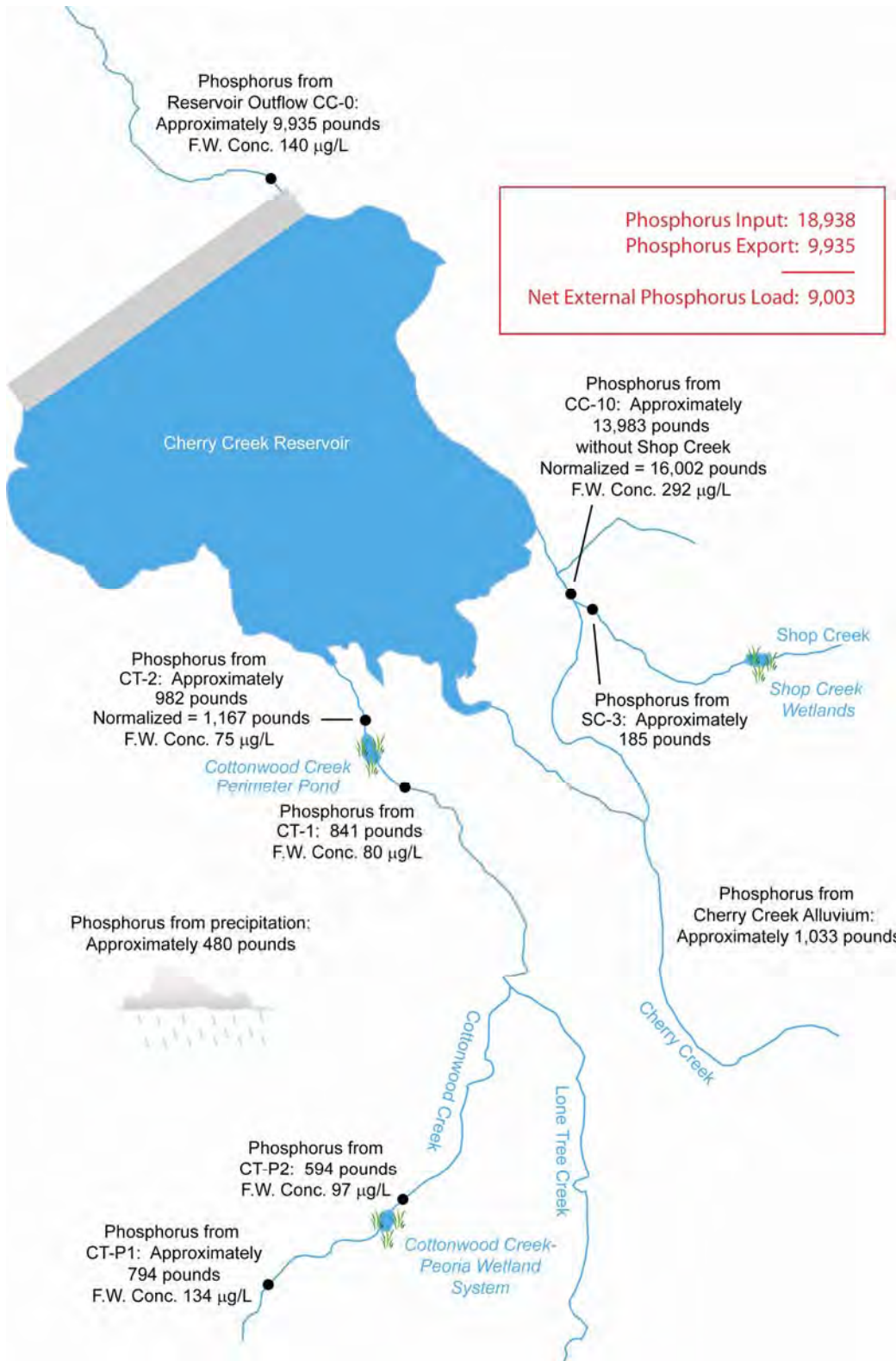


Table 8-8. Annual Average Total Suspended Solids and Flow-Weighted Total Phosphorus Concentrations Through the Cottonwood Creek-Peoria Wetland Pond					
Parameter	Year	Sampling Sites		Difference	Percent Change Downstream
		CT-P1	CT-P2		
Average Total Suspended Solids (mg/L)	2002	66	79	+ 13	+20
	2003	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
	2009	48	28	-20	-42
	Mean	54	46	-8	-15
Flow-weighted Total Phosphorus (µg/L)	2002	114	72	-42	-37
	2003	107	109	2	+2
	2004	144	134	-10	-7
	2005	132	129	-3	-2
	2006	142	135	-7	-5
	2007	177	131	-46	-26
	2008	116	86	-30	-26
	2009	134	97	-37	-28
	Mean	133	112	-22	-16

8.4.2 Cottonwood Wetlands Pond

In 2008, the Cottonwood Creek Reclamation Project was completed which relocated the channel to its historic location and substantially reduced the amount of erosion by widening the channel and dissipating the flow energy through this reach. This channel stabilization and reclamation project appears to have greatly reduced the amount of phosphorus in flows through this reach. In 2009, the flow-weighted phosphorus concentration upstream of the Cottonwood Wetland Pond as Site CT-1 was 80 µg/l (Table 8-9). Site CT-1 is located at the downstream end of the reclamation project. During the past two years, the flow-weighted phosphorus concentration at this site has been reduced by approximately 60 percent as compared to the previous 10 years. The 2009 flow-weighted concentration downstream of the pond was 74 µg/l, which indicates this PRF was effective in decreasing the phosphorus concentration by 8 percent. Stream flows have shown a similar decrease of 75 percent in total suspended solids during the past few years when compared to the previous 10 years of data. In 2009, the mean total suspended solid concentration upstream and downstream of the PRF was 34 mg/l and 32 mg/l, respectively. The effectiveness of the Cottonwood wetlands pond appears to have been diminished over the past few years and is currently undergoing final design to rehabilitate the PRF; however, the Cottonwood Creek Reclamation Project appears to have had a substantial benefit on water quality by reducing total phosphorus concentrations by approximately 60 percent of historic conditions.

Table 8-9. Annual Average Total Suspended Solids and Flow-Weighted Total Phosphorus Concentrations Through the Cottonwood Wetlands Pond

Parameter	Year	Sampling Sites		Difference	Percent Change Downstream
		CT-1	CT-2		
Annual Average Total Suspended Solids (mg/L)	1997	207	87	-120	-58
	1998	311	129	-182	-59
	1999	267	68	-199	-75
	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	+10
	2007	81	71	-10	-12
	2008	30	56	26	+87
	2009	34	32	-2	-6
	Mean	130	71	-58	-45
Flow-weighted Total Phosphorus (µg/L)	1997	467	166	-301	-64
	1998	217	161	-56	-26
	1999	143	132	-11	-8
	2000	284	161	-123	-43
	2001	158	145	-13	-8
	2002	121	112	-9	-7
	2003	192	126	-66	-34
	2004	192	140	-52	-27
	2005	148	128	-20	-14
	2006	172	135	-37	-22
	2007	216	158	-58	-27
	2008	73	74	1	1
	2009	80	74	-6	-8
	Mean	189	132	-58	-30

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9. CONCLUSIONS AND FUTURE 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 adopted the Watershed Plan 2003 and considers the recommendations as part of the CIP annual update.

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. In 2010, the Authority will begin updating the Watershed Plan to reflect changes to Regulation No. 72.

9.1 Status of Compliance with Discharge Limits and Conditions

All wastewater treatment plants were in compliance in 2009 with their required phosphorus limits and conditions, with the exception of one slight reported exceedence which was due to contaminated sample preservative.

9.2 Updated List of Planned PRFs with Implementation Schedule

On an annual basis, the Authority develops 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. In addition to Authority-initiated investigations, the Authority also identifies pollutant reduction opportunities by monitoring watershed drainage master plans conducted by the Urban Drainage & Flood Control District (UDFCD) and local jurisdictions, or master plans developed independently by local jurisdictions, such as Castle Rock. These master plans historically have often recommended implementation of detention and stream stabilization measures throughout the watershed with the goal of reducing flood damages. More recently, these watershed master plans have included the goal of improving the stormwater quality in the planning process, such as the SEMSWA plans for Cottonwood Creek and Lone Tree Creek and Castle Rocks plan for McMurdo Gulch, which have resulted in a more integrated approach at the sub-watershed or tributary watershed level. Table 6-1 shows a summary of PRFs recommended for 2010 through 2014.

9.3 Recommendations for Improving Water Quality

Because of substantive changes to Control Regulation No. 72 and the fact that the Authority's master plan was last updated in 2003, the Authority will be reevaluating its goals and objectives beginning in 2010 and will update the master plan. The current master plan includes the following recommendations, among others, for improving water quality that are part of the Authority's long-range plans at this time:

- Fund, design, and construct high priority stream reclamation projects,
- Investigate other PRF opportunities, such as retrofit of existing detention facilities,
- Reduce pollutant loads from individual sewage disposal systems,
- Promote reuse of wastewater through land application,
- Investigate voluntary programs to reduce nonpoint source pollutant discharges from agricultural activities in the watershed,
- Collaborate with other public and private interests to leverage Authority funds to meet watershed goals,

9.4 Proposed Special Water Quality Investigative Studies/Modifications to Monitoring Program

Because of substantive changes to Regulation 72 and because the Authority's master plan was last updated in 2003, the Authority will be reevaluating its goals and objectives beginning in 2010 and update the master plan. The plan may include, among other items, additional investigative studies, which will be discussed in the 2010 Annual Report. In addition, the monitoring program will be reevaluated to ensure it is designed to support the new focus of Regulation 72.

9.5 Decisions and Agreements to Implement Goals

In 1985, local governments in the Cherry Creek basin worked with the Water Quality Control Division, federal agencies, and the Denver Regional Council of Governments to develop a watershed management master plan for Cherry Creek Reservoir. One of the management plan recommendations was the creation of a single entity with legislative authority to control point and nonpoint sources of pollution. Initially, the Authority was formed by an intergovernmental agreement in 1985. In 1988, the legislature passed a bill creating the Cherry Creek Basin Water Quality Authority that was subsequently revised in 2001 altering the structure of the Authority members.

The governmental and Governor appointee members continue to actively participate in the Authority, working cooperatively to develop and implement Authority goals and objectives.

9.6 Financing of Nonpoint Source Projects

The Authority funds nonpoint source projects, i.e., PRFs, through taxes, fees, and wastewater surcharges. Total revenue has varied from \$1,700,000 in 2006 to \$1,800,000 projected for 2010. During the same period, capital expenditures ranged from around \$400,000 to over \$1,200,000 with the variation due in part to the multiple year process required for PRFs from concept through construction. As the result, the Authority funds have been sufficient to plan for and implement the projects in the 5-year CIP. Whereas the Authority expects revenues to decline over the next few years, the current funding level of PRFs is expected to continue for the next year or two.

9.7 Regulated Stormwater Permit Requirements

The Authority continues to work with local MS4s to implement an aggressive stormwater management program. The Authority's 2000 Stormwater Requirements will be updated in 2010 to reflect changes to Control Regulation. The updated document is referred to as CR 72.7 Guidance Document specifically addressing Section 72.7 of the Regulation titled "Stormwater Permit Requirements".

9.8 Adoption and Implementation of BMPs by Local Governments

All MS4s in the watershed have adopted stormwater regulations-setting requirements for construction and post-construction BMPs for new and redevelopment projects within their jurisdiction. The MS4s are also working with UDFCD to update the Urban Storm Drainage Criteria Manual Volume 3 Best Management Practices to further improve the science and engineering for the design, construction, and maintenance of BMPs.

9.9 Reduction of Phosphorus Concentrations into Reservoir by Maximum Extent Practicable (MEP)

Phosphorus concentrations into the reservoir are meeting the maximum extent practicable (MEP) criteria from Regulation 72, as evidenced by the following information presented for the control categories required to be addressed under the regulation.

Point Source Controls

In 2009, all wastewater treatment plant dischargers were well below their allowed total maximum annual loads. Of the total allowed allocation of 1,728 pounds of phosphorus per year for the 7 wastewater treatment plants combined, only 469 pounds were discharged in 2009. With one minor exception¹, discharges in 2009 were well below the permit limits for phosphorus. Note that phosphorus concentrations in direct discharges to Cherry Creek or its tributaries are limited to 0.05 mg/l; this is well below the 0.20 mg/l flow-weighted phosphorus goal for discharges to the reservoir. The wastewater treatment facilities are accomplishing this through the use of Best Available Technologies (i.e., "BAT") including treatment techniques such as advanced wastewater treatment (AWT) and biological nutrient removal (BNR) for phosphorus removal.

Regulated Stormwater Controls

As required by both the State's and EPA's Stormwater Phase II Rule, MS4s must, at a minimum, adopt certain BMPs for six minimum control measures and implement them to the maximum extent practicable. Additional control measures are required by Regulation 72 for MS4s within the Cherry Creek basin. The MS4s need to submit an annual report every year to the Water Quality Control Division, documenting their compliance with the requirements, including MEP. Monitoring in the watershed confirms that the BMPs and other controls placed on regulated stormwater continue to be effective, and the total phosphorus concentration in the inflow to the reservoir has remained relatively constant.

¹ ACWA reported a 30-day average phosphorus concentration of 0.052 mg/l in January 2009, which is only slightly over its permit limit of 0.05 mg/l. The reported exceedence was later determined to have been caused by contamination in the preservative used to hold the phosphorus samples.

*NPS
Stormwater
Controls*

The Authority's PRFs have been designed to maximize the reduction in nutrients, particularly phosphorus, that flow into the reservoir from the tributary streams such as Cherry Creek and Cottonwood Creek. The Cottonwood Creek treatment train monitoring data show that the mean annual flow-weighted total phosphorus concentrations into the reservoir are significantly below what are believed to be background conditions for the watershed, contrary to some scientific beliefs that BMP performance is limited to background concentrations². In fact, the 2008 and 2009 flow-weighted concentrations entering the reservoir from the Cottonwood treatment train was 0.074 mg/l, which is below the lowest concentration (i.e., 0.15 mg/l) suggested by the Center for Watershed Protection³. Therefore, the Authority's Cottonwood Creek PRF monitoring results support the position that PRFs can reduce phosphorus concentrations into the reservoir by the maximum extent practicable.



² Center for Watershed Protection. *Irreducible Pollutant Concentrations Discharged from Stormwater Practices*. Technical Note #75 from Watershed Protection Techniques. 2(2): 369-372.

³ *Ibid.*

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