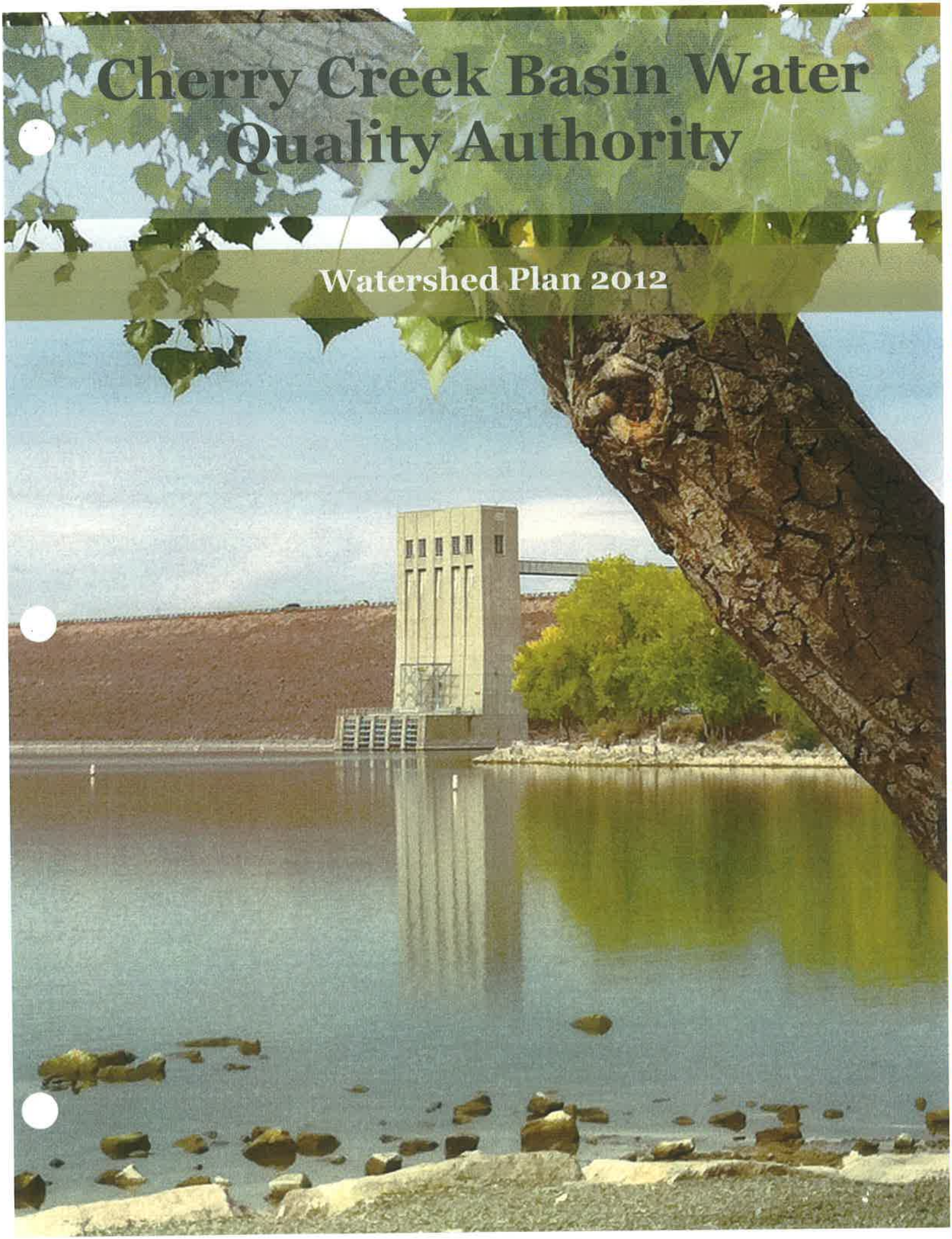
Cherry Creek Basin Water Quality Authority

Watershed Plan 2012



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Chapter 1

Cherry Creek Basin Water Quality Authority

Vision Mission Goals Objectives

Watershed Plan 2012 **Chapter 1**

Introduction

The Watershed Plan is driven by the Authority's vision. This vision defines what we want to be; what is possible; what we desire to create. The Vision Statement begins with the end in mind, which is the start of all successful journeys.

A mission statement helps us get to this end point. It describes what we do, and where and how we do it.

The first step in updating the Watershed Plan was to revisit the existing 2003 Watershed Plan mission statement, goals, and objectives. Substantive changes to the Cherry Creek Reservoir Control Regulation, effective in 2010, were a key driver. Thus, the Cherry Creek Basin Water Quality Authority Board of Directors (Board) and Technical Advisory Committee (TAC) began an in-depth strategic planning process to redefine the Authority's management strategies for the Cherry Creek Watershed and Cherry Creek Reservoir.

"The general assembly hereby finds and declares that the organization of a Cherry Creek basin water quality authority will: be for the public benefit and advantage of the people of the state of Colorado; benefit the inhabitants and landowners within the authority by preserving water quality in Cherry Creek and Cherry Creek reservoir; benefit the people of the state of Colorado by preserving waters for recreation, fisheries, water supplies, and other beneficial uses; and promote the health, safety, and welfare of the people of the state of Colorado."

Strategic Planning

Strategic planning is a dynamic, iterative process. Strategic planning involves the establishment of a vision and a mission statement, which are used to establish goals and objectives for the coming one to five years. These key elements are then incorporated into an organization's management practices and governing documents to provide a consistent, comprehensive foundation for decision making.

The Authority began by articulating key elements:

1) the vision statement
2) the mission statement
3) strategic goals
4) supporting objectives.

***Where** are we going?*

***Why** do we exist?*

***What** must we accomplish?*

***How** we will achieve it?*

***What** are the measureable steps for success?*

***When** will they be accomplished?*

***Who** will be involved?*

These elements function as building blocks. They will be used to direct the future focus of the Cherry Creek Watershed and Cherry Creek Reservoir improvement program, in both the near term and into the future.

Vision Mission Goals Objectives

Strategic Planning Elements

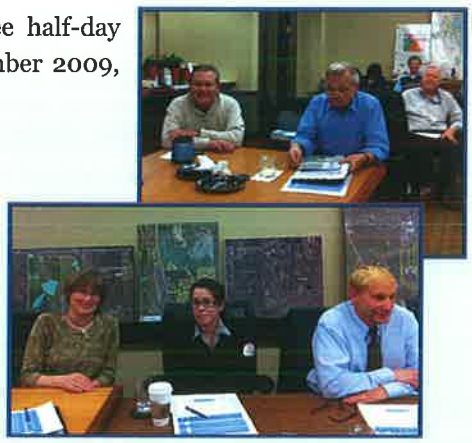
The ***Vision Statement*** is a concise statement that captures the long-term picture of ***what*** the organization wants to achieve, reflecting aspirations and desires. The Vision Statement identifies ***where*** the organization is going.

A ***Mission Statement*** is a concise statement that identifies the organization's purpose, aim, identity, and values. It answers the questions "***Why*** does our organization exist?" and "***What*** does our organization do?".

Goals present a roadmap to achieve the vision, specifying accomplishments to be achieved if the vision is to become real. Goals are aligned with and support the vision and mission statements. They define key targets achievable over the next several years.

Objectives are more detailed statements of the specific activities required to achieve the goals. They are created with the purpose of achieving individual goals. Objectives drive the annual workplan.

Our Strategic Planning Process



Authority members met on several occasions, including three half-day Strategic Planning Workshops. The first workshop, held in November 2009, targeted several areas for future focus:

- Prioritization of Capital Improvement Projects
- Funding
- Strategic Planning
- Partnerships
- Information/Special Studies
- Additional Source Control Opportunities
- Regulatory Issues

Additional workshops took place in October and November 2010. A strategic plan matrix was presented to visualize connections between these future focus areas to help develop the strategic plan. Using the Authority's 2003 mission statement, goals, and objectives as a starting point, the Authority brainstormed next steps for the reservoir and watershed. This was an unconstrained, open process to explore the vision, mission, goals, and objectives. Through a consensus-based process, including joint meetings between the TAC and Board, a shared vision and mission were developed.

Vision Mission Goals Objectives

Vision:

"Water quality in Cherry Creek Reservoir and Watershed that optimizes beneficial uses for the public."

Mission:

"Protect beneficial uses by preserving, enhancing, and balancing water quality in Cherry Creek Reservoir and Cherry Creek Watershed."

Applicable Laws and Regulations

Consistency with legal requirements and authorities was important to the participants.

The Authority was created by the Colorado Legislature in 1988. (Colorado Revised Statutes, Title 25, Article 8.5, Cherry Creek Basin Water Quality Authority). The Authority's general powers are defined in C.R.S. 25-8.5-111.

- In 2001, Senate Bill 01-006, adjusted the Authority's duties and membership, as well as provided increased protections for water quality in the reservoir.
- The Cherry Creek Reservoir Control Regulation (5 CCR 1002-72), was first adopted by the Colorado Water Quality Control Commission in 1985, and has been amended numerous times since. It is reviewed by the Commission at least once every 3 years.

Vision Mission Goals Objectives

GOALS:

- Understand watershed and reservoir
- Preserve beneficial uses
- Build projects Implement programs
- Prevent & Minimize negative water quality impacts
- Invest resources wisely
- Achieve numeric water quality standard

Goals are the building blocks that support the vision and mission.

In order to protect beneficial uses, a thorough understanding of both the reservoir and watershed is needed. To preserve, enhance, and balance water quality, we must first understand the linkages between water quality and how it affects recreation, aquatic life, drinking water, and agricultural needs, all of which are designated by the Water Quality Control Commission as beneficial uses for the reservoir.

Projects and programs must then be designed and implemented to make the vision happen. The Authority must guard against any adverse water quality impacts that may occur due to human actions, and should evaluate these possibilities along the way before starting a project.

We must be fiscally responsible; the Authority has a fiduciary responsibility to constituents and the users of the reservoir and watershed, including future generations. By doing all of these things deliberately and thoughtfully, the water quality standards that are designed to protect the beneficial uses of the reservoir will be achieved.

Vision Mission Goals Objectives

Objectives for Each Goal

For each of the six goals, short-term objectives were developed. They will be used to prioritize decisions and evaluate the effectiveness of water quality management strategies. As we complete the objectives, new ones will be added to the list, as we grow in our knowledge and experience.

Goal: Understand watershed and reservoir.

- Define all beneficial uses designated by the Colorado Water Quality Control Commission to be protected (recreation, fisheries, water supply, agricultural).
- Collect appropriate monitoring data for model(s).
- Conduct studies to more fully understand the role of both phosphorus and nitrogen, total organic carbon, pH, temperature, dissolved oxygen, total dissolved solids, sediment, the food chain, reservoir operations (including flood control), and the relationship between water quantity and quality.
- Develop a more comprehensive reservoir model to include causal parameters beyond phosphorus and chlorophyll α.
- Develop management strategies using watershed model.
- Use models/other tools to predict potentially adverse impacts of strategies; consider interaction with other factors, such as flood control operations and climate change.
- Actively work with US Army Corps of Engineers (Corps) to understand water quality effects of dredging; evaluate, predict, and monitor potential impacts on other beneficial uses.

Goal: Preserve beneficial uses.

- Develop measurable endpoints to determine when beneficial uses are protected.
- Develop methods to balance protection among competing uses.
- Investigate options for reservoir water quality standards (chlorophyll α, cyanobacteria, others).
- Prepare for standards rulemaking hearing with any needed recommendations.
- Educate public regarding water quality standards and beneficial uses including flood control.
- Share information on reservoir, uses, and measurable endpoints with Colorado Department of Public Health and Environment (CDPHE).
- Engage early with Colorado Water Quality Control Division (WQCD) and Colorado Water Quality Control Commission (WQCC) concerning plans and progress.

Vision Mission Goals Objectives

Goal: Build projects. Implement programs.

- Effectively use the Authority's powers and legal authorities in the areas of water quality controls; studies; incentive, reward, & credits; pollutant reductions; erosion and urban runoff controls; & ISDS.
- Develop a strategy to protect groundwater to prevent impacts to the creek, tributaries, & reservoir.
- Implement public education programs.
- Continue to implement the 5-year Capital Improvement Plan (CIP).
- Evaluate reservoir dredging as a potential project.

Goal: Prevent and minimize negative water quality impacts.

- Continue to support MS4 efforts throughout the watershed.
- Implement Regulation 72 stormwater requirements.
- Maintain and update CR72-7 Guidance Manual.
- Support a systems approach to watershed controls, recognizing linkages.
- Develop and implement new strategies to protect watershed quality as development occurs.
- Evaluate options to minimize adverse impacts from reservoir dredging and exercise of water rights.

Goal: Invest resources wisely.

- Maintain comprehensive program for water quality control facilities.
- Achieve and maintain 60/40 funding split for CIP projects.
- Incorporate evolving issues into decisions (e.g., water supply strategies, infrastructure, new technologies, societal priorities, etc.)
- Pursue partnerships, leveraging, & coordination with counties, municipalities, special districts, water supply committees, Corps, CDPHE, Colorado Department of Transportation (CDOT), etc.
- Consider synergistic opportunities to link water quality and quantity projects.
- Develop method to fairly allocate responsibility throughout watershed (e.g., locating & funding projects).
- Determine desired 208 role and implement as needed.
- Share externally our experiences for others' benefit.

Goal: Achieve numeric standard.

- Implement all Reg. 72 responsibilities; develop new strategies as needed.
- Monitor to document improvements in reservoir & watershed.
- Continually evaluate attainment of standard; consider adjustments as needed.

Chapter 2

History

Early History

Mid-1800's

The Cherry Creek watershed is one of the most dominant geographical and cultural features of the Denver metropolitan area. The creek connects communities in Denver, Arapahoe, and Douglas counties. For centuries this connection was used by Native Americans, trappers, traders, and adventurers. Today some of this history is preserved in historic stage stops along the trail which generally follows Parker Road: the 17-Mile House in Arapahoe County, the 12-Mile House Park in Cherry Creek State Park, and the 4-Mile House in Denver. The area also supported the first lumber industry and the initial purebred cattle industry within the state.

Early Agricultural Operations in Cherry Creek Valley

The watershed was also important agriculturally from the late 1800s through the 1930s, due to rich soil and flat land. There were numerous dairy farms, truck farms, orchards, and potato fields from Franktown to downtown Denver. Water was supplied from Castlewood Reservoir, built in 1890. Originally the plan was to provide water to irrigate about 30,000 acres of farmland downstream.

Floods and Construction of Cherry Creek Dam and Reservoir

1864

1864 Cherry Creek Flood in Denver

Though early settlers in the region were warned of the potential for flooding along Cherry Creek, early Denver grew along its banks and was subsequently flooded several times. One of the first recorded large floods in the basin occurred in May 1864. This flood originated in the upper end of the Cherry Creek and Plum Creek watersheds, killing nineteen people.

1933 Castlewood Flood Waters

1933

On August 3, 1933, the Castlewood Dam burst after several days of torrential rain. This released a wall of water into Cherry Creek, as high as 20 feet in spots, eventually reaching Denver.

1950

Castlewood Dam Today

Remains of Castlewood dam can be still be seen at Castlewood Canyon State Park. The Castlewood flood was the impetus for building the Cherry Creek Dam and Reservoir. Cherry Creek Dam was built in 1950 to protect downstream areas from catastrophic floods that had plagued the area for more than 100 years. During the 1965 Denver flood, all flow upstream from Cherry Creek was stored in Cherry Creek Reservoir, helping mitigate the flood.

Cherry Creek Dam and Reservoir

Urbanization and Growth

1960's

Throughout much of the early to mid 1900's, the creek degraded and was lost as a community asset. This began to change when, in 1959, recreational demands on the reservoir from the growing urban population led to the creation of the Cherry Creek State Recreation Area, Colorado's first state park. Today the park is one of Colorado's busiest, with an estimated 1.5 million visitors per year.

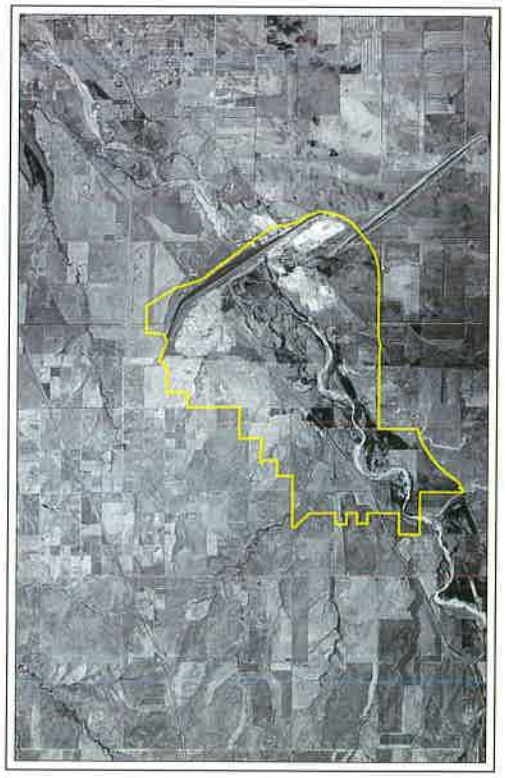
1970's

1980's

The Cherry Creek basin has seen rapid urbanization during the past several decades. Growth has historically been concentrated closer to the reservoir; however, several communities in the upper watershed have also experienced increasing growth. Recent population and housing densities in the Cherry Creek watershed, based on the most recently available Census data (2000), are shown in the table. The U.S. Bureau estimates that the population of Douglas County grew by 64% from April 1, 2000 to July 1, 2009, and that Arapahoe County grew by 16% over the same period.

Watershed Proximity	2000 Population	Total Housing Units	Pop. Density per Mile	Housing Density per Mile
Below the	237,323	122,149	6,132	3,594
Above the	202,918	71,839	879	312
Watershed	440,214	193,988	3,506	1,953

1953 Aerial Photo of Dam
(Note: Reservoir not yet filled)



2009 Aerial Photo of Reservoir
and Surrounding Area
(State Park boundary shown in yellow)

History

1984

Formation of the Cherry Creek Basin Water Quality Authority

A Clean Lakes Study of Cherry Creek Reservoir was completed in 1984. The study found that the reservoir's water quality and its uses were moderately impaired due to eutrophication. Phosphorus was identified as the controlling nutrient for algal growth in the reservoir.

"Eutrophication" is the process by which a water body acquires a high concentration of nutrients, which can promote excessive growth of algae.

As a result, the Cherry Creek Basin Water Quality Authority was created to develop and implement means to protect the water quality of Cherry Creek Basin and Reservoir.

1988

The Authority was initially created by an intergovernmental agreement, and then was specially authorized by legislation adopted in 1988. The makeup of the Authority Board was originally comprised of 2 counties, 4 municipalities, and 7 water and wastewater special districts. The Colorado Legislature changed the Board's structure in 2001 such that it now includes elected officials from 2 counties, 8 municipalities, one member representing all the special districts, and 7 citizens appointed by the governor.

2001

The Authority is statutorily charged with:

1. Improving, protecting, and preserving the water quality of Cherry Creek and the Reservoir, and
2. Achieving and maintaining state water quality standards for the reservoir and related watershed.

Regulatory History

There are two main regulations adopted by the Colorado Water Quality Control Commission that govern the water quality of Cherry Creek Reservoir and watershed.

Regulation 38 establishes water quality standards for the reservoir, Cherry Creek itself, and other tributaries in the watershed.

Regulation 72 is a control regulation and defines water quality management programs to achieve the water quality standards.

These regulations are required by law to be reviewed periodically. They have each been reviewed and amended several times. Regulation 38 was reviewed and/or amended for Cherry Creek basin waters in 1985, 1991 (no changes were made), 2000, and 2009. Regulation 72 has been substantively amended several times (1985, 1989, 1991, 1992, 1995, 1997, 2000, 2001, 2003, 2004, and 2009).

2009

IN 2009, THE FOCUS CHANGED FROM CONTROLLING PHOSPHORUS LOADS TO THE RESERVOIR TO A CONCENTRATION-BASED WATERSHED APPROACH FOR ALL NUTRIENTS.

History

Watershed Plan 2012

Implementation Highlights

Wastewater Treatment Plants (WWTP)

Regulation 72:

1985	Established a Total Maximum Annual Load (TMAL) for all discharges, including WWTPs, of 14,270 pounds
1990/91	Established technology-based effluent limits for phosphorus from WWTPs
2004	Required WWTPs to meet effluent limits for phosphorus discharges
2009	Established phosphorus effluent limits for drinking water treatment plant discharges and removed all TMALs

CCBWQA also reviews all site applications for WWTPs and lift stations, to ensure compliance with reservoir protection requirements.

Best Management Practices

- 2000: Adopted Stormwater Quality Regulations, which apply to both construction & post-construction
- 2002: EPA 319 Grant to develop a series of BMP fact sheets for a variety of audiences
- 2009: Adopted 3-tiered program for development & redevelopment

Authority has taken an active role in the development review process as a referral agency.

Pollutant Reduction Facilities

Constructed PRFs in watershed, including:

- Shop Creek Water Quality Improvements (1989)
- Quincy Outfall WQ Improvements (1995)
- East Shade Shelters Shoreline Stabilization (1996)
- Cottonwood Cr. Perimeter Rd. Improvements (1997)
- East Boat Ramp Shoreline Improvements (1998)
- Tower Loop Shoreline Stabilization (1999)
- Cottonwood Creek/Peoria WQ Improvements (2002)
- Cottonwood Creek Stream Reclamation Phase II (2009)
- Cherry Creek Reservoir Destratification (2007)
- Cherry Creek Stream Recl. @ Eco-Park (start 2012)
- Cherry Cr. Stream Recl @ PJCOS (ongoing)
- Cottonwood Creek Stream Recl. @ Easter Ave. (2011)
- Cherry Cr. Stream Recl. @ 12-Mile Park (Phase I 2012)
- Reservoir Shoreline Stabilization @ Mtn. Loop (scheduled for 2012)
- McMurdo Gulch Stream Reclamation (2011)
- Airport Ponds C3 & C4 (2012)

CCBWQA also conducts annual PRF inspections.

Implementation Highlights *(continued)*

Water Quality Monitoring

The Phase I Baseline Water Quality Study was begun in 1994 to determine baseline watershed conditions and trends. Several mainstem Cherry Creek and ground water stations continue to be sampled today to monitor progress made in the watershed.

Aquatic biological & nutrient monitoring on the reservoir and upstream tributaries, including Shop Creek, Cherry Creek, and Cottonwood Creek, has been conducted from 1994 to the present.

In 2007, additional reservoir monitoring of temperature at 1-m depths was added to assess the effectiveness of the destratification system.

Funding

The Authority receives funding for its activities primarily from:

- Property taxes
- Cherry Creek State Park user fees
- Wastewater surcharges based on volume of discharge
- Building permit fees

State Law requires that at least 60% of the Authority's annual revenues must be spent on construction and maintenance of PRFs. The remaining 40% is allocated towards activities such as monitoring, special studies, planning, technical reports, and administrative costs.

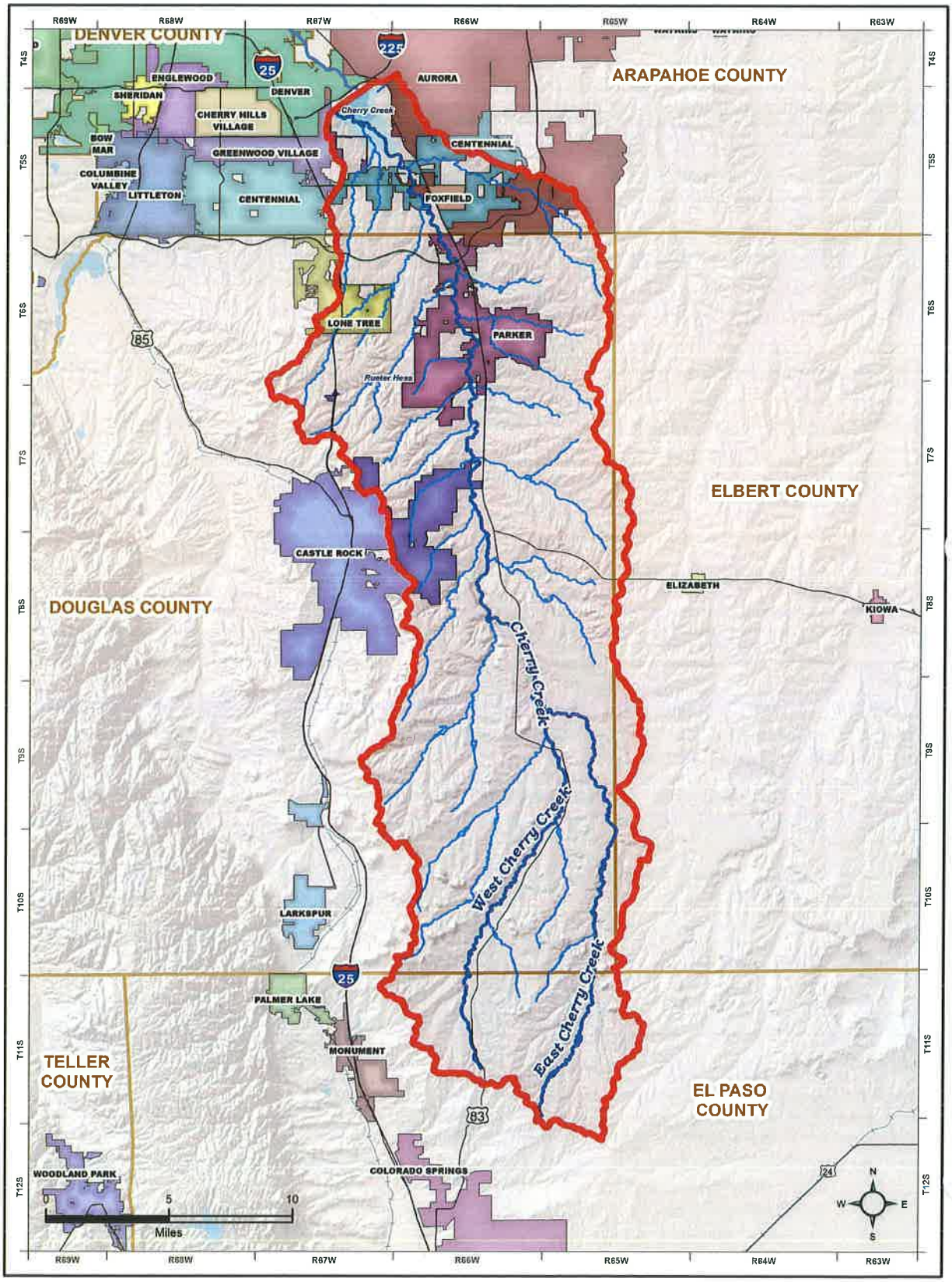
Cherry Creek Stewardship Partners

The Cherry Creek Stewardship Partners were formed in 1999. Since that time, the Partners have been successfully promoting active stewardship of the watershed. The focus is on cross-jurisdictional coordination and communication on watershed issues such as open space, recreation, and water quality.

The Partners sponsor activities and projects such as:

- Education Initiative in support of Reg. 72
- Guided tours and hikes such as the Winter Hawk Walk, Trails Day "Unique to the Creek" hike, and solstice and equinox hikes
- Volunteer projects focusing on activities such as silt fence removal, riparian area monitoring, weed control, and stormwater projects
- Youth science fairs with a focus on integrating watershed interests & science curriculum
- Water quality monitoring efforts involving basin residents and students
- Teacher Training Workshops
- Annual Run for the Watershed Relay Race
- Annual Watershed Conference
- Support of open space, habitat, and trails

For further information, visit: www.cherry-creek.org


DENVER COUNTY
ARAPAHOE COUNTY
ELBERT COUNTY
DOUGLAS COUNTY
TELLER COUNTY
EL PASO COUNTY
ENGLEWOOD
SHERIDAN
DENVER
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CHERRY HILLS VILLAGE
BOW MAR
GREENWOOD VILLAGE
CENTENNIAL
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Chapter 3

Regulation 72

What is Regulation 72?

Regulation 72 is the Cherry Creek Reservoir Control Regulation. This control regulation was first adopted by the Colorado Water Quality Control Commission in 1984. When appropriate, innovative solutions or management approaches to meeting water quality standards may be implemented through control regulations. The Cherry Creek Reservoir Control Regulation was only the second control regulation to be adopted in Colorado. Other control regulations exist for Dillon Reservoir, Chatfield Reservoir, Bear Creek Watershed, and Cheraw Lake.

History of Regulation 72

1984 Reg. 72 first adopted, with Total Maximum Allowable Load (TMAL) for phosphorus to protect water quality in the reservoir, specific Wasteload Allocations (WLAs) for wastewater dischargers, and Load Allocations (LAs) of 50% removal with local regulations only for nonpoint sources (NPS)

1989 Clarified use of wastewater treatment plant (WWTP) limits and extended compliance date for 50% phosphorus removal from nonpoint sources

1991 Added WWTP annual maximum discharge limit concentration

1992 Added temporary WLA for Denver SE Suburban W&SD

1995 Added requirements for land application of treated wastewater

1997 Established trading program to be administered by Authority

2001 Adopted phased TMAL, including WLAs for wastewater treatment plants, temporary transfers, emergency pool, and reserve pool, trading program modifications, nonpoint source control requirements, Phase II stormwater requirements, and monitoring requirements for nutrients (not just phosphorus)

2004 Eliminated trading poundage cap and trading ratio ceiling, added flexibility in use of return flow factors in WLA calculations, included individual sewage disposal systems (ISDS), and exempted certain land disturbance activities

2009 Commission adopted revised Reg. 72, including removal of all TMAL-related components, a new concentration-based management approach, phosphorus discharge effluent limits for drinking water treatment plant discharges, and a 3-tiered stormwater system for development/redevelopment

2012 Triennial Review & Rulemaking Hearing to consider changes to 72.7 stormwater requirements

TMAL = WLAs (for point sources like WWTPs) + LAs (for nonpoint sources + a margin of safety

Evolution of Regulation 72

Significant changes to Regulation 72 were adopted in 2009 and became effective in 2010, leading to a need to evaluate their implications for the Watershed Plan and make modifications to the Plan as appropriate. These changes are summarized in the table below.

	Previous Requirements	Reg. 72 Direction Adopted in 2009
Nutrient Control Strategy	Controlled phosphorus loads into reservoir	Determined flow-weighted concentrations in the inflow to reservoir are better correlated to chlorophyll α levels
Waterbody Focus	Reservoir was the main focus	Watershed management approach
Reservoir Standard	1985: Adopted phosphorus (P) standard of 35 µg/l 2000: Adopted seasonal mean chlorophyll α standard of 15 µg/l with a total phosphorus (TP) goal of 40 µg/l	2009: Adopted 18 µg/l seasonal mean chlorophyll α standard
Total Maximum Annual Load	TMAL = 14,720 lb. phosphorus; WWTPs assigned individual wasteload allocations (WLAs)	Removal of all TMAL-related components from the regulation; No reserve pool; Trading program suspended
Point Sources	WWTPs subject to both individual WLAs (pound limits) and discharge limit of 50 µg/l	WWTP permit limits retained at 50 µg/l; Industrial process wastewater sources given 50 µg/l limits; Added new effluent limits (200 µg/l) for drinking water treatment plants
Nonpoint Sources	Incorporated Phase II Stormwater Requirements for development, including construction & permanent Best Management Practices (BMPs)	Established a 3-tiered stormwater program for new development and redevelopment
Special Studies	2001: WQCC directed Authority to conduct 13 specific special studies, in support of phased TMAL	No studies defined at this time; Regulation discusses potential for special studies re: nutrient removal from point sources, NPSs, PRFs, BMPs

2009 Revisions to Regulation 72

The arrows below indicate the significant changes in the focus. These changes will encourage a new approach for watershed planning. Potential new activities are shown in the boxes.

Load-Based → Concentration-Based

- Design projects based on resultant concentrations rather than pounds removed
- Focus on reducing concentrations throughout watershed (stream system approach) vs. individual PRFs & NPS load reductions
- Review/revise monitoring program

Reservoir Focus → Watershed-Based Approach

- Focus on entire watershed
- Understand fate and transport as important mechanisms
- Review/revise monitoring program
- Focus education on how watershed/ riparian condition impacts reservoir

Phosphorus inputs → Chlorophyll a responses

- Understand reservoir ecology, food chain, and beneficial uses
- Consider all nutrients (including P, N, & TOC), as well as pH, temperature, DO, TDS, & sediment
- Understand impacts of internal load

Individual WWTP/ MS4 Efforts → Partnerships/ Leveraging

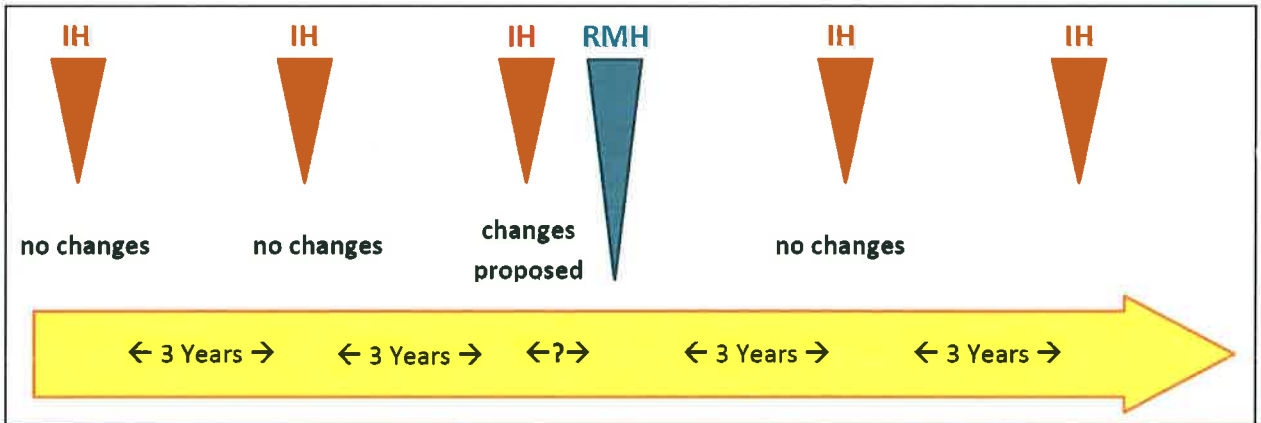
- Pursue partnerships, leveraging financial resources
- Coordinate with counties, municipalities, special districts, and water suppliers
- Continue to closely coordinate with and support efforts of MS4s, CDOT, CCSP, etc.

Chemistry-Based (P) → Lake Ecology-Based

- Understand the reservoir ecology
- Coordinate with Colorado Division of Parks and Wildlife
- Monitor biology of reservoir
- Consider a broader range of constituents

How is Regulation 72 Modified?

At least once every three years, the Water Quality Control Commission must review Regulation 72, to determine whether anything should be changed. The Commission holds an Informational Hearing (IH), where any interested party can provide its opinion or recommendations concerning changes it believes should be made (or whether the regulation should continue in its current form). Any suggested changes deemed by the Commission to require further action will be proposed as regulatory changes for subsequent public rulemaking. This rulemaking hearing (RMH) can be scheduled at any time, at the Commission's discretion. Once the rulemaking hearing to consider the changes is held, the three-year time clock starts again.



Summary

All nutrients and watershed/reservoir interactions must now be considered in maintenance of water quality. Both point and nonpoint pollutant sources will need to be aggressively pursued. Unregulated nonpoint source pollution may prove to be the biggest challenge due to its diffuse nature and the fact that vast amounts of land involved. However, reclaiming the stream corridors in the watershed partially mitigates for some impacts from both regulated and nonpoint sources of pollution. Effective partnerships and leveraging of financial resources will be key to effectively addressing these challenges.

Chapter 4

Cherry Creek Basin Water Quality Authority

Existing and Projected Conditions in the Watershed

Watershed Plan 2012

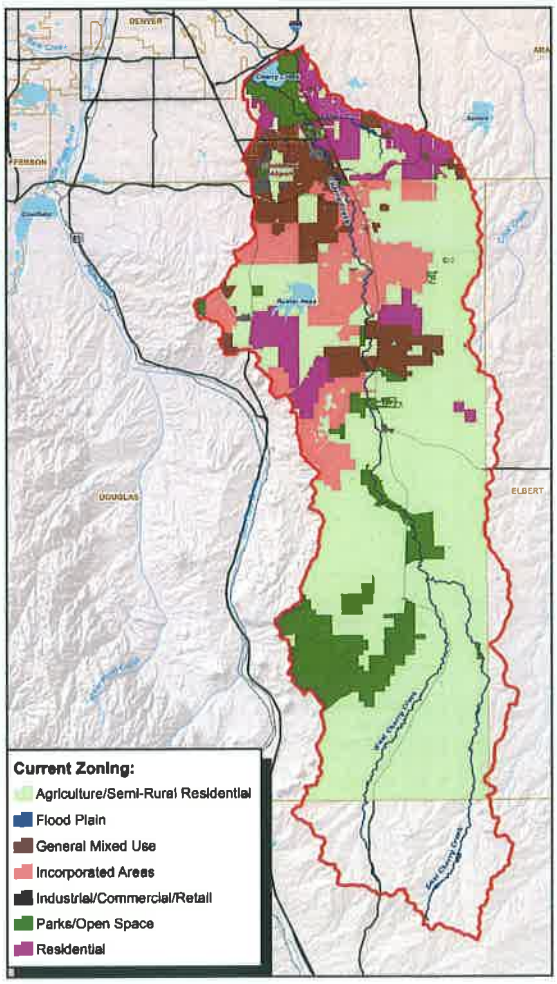
Chapter 4

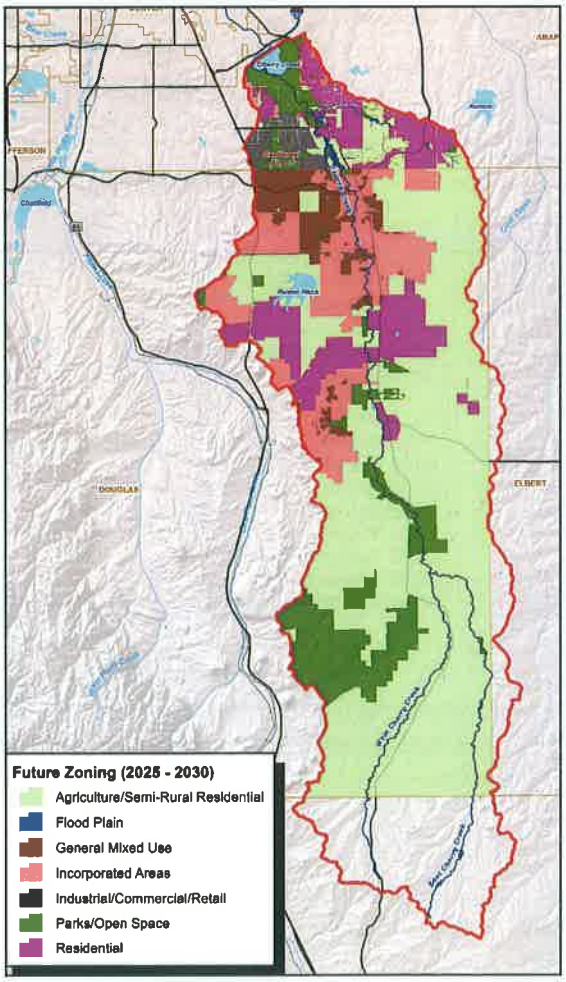
Introduction

The source of the Cherry Creek drainage is on the Palmer Divide, approximately 40 miles south of Cherry Creek Reservoir. The watershed is about 386 square miles. It is located primarily in Douglas County, with the northern portion of the drainage located in Arapahoe County and small portions located in Elbert and El Paso Counties on the eastern and southern portions of the watershed.

When construction of the Cherry Creek Dam was completed in 1950, the most predominant land use in the basin upstream of the reservoir was livestock ranching. The Town of Parker was originally settled in the mid-1800s, however, incorporation did not occur until 1981. At that time Parker's municipal boundary was one square mile with a population of 285. Today Parker encompasses 18.8 square miles with a population exceeding 46,000.

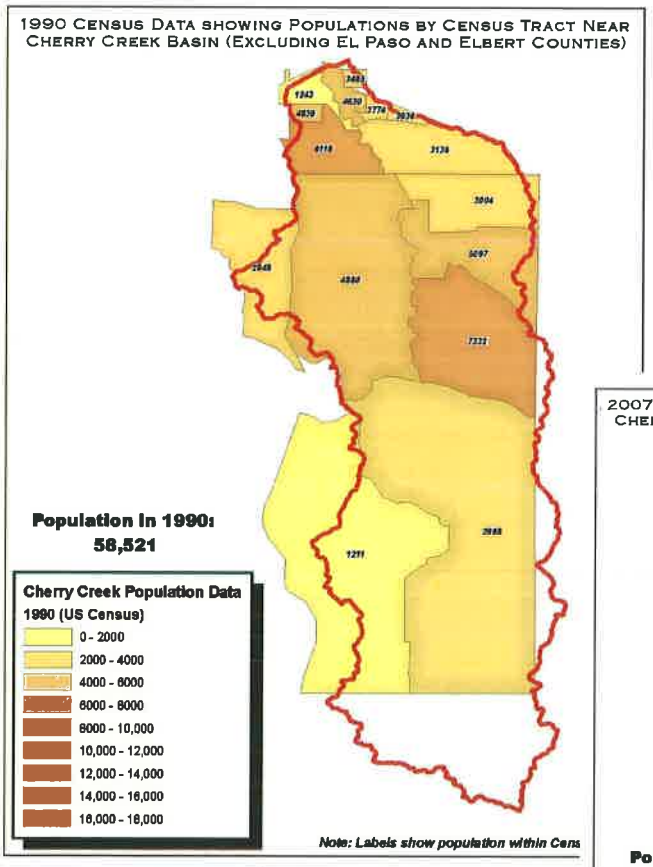
The boundaries of the Authority, under State law, are actually only those lands in Arapahoe and Douglas Counties, within the Cherry Creek Drainage Basin, from the headwaters to the dam.



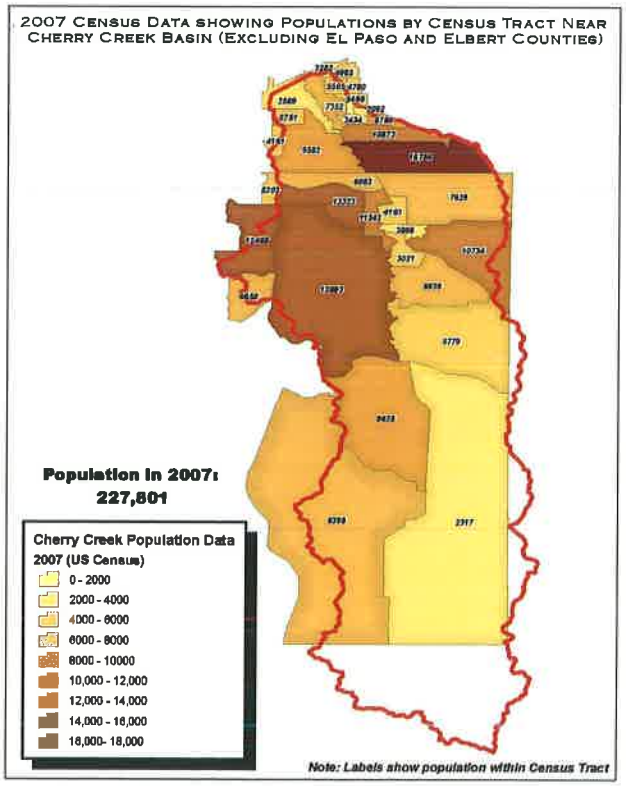


Introduction (cont'd.)

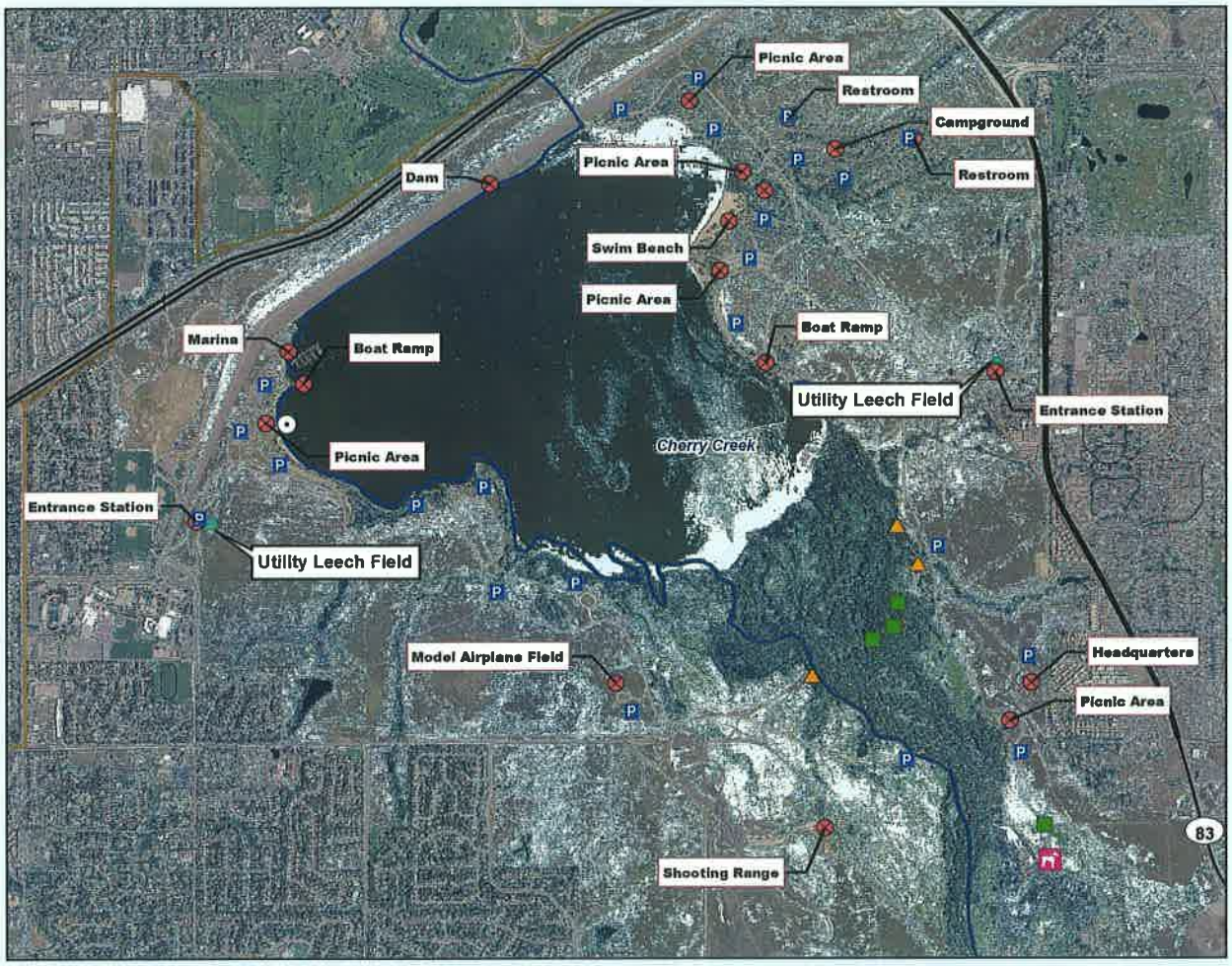
During a recent 17-year span, the population in the basin increased by 289%, according to the U.S. Census Bureau for census blocks encompassing the Cherry Creek Basin in Douglas and Arapahoe Counties. The population rose from about 58,500 residents in 1990 to 227,801 in 2007. Growth in Arapahoe County within the Cherry Creek Basin is closer to build-out than Douglas County. The Colorado Department of Local Affairs projects that the population in Douglas County will increase nearly 60% from about 300,000 to 475,000 residents between 2010 and 2030.



The rapid growth of the Denver Metro area and the Colorado Front Range outside of the Cherry Creek drainage has also affected the reservoir and watershed. Metro area residents commute into the Cherry Creek watershed for work and recreation. The Cherry Creek State Park itself attracts visitors from throughout the Denver Metro area and is the most-used State Park in Colorado, hosting about 1.5 million visitors annually. The volume of recreational usage strains the resource resulting in on-site pollution and erosion. Considerable effort has been directed by the Colorado Parks Department and the Authority to clean pollution sources and control erosion within the Park and the immediate vicinity. The Park supports recreational facilities to satisfy almost every outdoor recreational interest.



Popular facilities include: stables for horseback riding; shotgun, pistol, and rifle ranges; boat launching facilities and marina; picnic areas; swimming beaches; an off-leash dog exercising area; fishing; and biking and walking paths.



The basin supports an important and vibrant commercial and high-tech economy that attracts a workforce from areas throughout the United States. A commercial hub, the Centennial Airport, is located entirely within the Cherry Creek drainage. The airport opened in 1967 on undeveloped land 13 miles from downtown Denver. Since then, it has become the third busiest General Aviation airport in the nation and is among the top 25 busiest of all airports. The airport attracts other businesses that are dependent upon shipping and access to convenient aviation facilities.

Existing and Projected Conditions in the Watershed

The rapid urbanization in the watershed has replaced many of the historic agricultural operations with housing, commercial, and office developments. These land use changes have influenced runoff and water quality characteristics of stormwater in the basin. With increased urban development, the amount of impervious surfaces has greatly increased, potentially increasing the amount and timing of stormwater runoff. However, conversion from agricultural to urban landscapes in Douglas and Arapahoe Counties has also brought additional stormwater control requirements.

Regulations limiting the peak runoff rate and duration of stormwater discharge from new developments have been enacted requiring detention storage to attenuate runoff to pre-development levels. The construction of grassed detention basins may improve water quality over undeveled agricultural land, serving to trap sediments and nutrients that may have otherwise reached Cherry Creek Reservoir.

Despite the tremendous population growth and development within the Cherry Creek Basin over the past thirty years, water quality in Cherry Creek Reservoir remains high. This can be attributed to increased efforts in controlling point source and nonpoint source pollutants (including construction and post-construction BMPs), and stream channel restoration and stabilization efforts that have reduced sediment transport. As agricultural lands have been converted to housing and business developments, construction of detention facilities that trap sediments have also resulted in reduced nutrient loading to the reservoir.

Future Conditions in Cherry Creek Reservoir and the Watershed

By 2030, nearly all of the large agricultural areas in the Cherry Creek Watershed are expected to be developed into housing, commercial, business, small ranch, or large lot developments. The resident population in the basin is projected to continue growing. The magnitude and type of growth will require a long -term commitment of resources to maintain water quality in Cherry Creek Reservoir and Cherry Creek.

Future threats to water quality in Cherry Creek and the reservoir are primarily driven by the influx of residents and businesses into the watershed. Future development will bring new challenges to maintaining water quality in the basin. Future growth will result in construction and changes in operations that may have water quality changing effects.

- The amount of impermeable area in the watershed will increase requiring more stormwater facilities to control urban runoff, to prevent nutrients and sediments from entering the reservoir, and maintain or improve channel stability.
- More roads will be constructed, potentially resulting in contamination from petroleum products, automotive fluids and lubricants, accidental hazardous materials spills, and contamination from snow removal chemicals.

- The number of hazardous waste storage and containment facilities, such as gas stations and maintenance yards, will likely increase.
- Use of lawn and garden fertilizers and pesticides will likely increase.

Future Conditions in Cherry Creek Reservoir and the Watershed (cont'd)

- The use of non-tributary water for domestic and commercial use will increase, as will imports of water from outside of the Cherry Creek Basin. These supplies may include Denver Basin groundwater, imported water from the South Platte downstream of the Denver Metro area, and potentially the Colorado and Arkansas River Basins. Even if treated outside the Cherry Creek Basin, imported water may have higher total dissolved solids (TDS) than current supplies.

- Additional use of Cherry Creek Basin surface water supplies for municipal purposes may periodically reduce flows in Cherry Creek and possibly affect residence time of water stored in Cherry Creek Reservoir, resulting in reduced flushing of nutrients from the reservoir.

- More reuse of wastewater is planned to meet the needs of the growing population in the Basin. The potential import of out-of-basin water of poorer quality may result in a higher concentration of conservative contaminants, such as TDS, unless they are removed prior to discharge. If processes such as reverse osmosis (RO) are used to remove the solids, a concentrated waste brine stream is produced; disposal of such brine may be costly and/or difficult to permit. Storage of poorer quality imported water could also increase the TDS as a result of evaporation.

- Water quality control regulations are likely to become more stringent in the future. New nutrient control requirements of Regulations 85 and 31 may drive additional monitoring and controls.

- Drainage design and runoff controls will take on added importance along with protection and enhancement of small, intermittent stream channels.

- Increased use of Low Impact Development concepts is expected to increase throughout the industry.

Opportunities for Enhancement of Water Quality

During the past twenty years, effective point and nonpoint source pollution controls have been implemented in the Cherry Creek Basin. The fact that there has not been significant degradation of water quality during that period despite the incredible growth rate, can be attributed to the extensive efforts undertaken to date. Despite the projected growth in the watershed, there are reasons to be optimistic that water quality can be maintained and improved in the Cherry Creek ecosystem.

Public Education and Involvement

Since 1999, the Cherry Creek Stewardship Partners has been an effective organization for public education, organizing watershed improvement projects, and annually conducting numerous public outreach projects. The Partners' efforts have raised awareness and support for water quality, water resource, and ecological issues in the watershed. At the 2010 annual conference, a survey presented to public participants revealed considerable support for watershed and stream channel improvements upstream from Cherry Creek Reservoir. Results of this survey have been incorporated in the Watershed Plan recommendations.

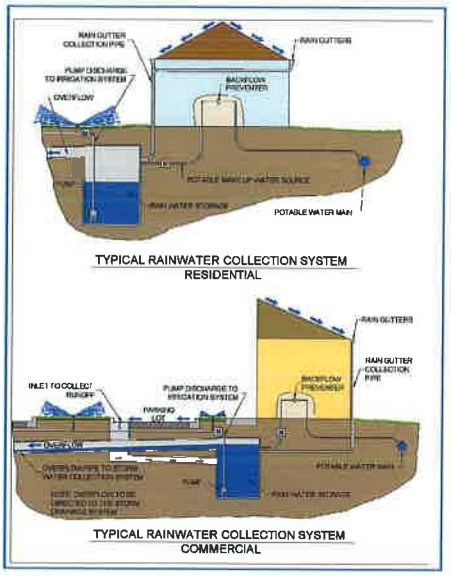
Monitoring

Improved monitoring of Cherry Creek Reservoir and Cherry Creek has resulted in a better understanding of nutrient loading and dynamics in each. This has resulted in the refinement of pollution control facility designs and the installation of a destratification system in the Reservoir that appears to have reduced the amount of cyanobacteria (blue-green algae) in the reservoir.

Opportunities for Enhancement of Water Quality (cont'd)

Rainwater Harvesting

Rainwater harvesting is being investigated as an option to extend water supplies and provide a source of supply for non-potable use. Rainwater harvesting may be feasible for irrigation of parks, open space, and to establish vegetative cover on disturbed or degraded areas. It may be feasible to construct rainwater storage impoundments in conjunction with detention storage facilities. Nutrient and other contaminant loading to streams and the Reservoir could potentially be reduced by using the rainfall runoff captured from impervious surfaces for irrigation.



Drainage Improvements

Water quality enhancements have been realized from improvement projects on Piney Creek, Shop Creek, Cottonwood Creek, and other degraded drainages. These projects have also achieved improvements to aesthetics and wildlife habitat, resulting in broader public support for similar projects.

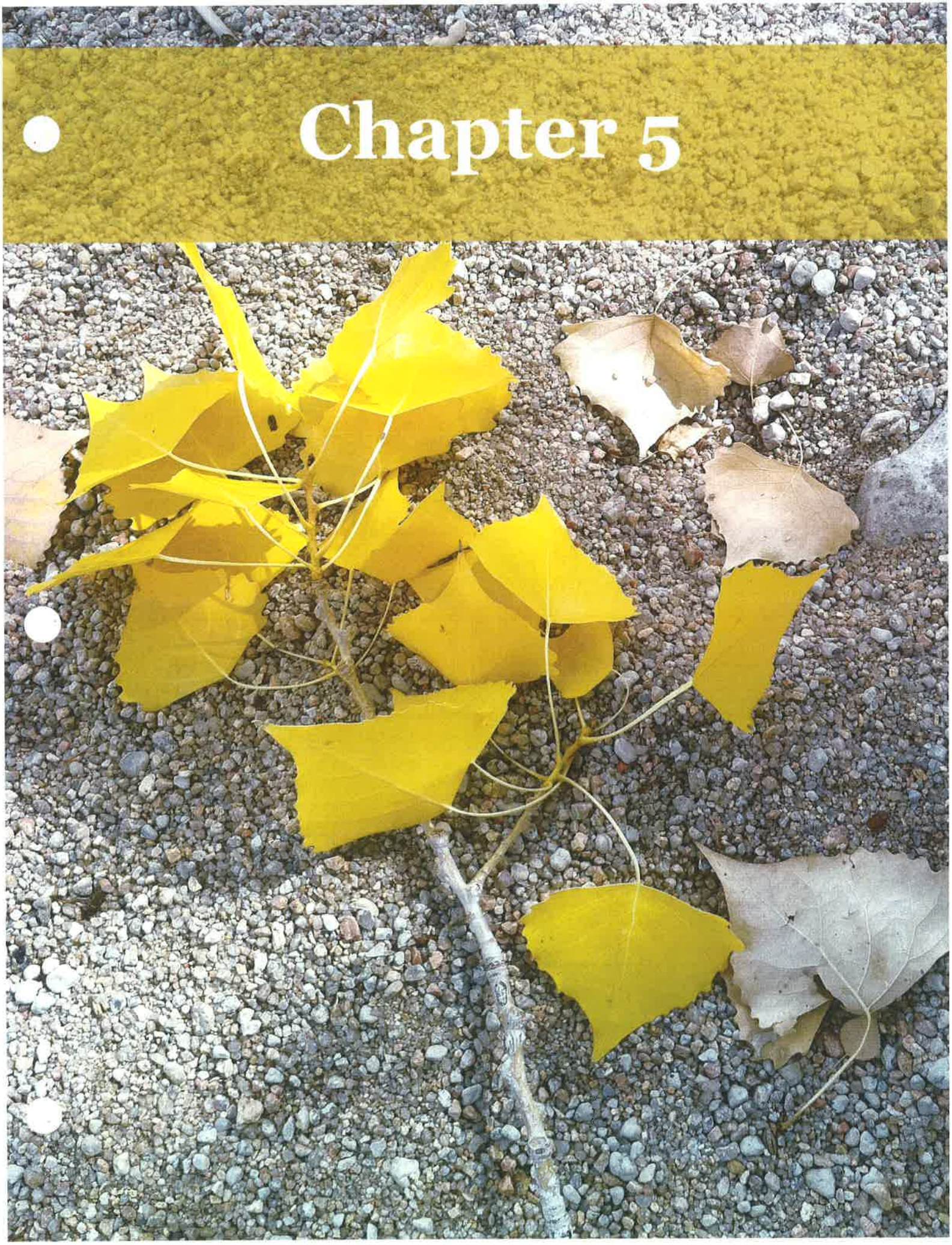
Regulatory

Regulations limiting irrigated landscape areas could serve two purposes: 1) water conservation and 2) reduced use of fertilizer.

In the future, the Authority may wish to consider working with the water providers in the Basin to acquire water supplies to provide flushing flows and to provide for needed dilution.

The Authority has taken a proactive stance in data collection and working with CDPHE during the triennial review process.

Chapter 5



Potential Management Strategies

Management Strategies - General

Potential Pollutant Sources

Based on the information in previous chapters, several potential pollutant sources or areas were identified. These include both point and nonpoint sources of nutrients. Each source is covered separately in this chapter. Where available, information is provided for the following components:

- Existing conditions and operations
- Information on nutrient contributions, or loads, where data were available, to help identify implications for water quality downstream
- Existing regulatory requirement and controls (i.e., "sticks")
- Management strategies that could be used to control/ reduce these sources
- Recommendations on which options appeared most viable for the basin

In addition, information is provided at end of this chapter on previously developed models for the watershed and reservoir, which can be used to help prioritize sources to address.

Below is a table identifying the sources evaluated:

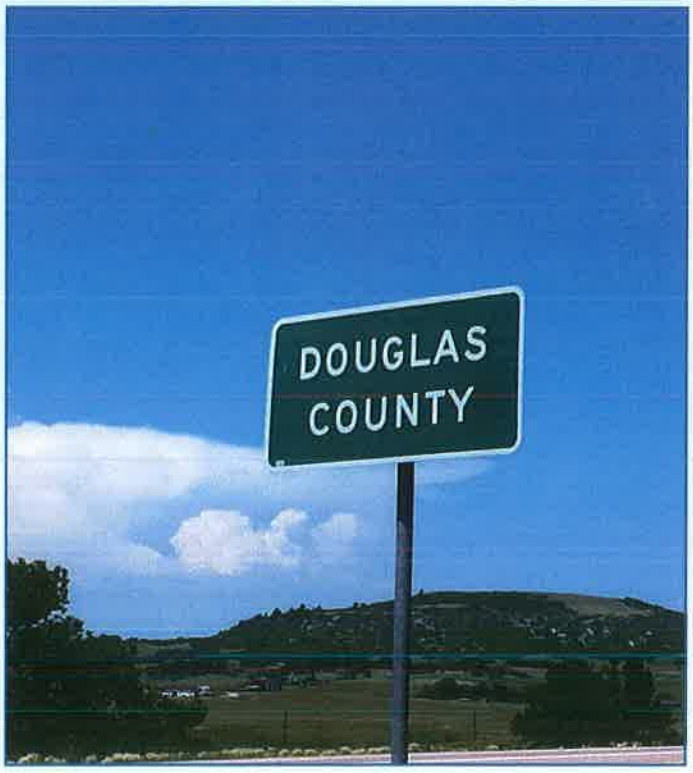
Potential Management Strategies

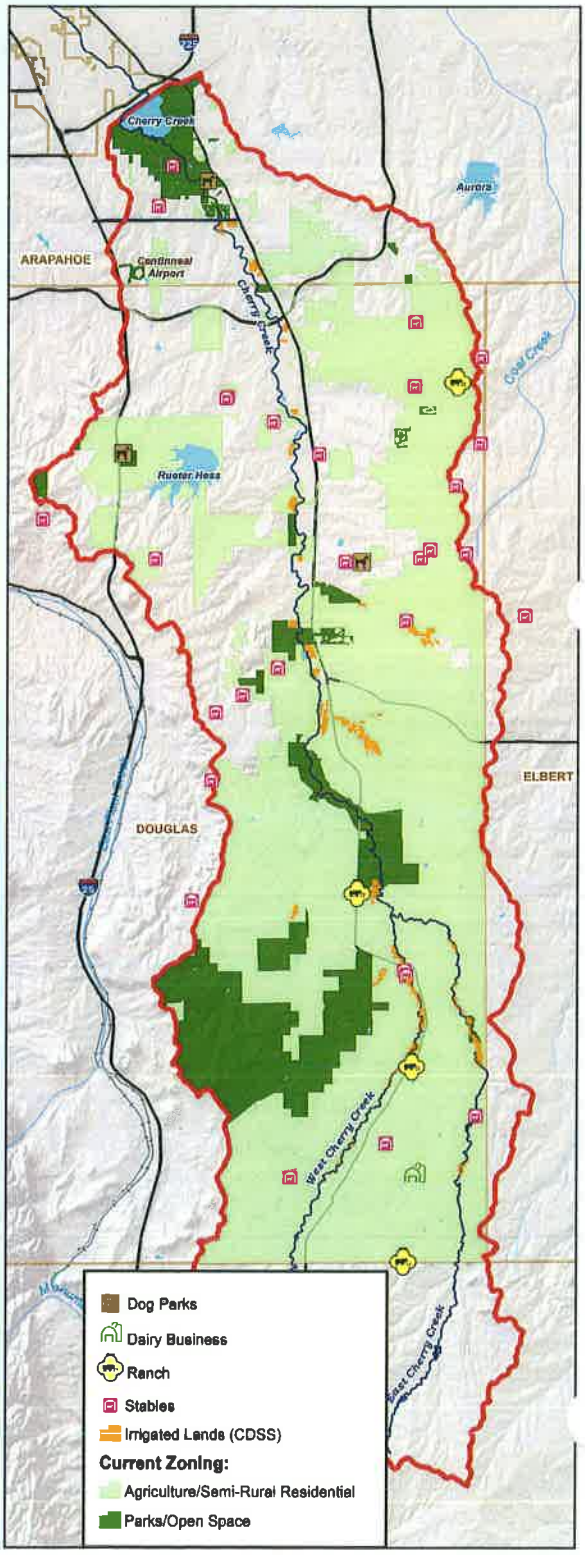
Agricultural Operations

Current Agricultural Operations

Agricultural operations in the watershed include livestock grazing, tilled cropland, irrigated and non-irrigated hay land, sod farms, tree nurseries, and greenhouse operations. The Cherry Creek Watershed is largely agricultural and semi-rural, especially in the upper portion of the basin, in Douglas County (see map). The map also shows irrigated lands, stables, dairy farms, and cattle ranches.

Douglas County: Over 75% of Cherry Creek basin in Douglas County is zoned as agricultural, semi-rural, or parks and open space. (Douglas County makes up approximately 75% of the watershed.) The average size of a farm in the county is 221 acres. About 52% of the total market value of agricultural products sold is from nursery, greenhouse, floriculture, and sod. The sale of livestock, poultry, and their products accounts for about 43%. Hay is also produced for sale within the basin.





County Regulations and Zoning Requirements

Both Douglas and Arapahoe Counties, through their zoning regulations, control the uses of agriculturally-zoned lands within the counties. The county regulations also have specific provisions requiring the protection of water quality.

Arapahoe County: Agricultural zones include A-1 (agricultural-1, minimum lot size of 19 acres) and A-E (agricultural estates, 35-acre minimum lot size) . Permitted uses include agricultural or ranch use, flower farms, greenhouses, farm or ranch animal centers, guest rancher, and stables. Special exception uses or uses allowed by special review include commercial feed lots, guest ranches, hunting clubs, and kennels.

Water quality protections for both the A-E & A-1 zoning categories include the following:

- "All development must be sited to avoid or mitigate any adverse impacts on ... important riparian corridors..."
- "All development must have no detrimental effects on soil stability or ground water supplies, and all development must also mitigate impacts from runoff or from changes to the drainage characteristic of the land"

Douglas County: Principal uses allowed in the Agricultural One District zone include farming, ranching, forestry, tree farming, gardening, plant nurseries, greenhouses (≤ 1 acre), agricultural recreation activities, and animals. Uses permitted by special review include non-domestic animals, dude ranches, feedlots/confinement centers, greenhouses (> 1 acre), large horse boarding or training facilities, horse rental stables, kennels, septic waste, and domestic sludge application.

Approval criteria used during administrative reviews include:

- "Whether the proposed use will not cause significant water pollution"

Potential Management Strategies

Agricultural Operations

Requirements for Animal Feeding Operations

All animal feeding operations in Colorado are subject to the State's Animal Feeding Operations Control Regulation #81.

AFOs are facilities where animals are confined for at least 45 days in any 12-month period in an area that does not sustain crops or other vegetation while the animals are confined. In other words, AFOs are bare-lot or housed operations.

Appropriate Best Management Practices (BMPs) are required for all AFOs. Example BMPs for protecting water quality include:

- Diverting stormwater from operation
- Decreasing open lot surface
- Minimizing manure transport to streams

- Locating facilities down-gradient and at least 150-feet away from water supply wells

Clean Water Act Requirements

People believe that agricultural runoff is exempt from regulation. It is true that certain agricultural activities are specifically exempted from Clean Water Act requirements.

Neither EPA nor the State can require a discharge permit for a discharge composed entirely of return flows from irrigated agriculture.

"Point Sources", which normally require permits, do not include agricultural stormwater discharges and return flows from irrigated agriculture.

The Clean Water Act does, however, regulate Animal Feeding Operations (AFOs), including the application of biosolids to agricultural land. It also encourages the voluntary use of best management practices to reduce nonpoint source pollution derived from unregulated agricultural activities. Targeted reductions from agricultural activities can also be identified as part of a Total Maximum Annual Load.

Confined animal feeding operations may be classified as small, medium, or large. Medium or large operations typically have hundreds or thousands of animals. For example, to be classified as a medium operation, you must have more than 150 horses, 200 dairy cows, or 300 cattle. Medium and large facilities require discharge permits; small AFOs may also be required to get a permit if the State determines the operation is contributing significant water pollution.

Potential Management Strategies

Agricultural Operations

Tree Nurseries/Sod Farms

Currently, there are a few sod farms in the watershed and a few tree nurseries operating in the Parker area. Tree nurseries usually have large areas of bare ground, which increases the potential for runoff during precipitation events. Because tree nurseries and sod farms both tend to use large amounts of fertilizer and herbicide, these chemicals may be transported with any runoff events, including runoff from irrigation, and return to the stream system. Tree nurseries and sod farms may be expected to have a greater effect on water quality than other irrigation operations like hayland or cropland. Sod farms produce about 140 to 1,160 pounds of phosphorus per acre per cut.

Recommendations

Minimizing the use of fertilizers and pesticides, as well as preventing runoff from irrigation to leave the site, can help minimize adverse water quality impacts.

Annually Tilled Cropland

The Natural Resources Conservation Service (NRCS; formerly the Soil Conservation Service) estimates that there are only a handful of operations of annually tilled cropland within the watershed, located south of Franktown. These operations grow mostly corn and sorghum, both used as livestock feed. Commercial fertilizers applied to cropland are up to 82% nitrogen and up to 72% phosphorus by weight. While the impact is minimal due to the small number of operations in the basin, potential water quality affects include runoff carrying sediment, herbicide, and fertilizer. Because these operations are annually tilled, the amount of bare ground each year is almost the entire acreage directly following the tilling. These are the times when runoff will be highest and impacts will be the greatest, although the furrows themselves promote infiltration .

Recommendations

Minimizing tillage helps with erosion on the surface, but this tends to require a higher use of pesticide, so the impacts to the water quality may not be reduced. Another option to help protect water quality is the NRCS best management practice for irrigation water management. This involves monitoring the amount of water, fertilizer, and herbicide required to grow specific crops. This minimizes the nutrient and water sources required rather than over-applying and having more nutrients and water run back to the river.

http://www.ers.usda.gov/publications/arei/ah722/arei2_2/arei2_2irrigationwatermgmt.pdf

Potential Management Strategies

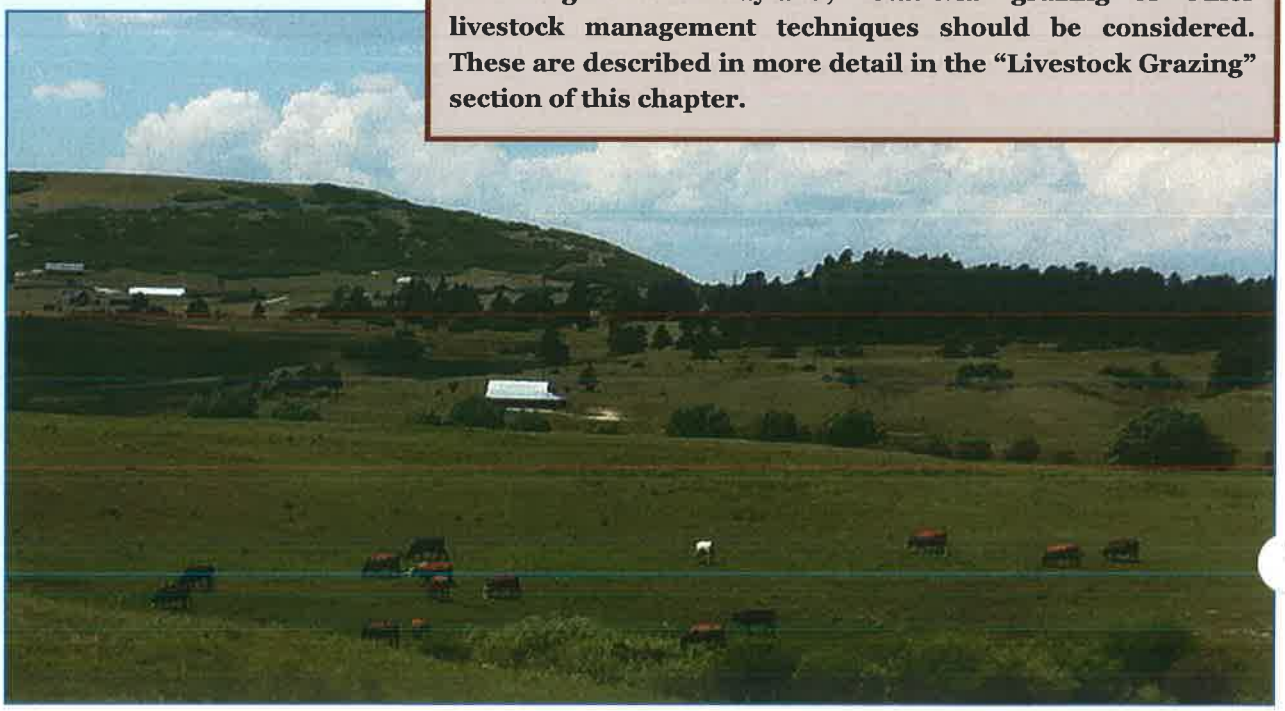
Agricultural Operations

Haylands

Within the Cherry Creek Watershed there are an estimated 30 to 50 hayland operations. About 10 to 12 of these have visible signs of irrigation (i.e., center pivots); however, additional operations may include flood irrigation. The potential for impacting water quality in these operations depends on the use of herbicide, fertilizers, and how frequently the land is tilled and replanted. Commercial fertilizers applied to cropland are up to 82% nitrogen and up to 72% phosphorus by weight. Alfalfa is a short-lived perennial and is typically tilled every 5 to 10 years. During tillage, additional erosion will occur, and the runoff potential is greater. It is also likely that additional fertilizer and herbicide is being applied during this time as well. Most, if not all, of the hayland within the watershed is likely also being used as livestock grazing.

Recommendations

Similar to cropland, one recommendation is to implement NRCS best management practices for irrigation water management to control the amount of water and pesticides applied during irrigation. Additionally, if grazing is occurring on the hayland, rotational grazing or other livestock management techniques should be considered. These are described in more detail in the "Livestock Grazing" section of this chapter.



Potential Management Strategies

Agricultural Operations

Stables

Small-acreage horse farms and stables can contribute nutrients and other pollutants such as organic matter and bacteria to the environment. Snowmelt runoff and rain can pick up nutrients from horse paddocks and/or manure piles and transport them to nearby waterways. Rainwater and melting snow may also leach salts, ammonia, and nitrates into the groundwater. Although horse manure is naturally dry, groundwater contamination can still be a concern, especially where manure piles are located on porous soils like sand and/or in areas with a high water table.

An average horse produces between 3/4 to 1 cubic foot of fresh manure every day, or about 9 tons per year. One ton of manure typically contains 12 lbs of nitrogen (N) and 6 lbs of phosphorus (P), on a wet weight basis. It has been estimated that the horse boarding area at Cherry Creek State Park (with approximately 50 horses boarded or rented for 150 days/year) generates about 700 pounds of phosphorus and 1400 pounds of nitrogen per year.

Recommendations

BMPs can include:

- **Locating equine buildings & facilities away from drainage swales and areas with poor soil drainage.**
- **Grading the area to divert stormwater runoff away from equine facilities to prevent it from picking up nutrients and other pollutants.**
- **Installing gutters, downspouts, and splash blocks on all barns and shelters; diverting roof runoff away from paddocks, exercise lots, and stall areas via a properly designed drainage system.**
- **Practicing good grazing management; rotate grazing to allow pastures to rest.**
- **Utilizing a "sacrifice" area to keep animals off wet pastures.**
- **Using a tarp (or roof) to cover manure piles during wet weather to prevent the leaching of nutrients and microorganisms into surface and groundwater.**
- **Spreading manure and compost when plants can use it.**
- **Installing grass or vegetative buffer strips.**

Potential Management Strategies

Agricultural Operations

Livestock Grazing

Livestock grazing may have a significant impact on water quality. Within the watershed, there are an estimated 50 to 100 operations, many of which overlap with haying operations. Livestock tend to prefer riparian areas, and ranchers tend to use areas along the stream during winter grazing. With livestock closer to the streams, animal waste and overgrazing are immediate threats to the water system. When overgrazing occurs, especially in riparian areas, there is the possibility that native plants will be replaced with non-native species or reduced to bare ground. Additionally, overgrazing can increase runoff, carrying with it animal waste, sediment, and any fertilizer and herbicide used on the property. One cow can produce about 48 pounds of phosphorus and 230 pounds of nitrogen per year.

Recommendations

Rotational grazing can be used to limit overgrazing. NRCS staff developed a number of rotational grazing options based on number and type of livestock and lot size. An option to limit the amount of direct influence livestock have on the riparian system is to fence off riparian and stream areas from direct use. A small water gap in the fence could allow an alleyway into the stream in one spot, localizing and limiting total impacts. If rotational grazing is operated effectively, a fence around riparian areas should not be necessary. Placing fencing in the floodplain may be an issue that would need to be addressed.

Another option to decrease direct contact between livestock and streams/riparian habitat is a hydraulic ram pump. Ram pumps use the natural flow from a water source moving with gravity to create pressure and push some of the water up through a delivery pipe, away from the water source. Ranchers could build a ram pump using the river as a source (water rights will need to be decreed for appropriate use) to pump water up to a pond located in an area upland on their property to use as a source of water for livestock, thus keeping livestock from entering the stream system.

County regulations should be reviewed to see if they address grazing as part of their floodplain rules.

Potential Management Strategies

Animal Wastes (Dog Parks/Trails)

Background

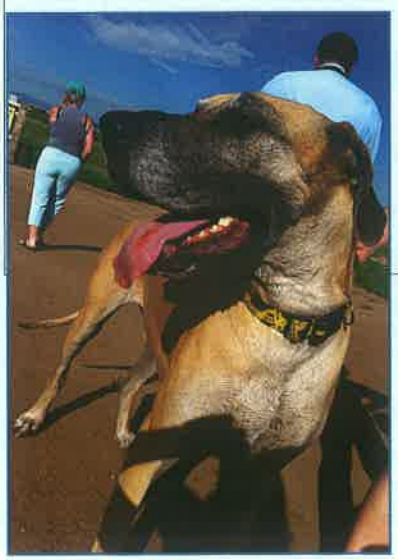
In a concentrated form, animal waste from domestic animals such as dogs and horses can pose several water quality concerns. It is a potential source of nutrients and pathogens which can degrade water quality. Water quality can be impacted when heavy precipitation events wash fecal waste into nearby waters, contributing nutrients and organic matter which can result in depleted oxygen levels.

Potential sources of animal waste in the Cherry Creek Watershed include a few dog park areas including the dog off-leash area (DOLA) just upstream of Cherry Creek Reservoir in the State Park. There are significant impacts from human and dog interactions in this area, including large areas of visible bare soil along the banks of streams caused by the high amount of traffic in this area. Animal waste and sediment run off directly into the stream.

Nutrients in Dog Waste

Studies have shown that nearly 50 percent of dog owners exercise their pets in public use areas. Of these, almost 40% do not clean up their pets' waste.

For example, a conservative estimate is that there 450,000 dog visits per year at the DOLA. Dog waste contains about 10% phosphates and 2% nitrogen by weight. Thus, the DOLA is calculated to generate over 25,000 pounds of phosphorus and 5,000 pounds of nitrogen per year that could reach the stream and reservoir if not properly managed. Actual data from DOLA personnel show waste production of 33,0000 lbs/year.



Regulations

The Douglas County Rules & Regulations for County parks, trails, and open space lands include the following: "Any person who brings a dog into a Park or Open Space shall pick up, carry out and dispose of that dog's excrement."

Potential Management Strategies

Animal Wastes (Dog Parks/Trails)

Cherry Creek State Park Dog Off-Leash Area

In 1971, a dog trail area was first established at the 12-Mile area in the park, used mostly by dog trainers. Trends in use began to change in 1985 as off-leash dog exercise gained popularity. By 1994, visitation reached 12,000. This increased almost twenty-fold within 15 years; by 2009, visitation reached 232,000, or 14% of park visitation. There are over 450,000 dog visits per year. This is one of the largest dog off-leash areas in the Denver Metropolitan Area.

In October 2010, State Parks adopted a Dog Off-Leash Area Management Plan. As part of this process, the effects of heavy dog use on the water quality and soils condition were studied in 2008. Fecal waste surveys and microbial analyses were conducted. There was a significant increase in pet waste in the off-leash areas compared with nearby areas, but no significant fecal coliform contamination. Instream fecal coliform standards were being met. However, this study was not designed to evaluate potential impacts of nutrients on water quality.

Several actions are planned, including education on picking up after dogs, provision of additional waste collection stations, and monitoring for compliance. "Hardened" access points to the creek will be developed to help restore and manage riparian and wetland areas, resulting in better water quality. This will be coordinated with the Authority's 12-Mile Park streambank stabilization project.

Recommendations

The Cherry Creek State Park dog waste management plan is anticipated to be 90% efficient in removal of waste and therefore phosphorus and nitrogen. A bioswale will be included as part of the stream reclamation work, which can immobilize 30% to 80% of phosphorus it receives.

Figure 2. Cherry Creek State Park Preferred Alternative

Potential Management Strategies

Goose Waste

Current Issues

Goose droppings are frequently included when calculating nutrient loads to lakes and reservoirs. However, some researchers have argued that geese are not a significant source of new nutrients; they simply "recycle" nutrients already in the area.

It is difficult to quantify, however, how much is actually deposited in the water. The number of droppings per goose may range from 28 to 92 per day; each dropping may weigh from 1.17 to 1.9 grams. The amount of phosphorus ranges from 0.36 to 1.41 pounds per goose per year. Nitrogen levels range from 1.15 to 3.11 pounds per goose per year.

Nutrient contributions from geese are difficult to control. Nonlethal methods that can be used to manage geese include landscape and habitat modification to make the area less attractive to geese; harassment and hazing with trained dogs or lasers; use of effigies (silhouettes of coyotes), capture and removal, and repellants (for which pesticide permits may be required). Other options include addling eggs to prevent eggs from hatching.

Recommendations

To better understand the contributions of nutrients from geese, a population survey could be conducted. If the loads are significant, the following may be considered. The U.S. Fish & Wildlife Service (USFWS has recently issued a Resident Canada Goose Nest and Egg Depredation Order (January 5, 2010). This order authorizes landowners and local governments who register with USFWS to destroy resident Canada goose nests and eggs on property under their jurisdiction when necessary to resolve or prevent injury to people, property, agricultural crops, or other interests. An annual report is one of several requirements that must be met by those registered. This may be an option for consideration. More information can be found at: https://epermits.fws.gov/eRCGR/DOC/eRcgrFaq.pdf

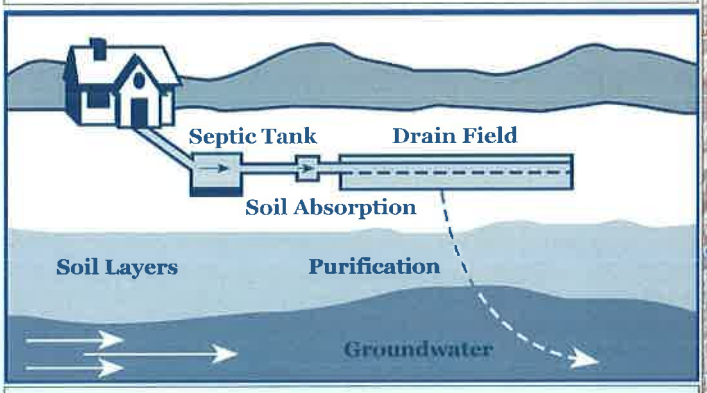
Potential Management Strategies

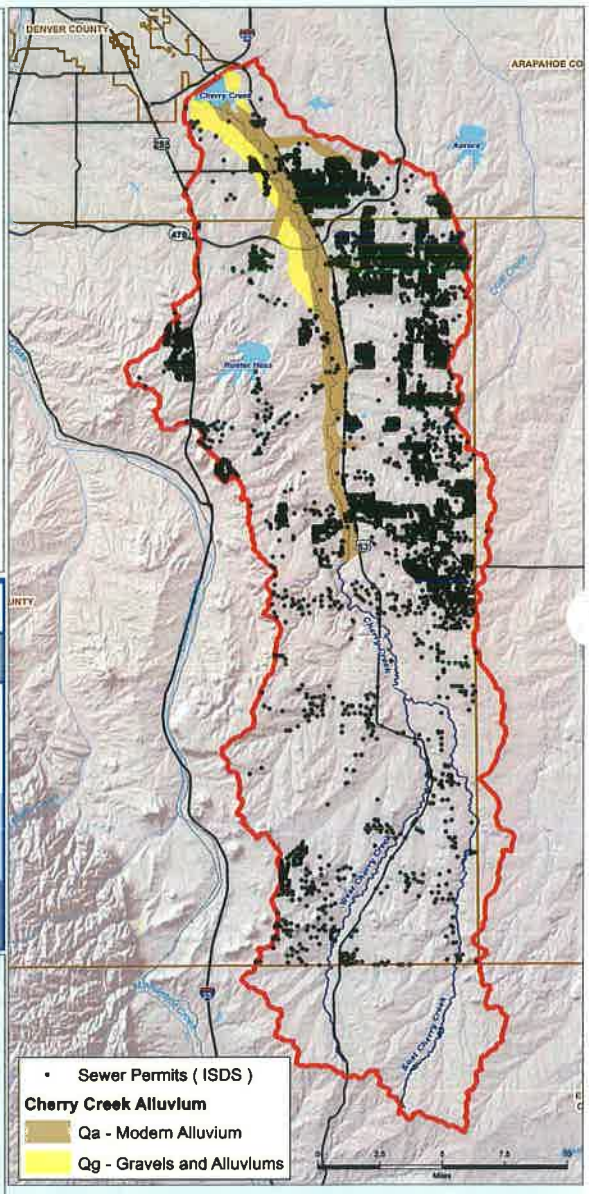
Individual Sewage Disposal Systems

Extent of Existing Systems

Individual Sewage Disposal Systems (ISDS), also known as septic systems, serve numerous residents in the basin. ISDS are used when sewer service is not available through a centralized wastewater collection system. It is estimated that there are some 6600 ISDS in the Cherry Creek basin. ISDS in the basin (Arapahoe and Douglas Counties) are shown in black on the adjacent map.

Tri-County Health Department (TCHD) serves Arapahoe and Douglas Counties in the Cherry Creek basin and is responsible for the regulation of ISDS. In 2010, TCHD issued about 900 ISDS permits.





Applicable Regulations

TCHD has promulgated regulations as allowed under State law, and consistent with minimum State requirements. The regulations define requirements for permits, inspections, testing, use, maintenance and cleaning of the systems, and disposal of waste material.

TCHD's regulations also recognize CCBWQA's goal to reduce septic system phosphorus loads and contain additional requirements to ensure this:

- New systems installed in faster-draining soils are to have 2 alternating adsorption areas.
- No new ISDS may be constructed within the 100-year floodplain.

Additional regulations apply for systems with a design capacity ≥ 2000 gallons per day. For these systems, site approval and a discharge permit must also be obtained from the Colorado Department of Public Health & Environment.

Discussion of Nutrient Removal Capabilities

As can be seen in the table below from EPA's Onsite Wastewater Treatment Systems Manual (2002), ISDS are more effective at removing phosphorus than nitrogen. Most soils will naturally adsorb phosphorus for many years. Soils containing iron and aluminum compounds effectively immobilize phosphorus in acidic soils; calcium compounds in calcareous or alkaline soils adsorb phosphorus. Ammonia in wastewater is converted to nitrate in the aerobic drain field. Nitrate is highly soluble, and the soil environments that favor denitrification (removal of nitrogen or nitrogen compounds) are limited.

Phosphorus Removal

A significant portion of inflow phosphorus is removed by settling and subsequent pumping of tanks. Effluent phosphorus is about 85% soluble phosphorus. Studies show that 65% to 95% of effluent phosphorus is found in the soil within a few meters of the outflow point, even in older ISDS.

Parameter	Applied Concentration	Percent Removal
BOD_5 (mg/l)	130 - 150	90 - 98%
Total Phosphorus (mg/l)	8 - 12	85 - 95%
Total Nitrogen (mg/l)	45 - 55	10 - 40%
Fecal Coliforms (organisms/100 ml)	10^6 - 10^8	99 - 99.99%

Pretreatment systems may be added to an ISDS to enhance phosphorus removal, including chemical, physical, and biological processes. Some success has been shown with the use of biological processes utilizing aerobic treatment, and filters (such as single-pass or recirculating sand filters using special filter material, such as iron-rich media that adsorb phosphorus). However, these systems can be costly and require more complex operation and maintenance.

One way to cost-effectively minimize phosphorus from ISDS sources is the use of low-phosphate or phosphate-free detergents. New low-phosphate detergents have reduced phosphorus loadings to wastewater by 40-50%; before detergents were reformulated, detergents were responsible for more than 70% of phosphorus in residential flows. Eliminating the use of garbage disposals can result in slight reductions in phosphorus loads (~ 4%) In the past, the Authority did attempt the adoption of a phosphate-free detergent policy.

Phosphorus can more readily enter surface waters and cause eutrophication problems when the water table is elevated. The prohibition of new ISDS construction in the floodplain in Regulation 72 has been adopted by TCHD. TCHD requires verification of the depth to groundwater as part of the permitting process. The TCHD regulations also require that soils effectively filter the effluent prior to it reaching any seasonal or perched water tables. Special design requirements must be met where higher seasonal groundwater tables exist. Better phosphorus removal is achieved in fine-textured soils without continuous macropores that allow for rapid percolation. Therefore, TCHD's requirement specific to the Cherry Creek basin that requires two alternating absorption areas in more rapidly draining soils is a good step.

Nitrogen Removal

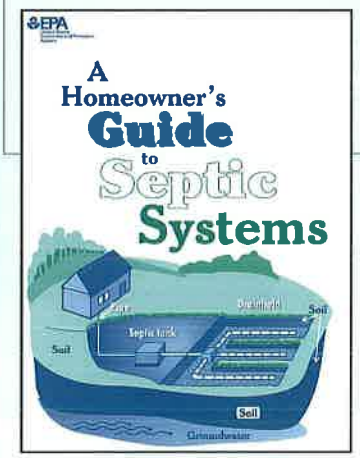
Nitrogen can be transformed in the ground, through mechanisms such as adsorption, volatilization, mineralization, nitrification, and denitrification. Nitrate is highly soluble in groundwater. Biological denitrification can occur under anaerobic conditions. Denitrification is favored in fine-grained soils containing silts and clays, and layered soils (especially if organic matter is contained in the finer-grained layers). System designs may more effectively remove nitrogen by maximizing the use of the organic matter in the upper soil horizons (or infiltrate effluent through organic-rich bottom sediments).

Recirculating and filters with biofilms can also be used as a pretreatment mechanism to remove nitrogen. Removals can be enhanced with the use of an anoxic reactor prior to the recirculation tank. Constructed wetlands placed after the septic tank and prior to the soil absorption system can also be effective. Other proprietary systems also exist. Again, these pretreatment systems can be costly, as well as operation and maintenance-intensive. Managed systems can achieve from 40 to 75% or more nitrogen removal.

Elimination of garbage disposals can slightly reduce nitrogen levels (~ 5%), as can segregation of toilet wastes (by using a composting or other biological toilet system).

Management Options

Effective inspections and maintenance can extend the system's life. TCHD's new regulations contain numerous provisions to ensure adequate pumping and maintenance. TCHD also requires a Use Permit authorizing the actual use of the system; this is in addition to a typical installation or repair permit. A Use Permit (or Renewal of a Use Permit) is also required upon the sale of a property or an expanded use. To obtain a Use Permit, numerous conditions apply, including that the system be in good working order, have an adequate absorption area, submit an Inspection Report by an approved Use Permit Inspector, and verify that any deficiencies identified during the inspection have been remedied.



Potential Management Strategies

Individual Sewage Disposal Systems

Relative Potential Nutrient Loading from ISDS

Assuming 6,632 ISDS in the basin; 2.7 grams of total phosphorus and 11.2 grams of total nitrogen per capita per day; just under 4 persons per ISDS, a 90% removal rate for phosphorus and a 25% removal rate for nitrogen for a typical ISDS, this would produce 5,326 pounds of phosphorus and 165,715 pounds of nitrogen per year. This is compared to an annual average total phosphorus input to the reservoir of 6,665 pounds from 1992 to 2010. Note that this does not consider any conversions/losses during transport to the reservoir; the amounts that would actually enter the reservoir would be significantly less. Nitrogen would probably be transported more readily than phosphorus after entering groundwater. The location of ISDS relative to the alluvium and water courses is also an important factor in how many nutrients will be transported to the reservoir.

Options for Further Consideration

Based on the above rough estimates, potential phosphorus and nitrogen loads from ISDS could be significant. Therefore, options for possible next steps include:

- Monitor to determine actual TN (likely as NO_3) contributions from ISDS; identify potential areas to monitor.
- Map ISDS locations relative to alluvial aquifers and streams.
- Determine fate & transport mechanisms, especially for nitrogen. Focus initial efforts on ISDS located in or near alluvial aquifers (see maps) and ISDS close to surface water courses.
- Consider modeling to identify "hot spots" (see box below). Evaluate watershed model for opportunities to refine estimate of ISDS phosphorus and nitrogen contributions.
- Identify specific options for known areas, such as ISDS near Valley Country Club. Consider incentives (potential use of PRF funds), potential to encourage "sewering up".
- Continue to support stringent requirements in TCHD regulations for CCBWQA. Explore inclusion of measures for nitrogen.

Assessment Methods

EPA has developed an assessment tool ("MANAGE") , which is designed to estimate existing and projected future (build-out) nutrient loads and to identify "hot spots" based on land use and cover. (see **http://www.epa.gov/owow/watershed/Proceed/joubert.html; http://www.edc.uri.edu/cewq/manage.html**) These estimates can be used to provide some guidance in siting onsite systems and considering acceptable levels of both numbers and densities in sensitive areas.

MANAGE generates 3 types of assessment results that can be displayed in both map and chart form:

(1) pollution "hot spot" mapping of potential high-risk areas,
(2) watershed indicators based on land use characteristics (e.g., percent of impervious area), and
(3) nutrient loading in the watershed based on estimates from current research of sources and generally assumed fates of nitrogen and phosphorus.

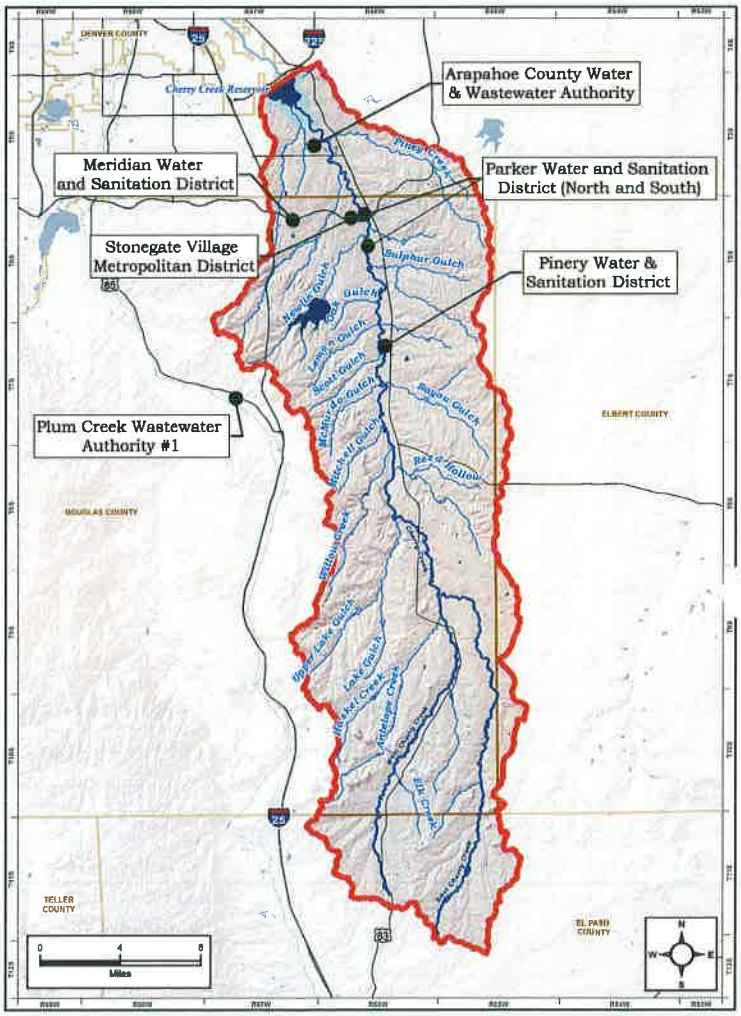
(Source: EPA's Onsite Wastewater Treatment Systems Manual, 2002)

Potential Management Strategies

Point Sources-Wastewater Treatment Plants

Existing Facilities

There are currently five wastewater treatment plants located within the Cherry Creek watershed. One out-of-basin facility applies treated effluent to irrigation within the watershed. Regulation 72 applies a limit on phosphorus concentrations to all dischargers within the watershed. Permits require dischargers to monitor and report the quantities of phosphorus discharged to the surface water and groundwater.



Phosphorus Requirements

The Regulation 72 discharge limits for wastewater treatment facilities are:

- For direct discharges: ≤ 0.05 mg/l total phosphorus as a 30-day average, unless a 90-day average is approved
- 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
- 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 average is approved

Nitrogen Requirements

There are currently no wastewater discharge limits for total nitrogen in Regulation 72. Monitoring requirements vary by permittee. All have limits for total ammonia and are required to monitor and report on this parameter. Some are also required to monitor for total nitrate plus nitrite; one is required to monitor total inorganic nitrogen.

Potential Management Strategies

Point Sources-Wastewater Treatment Plants

Nutrient Loads Contributed to Watershed and Reservoir

Cherry Creek Basin wastewater treatment facilities (WWTFs) contribute a few percent of the total phosphorus load to the reservoir. For example, in 2009, all the WWTFs combined discharged about 469 pounds of phosphorus, which is less than 3% of the total phosphorus inputs to the reservoir for that year. In 2010, they contributed 525 pounds, or less than 5% of the total load for the year.

Recent Changes to State Nutrient Regulations

The Colorado Water Quality Control Commission adopted new nutrient regulations in 2012. Regulation 85 is a new Nutrient Management Control Regulation. In addition, existing Regulation 31, the Basic Standards Regulation, was modified to address nutrients as well.

The Regulation 85 effluent limits for existing wastewater treatment facilities are shown below. These effluent limits will not be included in permits for currently permitted domestic wastewater treatment facilities that are subject to the Cherry Creek Control Regulation (Regulation 72) prior to May 31, 2022. Note that existing Regulation 72 phosphorus limits for basin wastewater treatment plants are already significantly more stringent than the Regulation 85 phosphorus limits (0.05 mg/l vs. 1.0 mg/l), and thus are not expected to be applied in the basin.

Parameter	Parameter Limitations	
	Annual Median	95th Percentile
Total Phosphorus (TP)	1.0 mg/l	2.5 mg/l
Total Inorganic Nitrogen (TIN)	15 mg/l	20 mg/l

Regulation 85 includes new nutrient monitoring requirements for wastewater facilities. MS4s are required to incorporate nutrient-related control measures into their stormwater management programs. MS4s must also complete a Discharge Assessment Data Report by October 31, 2014, which identifies nutrient monitoring information that already exists and the need for additional monitoring in the future, to allow determination of approximate nitrogen and phosphorus contributions to State waters from the MS4. Cooperative monitoring efforts are encouraged for both WWTFs and MS4s.

(Regulations 31 and 85, cont'd.)

Regulation 31 was modified to establish interim numerical values for phosphorus, nitrogen, and chlorophyll *a* that are deemed to be suitable for the protection of different categories of water, based on its beneficial use(s). These values are shown below.

	Warm Lakes/Reservoirs (>25 acres)	Warm Streams
Total Phosphorus (TP)	83 µg/l (July 1-Sept. 30 avg. in mixed layer; allowable exceedence frequency of 1-in-5-years)	170 µg/l (annual median; exceedence frequency of 1-in-5-years)
Total Nitrogen (TN)	910 µg/l (July 1-Sept. 30 avg. in mixed layer; allowable exceedence frequency of 1-in-5-years)	2010 µg/l (annual median; exceedence frequency of 1-in-5-years)
Chlorophyll *a*	20 µg/l (July 1-Sept. 30 avg. in mixed layer; allowable exceedence frequency of 1-in-5-years)	150 mg/m² (5 year median; not to exceed)
Chlorophyll *a* - DUWS*	5 µg/l (March 1-November 30 avg. in mixed layer; exceedence frequency of 1-in-5 years)	n/a

*Direct use water supplies is a new classification applied to specific water bodies in special cases with different vulnerabilities and risks not applicable to all lakes. A DUWS requires an intake or man-made conveyance from lakes and reservoirs directly to the water treatment facility, or a WQCC determination that there is evidence that it will become a direct use water supply in the future. Cherry Creek Reservoir is not currently being considered for DUWS designation.

Prior to May 31, 2022, the interim values may only be applied to headwaters located upstream of all existing permitted domestic WWTFs and existing non-domestic facilities subject to Regulation 85 effluent limits, or when the WQCC has determined they are necessary. After this initial 10-yer period, the WQCC will review water quality improvements achieved to date, and determine whether the stringent Regulation 31 should be applied as water quality standards in given stream segments because they necessary to further control nutrients.

Potential Management Strategies

Point Sources-Wastewater Treatment Plants

Recommendations

The Reg. 85 effluent limits will not be incorporated into Cherry Creek WWTF permits until May 31, 2022 at the earliest. The WWTFs already discharge well below the TP limit of 1 mg/l. Data available for two of the largest WWTFs in the basin (Parker Water and Sanitation District and Pinery Water and Sanitation District) show that they are currently meeting the future TIN limit of 10 mg/l. The other facilities should collect TIN discharge data and evaluate whether they can meet the 10 mg/l limit, or whether upgrades would be needed.

The Reg. 31 water quality standards will not likely be implemented in the reservoir or segments to which basin WWTFs discharge prior to 2022. The WWTFs already discharge TP at levels lower than the proposed stream standards. The existing chlorophyll α standard is already lower than the Reg. 31 standard. The reservoir is not consistently meeting the proposed reservoir TP and TN standards. These new standards, if ultimately adopted, may drive further wastewater treatment and nonpoint source controls.

The Authority should continue to aggressively pursue nutrient control measures and investigate the role of nitrogen in the watershed and reservoir. It should evaluate impacts the new TN standards and reservoir TP standard could have if applied in the basin. Development of site-specific standards may be an option.

Potential Management Strategies

Stormwater-Regulated

Background

The Federal Clean Water Act requires stormwater discharges from certain types of facilities to obtain a stormwater discharge permit. The goal of the stormwater permits program is to prevent pollutants that are picked up by rainwater from entering streams, lakes, and rivers. (For comparison, the long-term median TP concentration in precipitation that falls directly on Cherry Creek Reservoir is 116 µg/l; runoff from residential, commercial and industrial areas that has picked up additional pollutants can have TP concentrations 5 to 10 times higher than the rainfall itself.) The original 1990 EPA Phase I regulation covered municipal (i.e., publicly-owned) storm sewer systems in municipalities over 100,000 population. The regulation was expanded in 1999 to include smaller municipalities as well and is referred to as Phase II.

Stormwater discharge permits are issued by the Water Quality Control Division pursuant to Regulation 61 (Permits Regulation). Phase II municipal separate storm sewer systems (MS4s) are covered under a general permit for stormwater discharges from MS4s. The main requirement of the general permit is for the MS4 operator to develop and implement six stormwater management programs, or minimum measures.

A **special general permit** has been developed for MS4s in the Cherry Creek basin (Permit No. COR-080000). This permit incorporates several additional requirements of Section CR 72.7.

Stormwater discharges from Phase I and II MS4s within the Cherry Creek Reservoir Watershed are further regulated under Regulation 72 (specifically Section 72.7). This includes, among other requirements, additional measures for MS4s within the Cherry Creek Reservoir watershed to protect the water quality of Cherry Creek Reservoir and Cherry Creek.

Six Minimum Measures

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

Potential Management Strategies

Stormwater-Regulated

Regulation 72.7 Requirements

Regulation 72 applies water quality controls to regulated stormwater sources, and in a 2010 update has defined a three-tiered approach to stormwater management BMPs. MS4 communities are required to implement measures to control the quality of stormwater runoff for all new and redevelopment activities within the watershed. MS4 permits incorporate relevant requirements as set forth in Regulation 72. All of these regulations are being reviewed and adjusted to maintain consistency between all of the required elements for stormwater control.

Regulation 72.7 sets requirements for any Stormwater Permit issued to a MS4 in the Cherry Creek Watershed in addition to requirements set forth in Regulation 61. Section 72.7 requirements are more stringent than those set in place by Regulation 61. The key difference is that Regulation 72 requirements apply to all land disturbances. Construction BMPs are required for all disturbances, not just those greater than one acre. Post-construction BMPs are required for all land disturbances that result in 500 square feet or more of new or increased imperviousness.

MS4 agencies are required to adopt and implement, at a minimum and in addition to applicable MS4 requirements included in Regulation 61, specific programs and requirements defined in Regulation 72.

MS4

A Municipal Separate Storm Sewer System (MS4) is a conveyance or system of conveyances:

1. Owned or operated by a State, city, district, or other public body having jurisdiction over disposal of sewage, industrial wastes, stormwater, or other wastes;
2. Designed or used for collecting or conveying stormwater;
3. Not a combined sewer; and
4. Not part of a publicly owned treatment works (POTW)

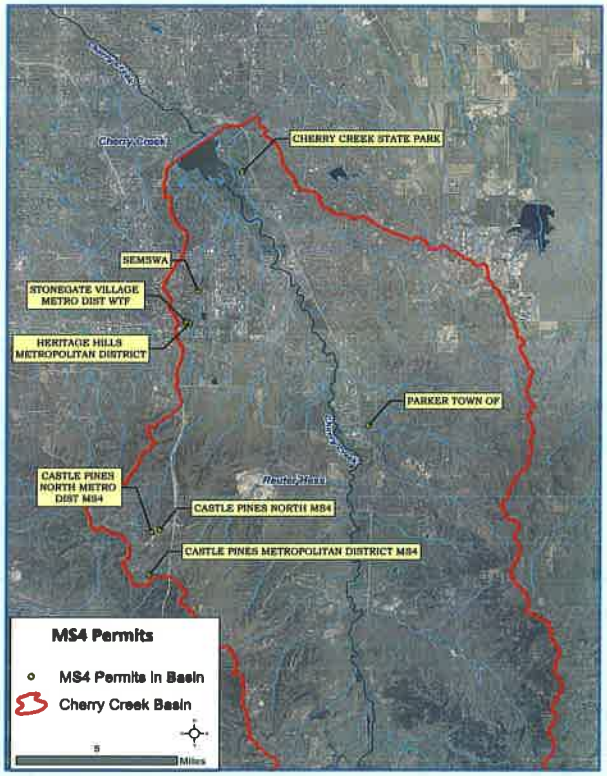
- **Public education and outreach** focused on various sources that potentially contribute significant nutrient concentrations in Cherry Creek Reservoir
- **Construction site stormwater runoff control** for regulated construction activities and individual home construction. Exclusions apply in some cases.
- **Post-construction stormwater management in development and redevelopment** for regulated construction activities and individual home construction. Exclusions apply in some cases and provisions defined for BMPs already in place at the site of new development in compliance with Regulation 61.

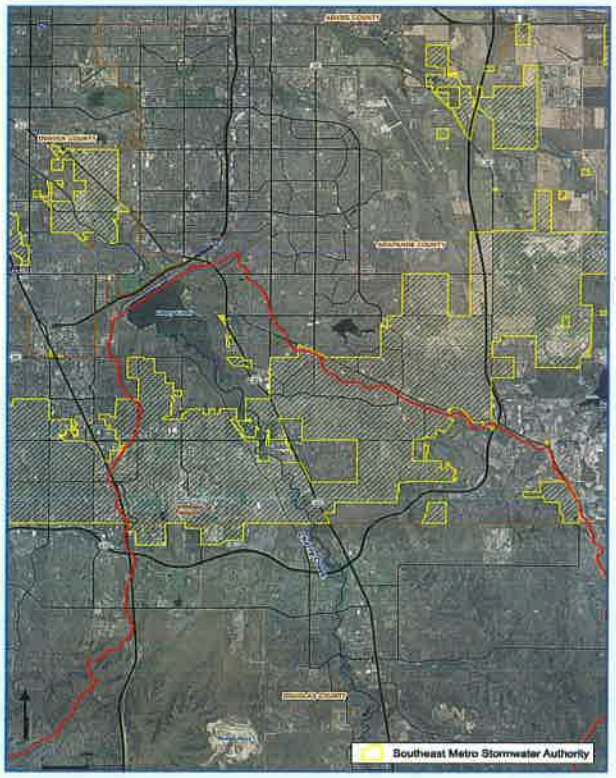
For each BMP, specific submittal requirements, operational provisions, inspection and maintenance guidelines, and variances are described individually. BMPs are to reduce phosphorus concentrations to the maximum extent practicable.

Potential Management Strategies

Stormwater-Regulated

Several types of MS4 permits are used in the Cherry Creek basin. General Permit COR080000 applies to regulated small MS4s that discharge wholly or partly within the Cherry Creek basin. It incorporates the more stringent requirements of Regulation 72, in addition to the statewide requirements of Regulation 61. Those holding Cherry Creek basin-specific MS4 permits include: Douglas County (COR080003); Arapahoe County (COR080010); SEMSWA (COR080021); City of Greenwood Village (COR080004); Town of Parker (COR080011); Town of Castle Rock (COR080012); City of Lone Tree (COR080016); and City of Castle Pines North (COR080022).





The Statewide Non-Standard General Permit COR0700000 is used for regulated small MS4s that are not cities or counties (i.e., Non-Standard MS4s). These include school districts, metro districts, and others. Some of the specific Non-Standard Permittees in the basin are listed below: Cherry Creek State Park (COR070220); Meridian Metro District (COR070214); Castle Pines North Metro District (COR070215); Castle Pines Metro District (COR070201); and Stonegate Village (COR070218).

Individual Stormwater Permits (using the numbering system COS000000) are issued for regulated MS4s when a General Permit is not appropriate. The City of Aurora holds an Individual Stormwater Permit (COS000003).

Potential Management Strategies

Stormwater-Regulated

Cherry Creek Basin Water Quality Authority Guidance

The Authority has developed guidance to implement the requirements of Regulation 72.7 It identifies items that must be included in an MS4's program to be compliant with Section 72.7, and is updated as needed to respond to specific needs in the basin. The guidance document includes chapters for the following areas, all of which are included in Regulation 72 :

- Construction Requirements
- Post-Construction BMP Requirements
- Industrial and Commercial Activity
- Agricultural BMP Requirements
- Stream Preservation Areas
- Rural Road Construction and Maintenance
- Highway and Roadway Construction (Reserved)
- Large Lot Single Family Development
- Trail Construction

The chapters define regulated activities and include design criteria and standards, as well as mandatory BMPs. Inspections as well as operation and maintenance requirements are also specified. In some cases, exclusions are allowed. The Authority also has adopted (and the WQCC approved) a three-tiered approach to stormwater management for post-construction development and redevelopment in the watershed. The Authority has adopted requirements that are more stringent than Regulation 61 for "significant development and redevelopment", as has the Southeast Metro Stormwater Authority (SEMSWA). The Authority also is a referral agency for land use agencies for land disturbance applications.

Development and Redevelopment Tiers:

Land Disturbance Area	New or Increased Impervious Area (sq. ft.)		
	0-499	500 - 4999	5000+
< 1 acre	Tier 1	Tier 2	Tier 3
1 acre +	Tier 3	Tier 3	Tier 3

Potential Management Strategies

Stormwater-Regulated

New Regulation 85 Requirements

Regulation 85 (adopted in 2012) expands existing program requirements for public education/outreach and pollution prevention/good housekeeping to include measures specific to nutrients into MS4 permits. MS4s must also complete a Discharge Assessment Data Report by October 31, 2014, which identifies nutrient monitoring information that already exists and the need for additional monitoring in the future, to allow determination of approximate nitrogen and phosphorus contributions to State waters from the MS4. The proposed regulation encourages collaborative monitoring plans on watershed level. The monitoring and data collection could lead to additional substantive requirements of MS4s in the future.

Recommendations

- **Continue to implement requirements in MS4 permits**
- **Continue updating Regulation 72.7 Guidance Document**
- **Complete Chapter in Regulation 72.7 Guidance on Highway and Road Construction (consider proposing additions to Regulation 72 if needed to address stormwater runoff issues from these areas)**
- **Take advantage of any opportunities to use existing or expanded watershed monitoring to meet requirements of new Regulation 85 after adoption**
- **Evaluate the possibility of a more integrated MS4 program among permittees**
- **Evaluate new/innovative trading program strategies, such as those developed by CDOT (e.g., trading treatment of existing imperviousness for treatment of new (more easily treatable) imperviousness)**

Potential Management Strategies

Water Development Implications

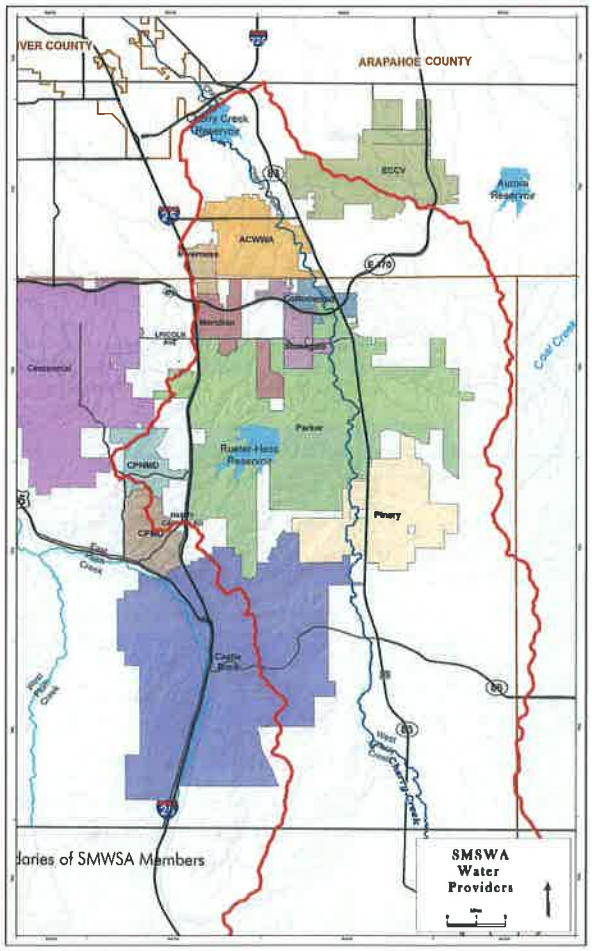
Background

Water quality in the Cherry Creek watershed will be impacted as additional water supplies are developed to serve increasing populations. The transition from non-renewable groundwater to renewable surface water supplies may also affect water quality. Future water supplies may come from alluvial groundwater wells, imported water from other basins, reuse water, and other innovative sources such as rainwater harvesting, as well as continued use of non-tributary groundwater. Conservation efforts are also expected to grow. Impacts of future water rights operations on water quality should be considered also.

South Metro Water Supply Authority (SMWSA)

SMWSA was founded to bring smaller water entities together as a regional water authority, a large part of which is located within the Cherry Creek Watershed. The 15 municipal and district entities that comprise SMWSA are primarily reliant upon non-tributary (non-renewable) Denver Basin Aquifer water. Members serve a combined 320,000 combined municipal and industrial customers. Surface water from Cherry Creek, Plum Creek, and the South Platte River comprises about 25 percent of the water needed to meet SMWSA members 2050 demands. Presently, these are the only renewable supplies available to the SMWSA members.

The SMWSA recently completed a ***Regional Water Master Plan*** that projected 2050 water demands of 120,900 acre-feet (AF), compared to existing (2010) demands of 67,200 AF. The SMWSA area currently has 27,200 AF of storage capacity but by 2012 this will more than triple to 93,200 AF with the addition of the expanded Reuter-Hess Reservoir. According to the Statewide Water Supply Initiative (SWSI), water demands for SMWSA in 2003 totaled about 40,000 AF, and at that time only about 10,000 AF of the demand was being met by renewable surface water supplies.



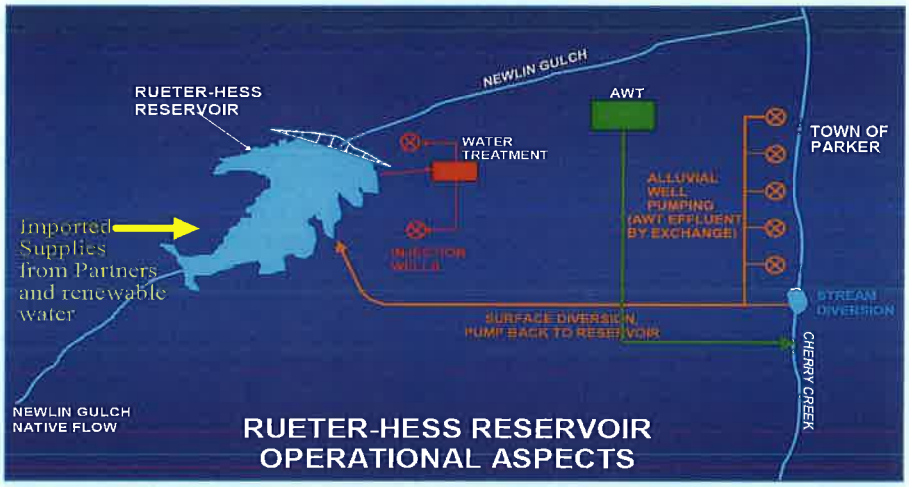
An **acre-foot** is enough water to supply at least two typical families water for one year.

SMWSA
SOUTH METRO WATER SUPPLY AUTHORITY
PLANNING, DEVELOPING AND SOURCING RENEWABLE WATER FOR DOUGLAS AND ARAPAHOE COUNTIES IN COLORADO

Rueter-Hess Reservoir

Rueter-Hess Reservoir is a major water storage facility constructed by Parker Water and Sanitation District. It is located on Newlin Gulch, a tributary to Cherry Creek, about three miles southwest of Parker. Other water supply entities that have purchased storage at the current time include the Town of Castle Rock, Castle Pines North Metropolitan District, and Stonegate Village Metropolitan District.

Construction on Rueter-Hess began in December 2004 and was completed in 2012. Originally designed and permitted in 2004 to impound 16,200 AF, the project was amended in 2008 to expand storage capacity to 71,920 AF. With a surface area of 1,140 acres, the reservoir is about one and a half times the size of Cherry Creek Reservoir.



The reservoir will impound native surface water and alluvial groundwater from Cherry Creek. Reusable effluent return flows that are discharged to Cherry Creek will also be exchanged for equivalent volumes of Cherry Creek surface water and/or alluvial groundwater, which may be stored in the reservoir or used directly in Parker's water supply system. Additional renewable supplies are currently being pursued and evaluated.

The reservoir is constructed on a dry tributary, Newlin Gulch, with an upstream drainage area of approximately 11 square miles. Alluvial wells will pump water from Cherry Creek to Rueter-Hess Reservoir. In-priority Cherry Creek and Newlin Gulch flows will also be stored in the reservoir, and possibly some Denver Basin groundwater. There is a requirement in the Record of Decision that either 1 cfs, or the native flow, will be maintained in Cherry Creek at the diversion, whichever is less, when Parker is diverting. If there is no room to store water in Rueter-Hess, the water can be treated and reinjected on the east side of Rueter-Hess. The only time it is anticipated that a release would be made from Rueter-Hess would be during an extreme flood event, or when out-of-priority water is temporarily stored.

Water Quality in Rueter-Hess

There will be a watershed management plan for land development in Newlin Gulch to maintain water quality in Rueter-Hess. All participants will be subject to source water quality requirements. These include: total dissolved solids ≤ 750 mg/l (blended goal ≤ 500 mg/l); total phosphorus ≤ 0.3 mg/l (or, on an annual basis, ≤ 0.05 mg/l); and total inorganic nitrogen ≤ 10 mg/l (annual basis ≤ 5 mg/l). Advanced water treatment will be used to treat reservoir withdrawals to drinking water quality; treatment process requirements, in part, drive these water quality goals.

WISE

Denver Water, the City of Aurora, and SMWSA have joined forces on a project that may supply customers with more water while minimizing the need to by new water rights. The partnership is called "WISE" (Water Infrastructure Supply Efficiency). This partnership is intended provide new renewable supplies to the Douglas County area by combining unused conveyance capacities in Aurora Water's Prairie Waters Project and East Cherry Creek Valley's pipeline with unused water supplies from Denver and Aurora. During years that Denver and Aurora do not need all of their reclaimed water, SMWSA partners will be able to buy the unused supply.

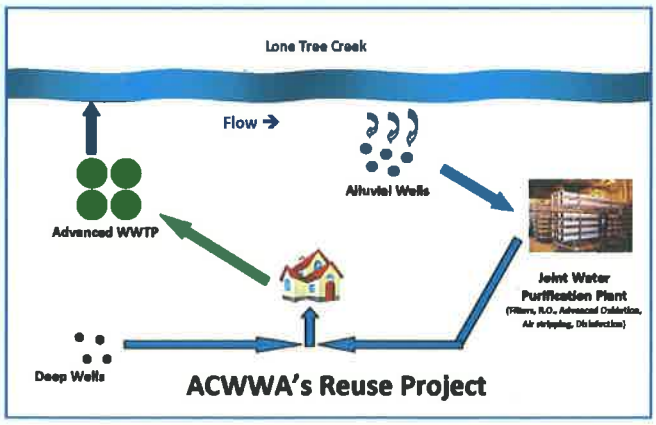
Denver Water and Aurora, via Aurora's Prairie Waters project, will supply treated water to the SMSWA. SMSWA will route the water through new and existing pipelines to either serve SMSWA entities directly, or the water may be directed to storage. Storage in Rueter-Hess Reservoir and other locations is being evaluated.

The WISE project would allow Denver Water and Aurora to sell water to the SMWSA partners during wet years in which there is a water surplus. During dry years, the south metro area would resort to using its existing groundwater sources.

Treated Effluent Reuse

Reuse of fully consumable wastewater is being utilized as an additional supply by a number of water providers within Colorado. The Arapahoe County Wastewater Authority (ACWWA) has implemented a reuse project on Lone Tree Creek. Denver Basin groundwater is considered a non-tributary supply and is available for reuse. Likewise, water imported from Colorado's west slope and agricultural water changed to municipal use may be used to extinction. All of the entities in the SMWSA are considering reusing their fully consumable supplies.

There may be water quality impacts as reuse increases. Discharges from wastewater plants into streams within the Cherry Creek Basin may be reduced, and the potential loading of contaminants to Cherry Creek will potentially be reduced. There is also the potential for increased concentrations of solutes in the wastewater flowing into Cherry Creek and its tributaries.



Water Conservation and Alluvial Pumping

Water Conservation

As water conservation programs are implemented and operations progress, it is difficult to predict what changes in water quality and quantity in the stream system may occur. Water providers are facing steadily increasing demands and limited or costly supplies, thus placing an emphasis on getting their supplies to stretch farther. Some common components of conservation plans include tiered billing rate structure, rebate programs, education and outreach programs, non-potable reuse, and promotion of xeriscape and efficient irrigation practices.

Alluvial Pumping

ACCWA, which historically had pumped Denver Basin groundwater, plans to start pumping alluvial groundwater near Lone Tree Creek and lower the use of the Denver Basin water. As the wastewater treatment plant discharge is upstream of the alluvial pumping site, water pumped will include effluent that has entered the groundwater system from the creek. Additionally, the creek system will see lower than historical flows as less Denver Basin water will be entering the system from the treatment plant.

Alluvial pumping for Rueter-Hess Reservoir may also have impacts on historical flows in Cherry Creek. By pumping from alluvial wells along the creek, surface water flows may decrease over time. Augmentation will likely be required to replace depletions to the creek from alluvial pumping, mitigating any changes in surface water flow. In this case, flow rates will not be impacted, but there is a potential for water quality to be affected based on the quality of the augmentation water source.

Implications and Recommendations

New projects, such as those described above (Rueter-Hess Reservoir, WISE, and reuse projects such as ACCWA's) should continue to be evaluated as they are being developed to determine whether there water quality impacts to Cherry Creek, its tributaries, or Cherry Creek Reservoir. For example, after a careful examination of the facts about Rueter-Hess, it was concluded that any water quality risks to the basin are minimal. Impacts from these projects are more likely to come from changing water management, which could affect local flow conditions and adjacent riparian areas and wetlands.

Rainwater Harvesting

Rainwater harvesting is being evaluated in Colorado as a water supply for outdoor landscaping. Under current Colorado Water Law, precipitation falling on impervious surfaces (roofs, driveways, streets and sidewalks) is subject to appropriation by downstream water users. However, it is believed that much of the precipitation that falls onto farmland, rangeland, and other undeveloped acreage never reaches surface waters. It becomes trapped in the soil or is consumptively used by plants. In 2009, the Governor signed Colorado House Bill 09-1129 into law. This law directs the state to approve 10 pilot projects for new housing or mixed-use developments to evaluate the feasibility of rainwater collection for use in non-essential (outdoor watering) use. The bill provides for these studies to be conducted through 2020 to determine the viability of using precipitation harvesting for household irrigation. The studies will quantify the impact of rainwater harvesting on stream flows.

Senate Bill 09-080 was also signed into law in 2009. The legislation allows for collection and use of precipitation for the individual residence subject to the following limitations:

1. The property where the precipitation collection takes place must be a residential property;
2. The landowner must use a well, or is legally entitled to a well, for the water supply;
3. The well must be permitted for domestic uses that are allowed by, and identified on, the well permit;
4. A water supply is unavailable from a municipality or water district; and
5. Rainwater may be collected only from the roof.

Implications and Recommendations

Because rainwater harvesting has the potential to reduce runoff from impervious surfaces, contaminants such as nutrients, oil and grease, and sediment may be prevented from entering the mainstem and tributaries to Cherry Creek and the Reservoir. Because downstream water users will be protected in water court, flows into Cherry Creek Reservoir will not be affected if this practice is adopted on a large scale. The Authority should monitor the Rainwater Harvesting studies and determine if there are significant benefits relative to nutrient removal.

Streamflow Modeling

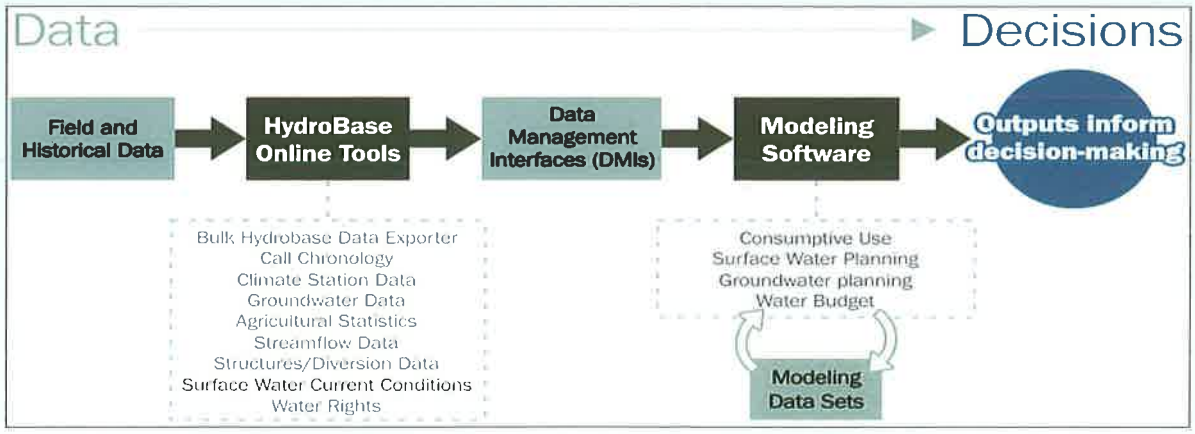
Understanding the characteristics of streamflow in the Cherry Creek basin is important to maintaining and enhancing the water quality and overall health of the basin. Many factors influence Streamflow, including drainage area and precipitation, timing of annual runoff, tributary inflows, surface and ground water uses, and water rights administration. Modeling these streamflow components in the Cherry Creek basin could assist the Authority with understanding the flow regime at key points in the basin, determining which components may significantly impact the health of the basin over time, and investigating various water use and operational alternatives for improving water quality.

StateMod is a surface water allocation model which determines water availability to surface and ground water users based on hydrology, water rights, and operational practices. StateMod was developed by the State of Colorado to assist decision makers at the state level with historic and future water use information (cdss.state.co.us). The State's goal is to develop surface water models for the entire state.

StateMod is a powerful tool that allows users to determine water availability on a monthly or daily time-step at any gaged or non-gaged point in the basin; model the impact of immediate and delayed depletions and accretions to the river system; and model 'what-if' scenarios to determine the feasibility of future alternative operations. CCBWQA could benefit from a StateMod surface water model of the Cherry Creek basin. Estimating streamflow at key water quality monitoring locations where there is currently a water quality impact, or there may be one in the future, and understanding and anticipating flows into and out of Cherry Creek Reservoir based on alternative operations could provide information as to how the watershed could operate in the future.

Recommendations

The state is in the process of developing models for the South Platte basin, likely over the next five years. This will include the Cherry Creek basin; the Authority may wish to participate or coordinate with these efforts.



Potential Management Strategies

Stream Erosion

Background

Stream erosion can contribute large quantities of sediment and nutrients to the system. Stream reclamation projects have been a focus for the Authority as an effective way to reduce phosphorus concentrations. Stream reclamation projects have been shown through the literature and the Authority's data collection program to provide water quality benefits beyond just reduction of phosphorus loading, such as reducing nitrogen and metals levels and increasing oxygen levels. Stream reclamation also improves the overall ecological health of the stream system by improving habitat for benthic macroinvertebrates and terrestrial wildlife, which are indirect measures of water quality. Stream reclamation can also lead to greater public understanding of the importance of water quality and recreational opportunities.

The Authority has used the following definitions to distinguish between stabilization and reclamation of channels or stream systems. Whereas both measures can result in water quality benefits, reclamation has greater potential than stabilization to improve water quality.

Channel or Stream Stabilization means the activities used to minimize erosion and sedimentation within a surface, stormwater-runoff conveyance. Channel (or stream) stabilizations are designed based on hydrology of the tributary watershed that factors in storm runoff rate, volume, frequency, and duration from projected future-development conditions. Stabilization activities include, but are not limited to, excavation and grading; placement of fill; construction of check structures, drop structures, and channel bed and bank protection measures; and placement of vegetation that protects the channel area of the conveyance. Stabilization can also be limited to construction of check structures and local grading activities.

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, both which reduce nutrient loads and concentrations. Therefore, the benefits from stream reclamation include the reduction in sediment and nutrients (i.e., phosphorus and nitrogen) transport from the main channel, but also reduction in nutrient loads from riparian and floodplain vegetation through 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.

Potential Management Strategies

Stream Erosion

Regulations & Incentives

In Regulation 72, the WQCC 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 use of stream stabilization is encouraged in the Regulation. For example, the permittee may allow for a landowner to use stream bank stabilization at a development site, and conservation of open space through clustering of development or setbacks from drainage ways, to reduce the need for the water quality capture volume for the whole site.

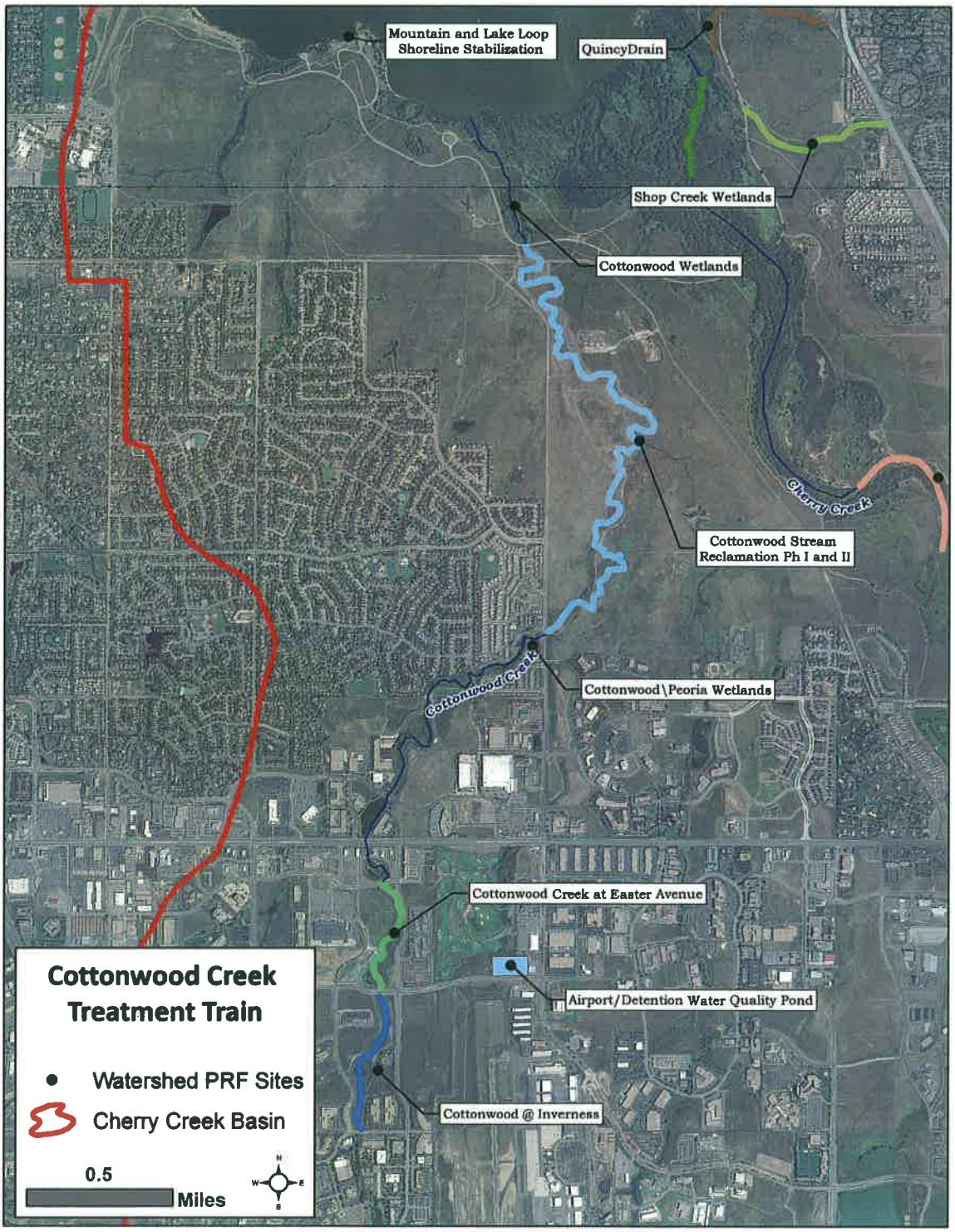
The Regulation 72.7 Stormwater Permit Requirements Guidance Document contains specific design criteria and standards, including BMPs, for Stream Preservation Areas (which include Cherry Creek Reservoir, all of Cherry Creek State Park, surface drainage and discharges to the Park within 100 feet of the Park Boundary, lands overlying the Cherry Creek 100-year floodplain, and all lands within the 100-year floodplain of Cherry Creek tributaries).

Treatment Train

Along Cottonwood Creek, about three miles of the stream has been reclaimed over several years through the installation of individual PRFs in series. These include Cottonwood - Peoria Pond, 2.2 miles of Cottonwood Creek Stream Reclamation, and Cottonwood Wetlands Ponds. This is a "treatment train", which shows very promising results. For example, in 2010 the overall phosphorus removal for the entire treatment train from upstream to downstream is over 32%. Phosphorus concentrations are well below the Authority-established flow-weighted concentration goal of 0.200 mg/l for all external flow sources to the reservoir and typically below 0.1 mg/l .

Potential Management Strategies

Stream Erosion



Stream Reclamation Water Quality Benefit Evaluation Report

The Technical Advisory Committee of the Cherry Creek Basin Water Quality Authority prepared a report to document procedures and methodologies, current knowledge, and understanding of water quality benefits associated with reclamation of stream and channel systems. This report was prepared as a first step in refining the Authority's procedures for identifying, evaluating, and prioritizing stream reclamation measures to reduce pollutant loads and concentrations discharged to Cherry Creek Reservoir and Cherry Creek.

The report attempted to address the following questions:

Stream reclamation is a pollutant reduction facility (PRF) which also includes detention, retention, and wetlands for treatment of regulated and non-point source stormwater within the Cherry Creek watershed.

- Is stream reclamation beneficial to water quality, and if so, why?
- Is stream reclamation used by other agencies or organizations to improve water quality, and what is their experience?
- Does the Authority's data support stream reclamation as a cost effective way to improve water quality in the Reservoir and Cherry Creek?
- What additional information is needed to further document water quality benefits of stream reclamation?
- How does stream reclamation fit into future PRFs and other watershed management techniques?

The investigation resulted in the following findings and conclusions:

Stream reclamation is beneficial to water quality in the stream and in the Reservoir. Load and concentration reductions for both phosphorus and nitrogen during base and storm flow conditions can occur by reducing flow velocities, providing greater areas for filtration and infiltration of stormwater and, to some extent, through increases in dissolved oxygen. This is supported by the several years of Authority water quality data collected to evaluate PRFs.

A more detailed analysis of the Authority's data for Cottonwood Creek further shows that stream reclamation projects can reduce phosphorus loads and concentrations to levels below the target flow-weighted concentration levels (i.e., 0.20-mg/l). The Cottonwood Creek data suggest that stream reclamation may also reduce nitrogen loads and concentrations.

A literature search shows that stream reclamation is one of the more extensive practices used to improve water quality in streams and water bodies in total maximum daily load (TMDL) implementation plans. However, more monitoring data are needed to evaluate water quality benefits for stream reclamation projects.

The report documented two quantitative methodologies for evaluating stream reclamation projects, one based primarily on economic factors and the second based solely on hydraulic characteristics of the stream.

Stream reclamation has been used extensively through out the country to protect and enhance water quality in stream systems and water bodies and is a widely accepted best management practice to control pollutant loads. Stream reclamation has been and should continue to be a priority PRF for the Authority in the future.

Recommendations

The monitoring program should be reevaluated and ecological assessments should be considered, not as a replacement to chemical monitoring, but as a way to improve our understanding of water quality benefits from stream reclamation and to include other, less direct measures of water quality.

The current procedures for calculating reduction in phosphorus loads should be refined to incorporate more robust algorithms for a very complex process, particularly related to riparian and floodplain areas. The more robust procedures would be available to project proponents as a means of justifying a greater financial contribution from the Authority when partnering with the Authority for stream reclamation projects.

Further refine the methodology to compare water quality benefits of stream reclamation using the five channel hydraulic parameters presented in this report that are based on the design of Cottonwood Creek Stream Reclamation within Cherry Creek State Park.

The Authority's watershed model can be used to estimate changes in phosphorus loads and flow-weighted concentrations for stream reclamation-type projects, with some minor modifications to the algorithms, to help assess long-term water quality benefits particularly at the Reservoir. Using the watershed model to evaluate stream reclamation, long-term benefits should be investigated.

In the past, the Authority has evaluated PRFs, including stream reclamation, based primarily on cost-per-pound of phosphorus removal from surface flow. Eleven additional evaluation criteria were developed, both quantitative and qualitative as part of this process. (These criteria should be refined and considered as a basis for prioritizing projects if required in the future.)

The Authority's methodology for evaluation of stream reclamation and other PRFs utilizes reductions in total phosphorus as the primary metric, since a total maximum annual load (TMAL) for phosphorus had been in effect for the Reservoir from 1984 to 2010. Recent changes to the Reservoir standard and Control Regulation No. 72 eliminated the TMAL, which prompted the Authority to consider a broader range of nutrients and other pollutants when evaluating water quality in the watershed including all forms of phosphorus, nitrogen, and other chemical, and biological constituents. However, for consistency, repeatability, and practicality, immobilization of total phosphorus continues to be the recommended primary metric for evaluating stream reclamation and other PRFs, although the Authority is investigating other pollutants that may also be used for evaluation in the future.

Existing Discharge Permits within the Watershed

In addition to the Cherry Creek Reservoir Basin MS4 General Permits and wastewater treatment plant permits, there are a number of general discharge permits issued and currently operating within the Cherry Creek Basin. Examples of some general discharge permits which could cover dischargers within the watershed are described below. See map on next page for current permit holders within the watershed.

Subterranean Dewatering or Well Development (COG603000)

An intermittent or temporary discharge containing low pollutant concentrations from activities that bring groundwater to the surface, which is released to land or surface waters of the state. Total Phosphorus daily maximum is 0.05 mg/l.

Construction Dewatering (COG070000)

Construction dewatering operation using groundwater or groundwater mixed with stormwater discharging to waters of the State. Total Phosphorus daily maximum is site specific but must be monitored monthly.

Sand and Gravel Process Water and Stormwater Combined (COG500000)

Sand, gravel, and other nonmetallic minerals being discharged to surface waters in stormwater runoff and process water discharges. Total Phosphorus daily maximum limits are as specified in the individual basin control regulations.

Water Treatment Plant Wastewater Discharge (COG641000)

Facilities producing, treating, storing, and/or distributing potable water discharging generated wastewaters into waters of the State. Total Phosphorus daily maximum limits are set only for waters with a control regulation for Phosphorus.

Individual Discharge Permits for Water Purification Plants

Arapahoe County Water and Wastewater Authority has an individual permit for water purification plants discharging to Windmill Creek. This permit was amended in 2010 to increase the Phosphorus limit to 0.2 mg/l to keep consistent with new Regulation 72 limits.

Recommendations

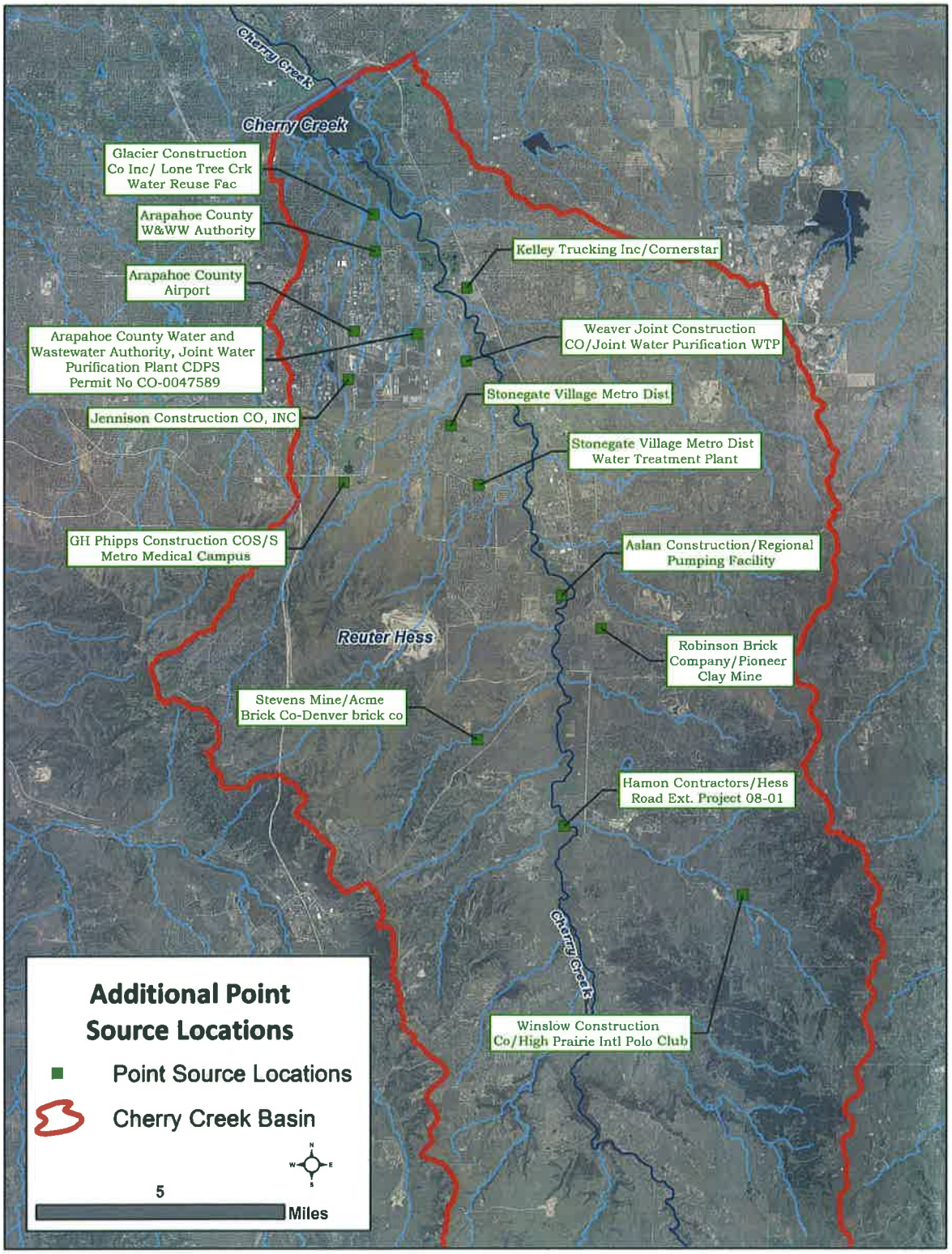
Continue to ensure the Regulation 72 discharge limits for other point source dischargers are incorporated into general and individual permits. These limits are: 1) for industrial process wastewater sources: ≤ 0.05 mg/l total phosphorus as a 30-day average, unless a 90-day average is approved; 2) for drinking water treatment facilities, ≤ 0.2 mg/l total phosphorus as a 30-day average, unless a 90-day average is approved.

In future annual reports, obtain discharge permit monitoring data for these other point source discharges and calculate their total phosphorus concentrations and loads to the watershed.

Based on the above findings, determine whether these are a significant source of phosphorus and deserve further attention.

Potential Management Strategies

Point Sources-Other Dischargers



Potential Management Strategies

Previous Models

Previous Studies

Several special studies previously completed by the Authority include: reservoir nutrient enrichment study; development of event mean concentration values for stormwater flows; quantification of soil and groundwater background P levels; identification of industrial process wastewater sources and associated P loading; evaluation of P removal effectiveness of nonpoint source control structures; monitoring shallow alluvial groundwater loading in tributaries; quantification of P loading from ISDS; characterization of watershed hydrology to establish reference conditions for evaluation of P loading; depth profiling of nutrient content for groundwater; calculation of background, industrial process wastewater, and ISDS sources of P; and quantification of groundwater flow and P loadings into the Reservoir.

Watershed and Reservoir Models

A new Watershed Model and Reservoir Model was then developed, to enable the evaluation of different future scenarios and resultant P and chlorophyll a levels in the reservoir. The Watershed Model was used to predict long-term changes in P loads, concentrations, and watershed yield volumes in relation to changes in watershed land uses, pollutant management strategies, and wastewater treatment plant operations This model tracked surface flows and alluvial flows separately and also quantified dissolved and particulate P separately.

The new Reservoir Model was developed using on a 15-year data set (1992-2006). It evaluated the chlorophyll a response to several variables, including in-lake phosphorus and nitrogen, and external P loads and concentrations.

Watershed Model Key Findings:

- **Continued implementation of post-construction BMP and completion of Rueter-Hess Reservoir could reduce median inflow concentration and P loads into the Reservoir, compared to conditions during the study, even with a 250% increase in basin population.**
- **Substantial reduction of external P loads would occur with completion of Rueter-Hess Reservoir and implementation of minimum standard BMPs (i.e., extended detention), but would not result in a similar reduction in P concentrations in the Reservoir inflow as the above scenario.**
- **<u>Enhanced</u> BMPs, consisting of additional treatment of storm water beyond the use of extended detention basins, such as filtering or infiltration, could further reduce external P concentrations to the Reservoir.**
- **Retrofitting existing detention basins could further reduce external P concentrations, providing even greater benefit to water quality.**

Reservoir Model Analysis Conclusions:

Using revised Reservoir Model, it was found that nitrogen limitation only occurs when algae are saturated with phosphorus. By reducing phosphorus below the saturation level, it can become the limiting nutrient, and algal biomass declines. Phosphorus controls were still deemed appropriate so that it remains or again becomes the limiting nutrient for algae growth. It was also found that the current TMAL based on loads would not achieve the chlorophyll standard; therefore it was proposed to use a methodology considering average inflow TP concentration as the control variable.

Chapter 6

Funding Considerations

Allowable Revenue Sources by Statute

1. The Authority's enabling legislation, C.R.S. 25-8.5-101 , gives the Authority the power to levy and collect ad valorem taxes on and against all taxable property within the Authority's boundaries. No mill levy for any fiscal year can exceed one-half mill. Ad valorem taxes greater than one-half mill can be levied if approved by the electors.

2. The Statute also allows the Authority establish rates, tolls, fees, charges, and penalties for functions, services, facilities, and Authority programs. The total annual revenue from these sources shall not exceed thirty percent of the annual Authority budget. Agricultural lands are excepted from the collection of these fees.

3. C.R..S 25-8.5-101 also gives the Authority the power to establish, in cooperation with the Department of Natural Resources, user fees for Cherry Creek Reservoir. These fees are subject to review and approval by the Parks Board, and cannot in total exceed the amount that would be collected if the reservoir user fee was one dollar per reservoir user per year.

Taxes

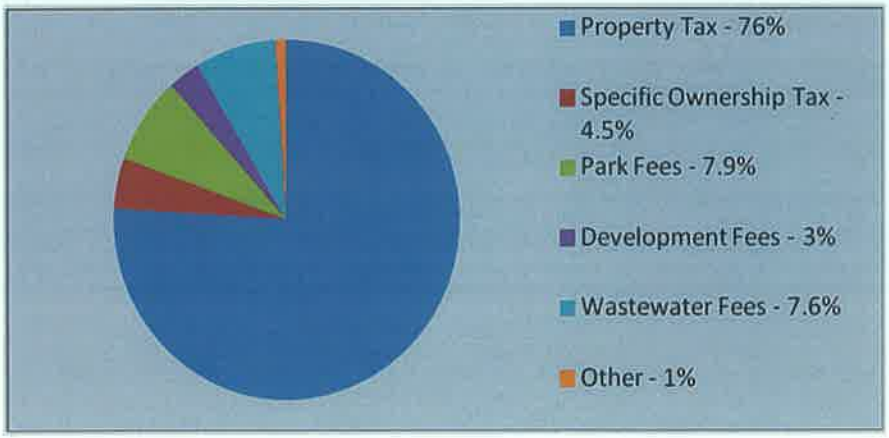
- **The mill levy in 2012 was 0.500, with no temporary mill levy reduction for TABOR compliance due to decrease in CCBWQA assessed valuation**

Fees

- **Development Fees: include $60 per single family residence and $0.04 per square foot of impervious area in commercial and multi -family developments**
- **Wastewater Fees: $0.25 per 1.000 gallons of treated wastewater discharged to Cherry Creek Basin**
- **State Park Fees: $3 on all annual passes and $1 fee for all single day passes**

Authority Budget

The Authority's budget has two funds: the **general fund** and the **enterprise fund**. The Authority typically spends budget first using the general fund, and then the enterprise fund. The general fund is supported by tax revenues and the enterprise fund is made up of land use fees, wastewater fees, and State Park fees. Most of the funding for the CCBWQA comes from property taxes. The Authority also receives funding from wastewater surcharges from wastewater treatment facilities in the Basin, Cherry Creek State Park user fees, and building permit fees. These primary sources are supplemented with funds from various grants, other fees and charges, and miscellaneous sources, such as reimbursed expenses and interest earnings.



Projected 2012 Revenues

Funding Considerations

Project Prioritization Process

C.R.S. 25-8.5-101 allows the Authority to impose fees and levy taxes; it also restricts how these funds can be spent. In accordance with statutory requirements, of the revenues the Authority collects, a minimum of 60 percent must be spent on planning, design, construction, and maintenance of pollution abatement projects in the Cherry Creek basin, or on payments due under loans or other debt incurred and spent by the Authority entirely upon pollution abatement projects. To implement this requirement, the Authority conducts a multi-year Capital Improvement Project (CIP) planning process to identify Pollutant Reduction Facility (PRF) construction projects. Potential PRFs are identified and evaluated; a list of potential PRFs is compiled, including capital, operation, and maintenance costs compared with potential benefits in terms of phosphorus reduction. From this a master PRF list of cost-effective projects is developed. Projects are selected from this list to be included on the five-year CIP list.

Capital Improvement Funds Pay For:

- Stream Reclamation Projects
- Shoreline Stabilizations Projects
- Stream Corridor Preservation
- PRF Restoration & Weed Control
- Reservoir Destratification
- Detention with Wetlands
- Sediment Removal
- Revegetation

Funding Considerations

Funding Trends

Over the past 25 years, the land use areas surrounding Cherry Creek Reservoir have changed dramatically. As land use changes, the Authority's funding has been changing. One change is the decrease in percentage of revenue from development fees as percent of total revenue, which has decreased from 15% in 2004 to 3% in 2012. Revenue from Cherry Creek State Park user fees has consistently increased over the past ten years, increasing from $124,069 in 2004 to $171,436 in 2010. Park fees will likely be capped by park capacity in the future.

The largest revenue source for the Authority is assessed values for property within the Cherry Creek Basin in both Douglas and Arapahoe Counties. Revenues from these sources have consistently increased, from $2.3 million in 2004 to nearly $3 million in 2012. While Arapahoe County is nearing build-out, Douglas County, especially around Franktown and Parker, is expected to continue growing. Wastewater fees paid to the Authority have been fairly constant over the past few years and are anticipated to remain close to $100,000 annually for the Authority.

Potential Grant Opportunities

As a general practice, the CCBWQA does not apply for grants as a source of funding. CCBWQA is internally funded and that funding has tended to be adequate in the past. The CCBWQA does support partners in applying for grants and providing in-kind matches to partners including data sharing, program participation, and providing funding for grant or loan matches.

Potential Partnerships

The Authority's role as a partner with its member municipalities and counties, as well as the special districts and other units of government located within the Authority's boundaries, has grown steadily over time. This partner role, coupled with an ever increasing focus on the importance of water quality will likely drive the Authority's future expenditures.

Because the Authority does not hold a stormwater permit, it is exempt from MS4 permit financial obligations, allowing the Authority to focus on its role as a partner in a project facilitator or funding partner role. While it is unlikely that funding will come from stormwater quality improvements, the Authority may take an active role in facilitating nutrient trades between MS4 permit holders for compensation.

Funding Considerations

Annual Budget Process

The annual process for developing the upcoming year's budget typically begins with the July Board meeting. A final budget is then presented at the November Board meeting and finalized. As required by CRS 25-8.5, at least 60% of the total budget must be spent on capital projects. For 2012, for example, a proposed 71% of the planned expenditures will be for capital projects.

The Authority's budget for 2012 included approximately $2.0 million in new revenues, with the estimated beginning fund balance (on January 1st) of $3.3 million. This would leave the Authority $5.3 million for projects and operations. Planned expenditures total ($3.7 million), leaving a projected ending fund balance (on December 31st) of $1.7 million.

Expenditures

Expenditures and revenues are not matched each calendar year because implementation, costs, and timing of capital projects vary significantly from year to year. Colorado mandates that the Authority must spend at least 60% of its annual revenues on capital projects, the funding for which is tracked and traded in a separate account. Remaining funds may be spent on planning, studies, water quality monitoring, reporting, and administrative costs.

Potential New Revenue Sources

In addition to potential compensation from the Authority acting as facilitator between MS4 nutrient trades, the Authority may consider charging fees to additional water providers benefitting from work currently being done to improve water quality. ISDS users may also be charged a fee for water quality improvements as this may be a potentially large source of nutrients entering the Cherry Creek System.

Recommendations

The Authority may want to consider comparing expenditures with revenue sources, to better show those paying the fees/taxes where their money goes. For example, parks fees could compared to the construction and maintenance of in-park PRFs and reservoir studies. Wastewater fees could be shown to support projects such as sewering-up priority ISDS areas, or supporting a stream fate and transport model. Because property taxes are the largest source of revenue, they likely help support projects throughout the entire watershed.

Chapter 7

Priorities & Implementation Strategy

Drivers

All components of the implementation strategy must clearly support the Authority's Vision and Mission.

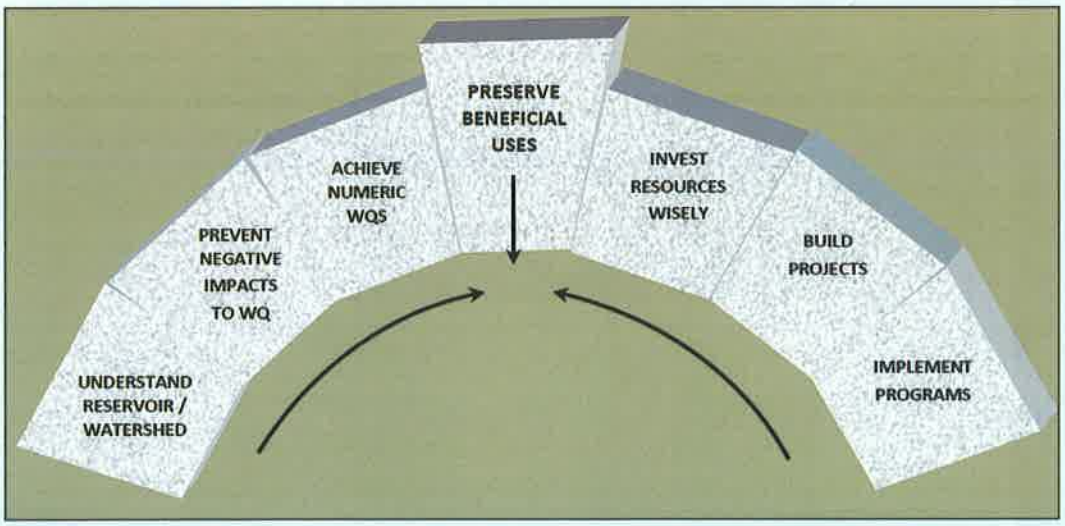
Vision: Water quality in Cherry Creek Reservoir and Watershed that optimizes beneficial uses for the public.

Mission: Protect beneficial uses by preserving, enhancing, and balancing water quality in Cherry Creek Reservoir and

A handful of goals were developed to support the Vision and Mission. The overarching goal, the one that drives all that we do, is to preserve the beneficial uses of the reservoir. Reservoir beneficial uses have been designated by the Colorado Water Quality Control Commission as:

- **Aquatic Life**
- **Recreation**
- **Water Supply**
- **Agricultural Use**

The preservation of beneficial uses is the centerpiece of the other goals; it can be viewed as a keystone. All the other goals are there to support the preservation of beneficial uses.



Priority Development

Together at a joint workshop, the Board and TAC evaluated the Chapter 5 management strategies for each of the pollutant source areas. These priorities were reviewed again at a later Board meeting.

Stream Erosion, by far, was the highest ranking priority. The following management options to prevent and control erosion received the most support:

- ☑ Protecting riparian zones through stream buffer programs
- ☑ Performing stream reclamation projects before the streams are eroded due to development (i.e., before they "unravel")
- ☑ Continuing the watershed monitoring program to document stream reclamation results

- ☑ Studying the impacts of water development on stream erosion, and the impacts of increasing alluvial well withdrawals on riparian vegetation

Other strategies also receiving significant support include:

- Continuing to prioritize projects using the TAC's Stream Reclamation Water Quality Benefit Evaluation Report
- Continuing to look for more opportunities to promote connectivity (i.e., "treatment train approach")

Regulated Stormwater was the second highest-ranking priority. Although several potential management options were identified by some as priority areas (such as retrofitting water quality and detention ponds, encouraging low-impact development (LID), and exploring control strategies for roadway sand and chemical de-icers), one particular strategy received the strongest support:

- ☑ Continuing to evaluate the stormwater provisions in Regulation 72, as the science and state-of-the-art improves, to influence the regulation. (Regulation 72.7 defines regulated activities, design criteria, and mandatory BMPs.)

Priority Development (cont'd)

Animal Waste was the third highest priority, with a focus on geese and dogs. The first management option below garnered the most support, and the others also had good support.

- ☑ Developing recommendations to address goose droppings, patterned after the successful programs of others
- Supporting the Cherry Creek State Park's Dog Off-Leash Area (DOLA) Management Plan
- Implementing the 12-Mile Park (DOLA) Stream Stabilization PRF Project

Agricultural Operations were identified as the fourth priority; strategies are focused on education and outreach.

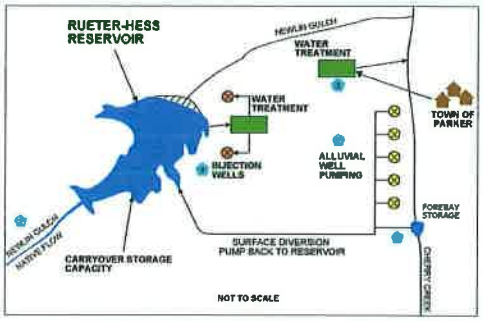
- ☑ Conducting education and public outreach in areas such as revegetation of overgrazed areas and re-use of manure as compost

Other management strategies that had some support included encouragement of BMPs such as minimal tillage and rotational grazing through education; determining the impacts of golf course fertilizers; and expanding county water quality requirements to include specifics such as BMPs for plant nurseries and tree farms.

Priority Development (cont'd)

Water Development Implications was the fifth highest priority, with two items receiving significant support.

- Evaluating the implications of importing WISE water into the basin
- Evaluating the effects of pumping from alluvial wells on stream flow and water quality



Other lower priority strategies for water development and related issues included understanding the impacts of water conservation and water reuse on water quality in the basin.

Individual Septic Disposal Systems were identified as the next priority, with one favored strategy:

- ☑ Completing a more comprehensive map of ISDS compared to the location of alluvial aquifers and water courses

Other items with much lower priority included identifying area-specific solutions, such as areas where sewering-up may be a possibility; monitoring below ISDS for nitrogen to confirm the actual concentrations contributed by septic tanks; and continuing to support Tri-County Health Department's stringent ISDS regulations.

Wastewater Treatment Facilities were the seventh priority, again with one preferred option:

- ☑ Developing a watershed transport model to determine the fate of phosphorus and nitrogen as it travels downstream, and how much reaches the reservoir.

Other recommendations included encouraging wastewater treatment facilities to share all nutrient data with the Authority, including total nitrogen, total inorganic nitrogen, total phosphorus, and soluble reactive phosphorus; comparing effluent limits to existing background for new WWTFs and consider options such as WWTF-PRF trades; and ensuring the Authority's requirements for lift stations are being implemented.

Priority Development (cont'd)

Reservoir Sediments was the eighth priority. Several tasks received limited support. One was identifying constituents other than nutrients that could be released from the sediments. There was mixed direction regarding potentially dredging the sediments: some wanted to pursue a dredging project for the reservoir while others wanted to identify alternatives to dredging due to potentially significant unintended consequences. Potential alternatives to investigate might include additional aeration at the sediment-water interface to prevent hypoxia, or chemical treatment of the sediments to prevent release of nutrients.

Other Point Source Discharges were the lowest priority with one item receiving moderate support:

- Evaluating pollutant loads from Centennial Airport and recommending control strategies where the Authority may be able to have positive impacts

It was also suggested that perhaps a system limit that regulates total discharge from collective area permits . be explored for other classes of point source dischargers.

Watershed and Reservoir Science is a High Priority

Underlying all the priorities is the need for good reservoir and watershed science, and the Authority places high priority on this. Understanding the fishery and other fauna is also a high priority. To this end, the Authority is pursuing the development of a stream fate/transport model and reservoir model.

Stream Model: The ultimate purpose of the watershed model is to determine which management techniques will be effective in protecting water quality; it will be used as a "test" of the effectiveness of new control activities prior to embarking in new directions. It will use input from the previous watershed model.

Reservoir Model: During 2013, the Authority will evaluate different types of reservoir models that could be used to better understand interactions within the reservoir. The goal is to make a determination as to which model or models to use to support management decisions for the reservoir.

Translating Priorities into Action Plans

The following recommendations for annual action plans are based on the final priorities from the previous sections. Tasks that need to occur first, as input to a priority item (such as monitoring for new parameters needed for a model), were also included. New initiatives are shown in blue shading; continuing items are shown with a white background. This is intended as a guide for the next few years in developing annual action plans and budgets; it will need to be updated for future years based on what is learned.

2013 Proposed Action Plan

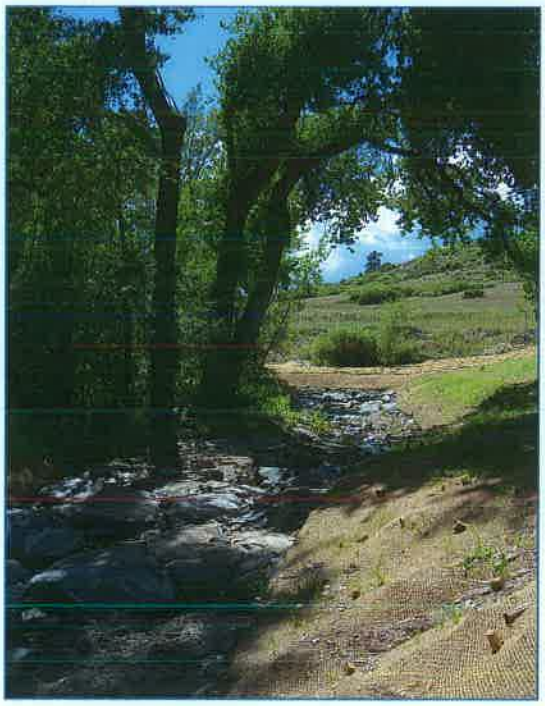
Planning and Evaluation Tools	Implementation
Evaluate impacts of water development & alluvial pumping on water quality	Implement stream fate/transport model
Map ISDS located in alluvium/near streams	Implement 12-Mile Park PRF; continue to support State Parks' DOLA Mgmt. Plan
Evaluate impacts of future development on stream erosion; evaluate source of high nutrients upstream of McMurdo project	Continue to implement CIP projects
Obtain and evaluate all WWTF data on phosphorus and nitrogen (& SO_5 & Cl^-)	Continue to identify & implement stream reclamation projects before they "unravel"
Monitor ISDS for nitrogen contributions	Continue to identify & implement projects that promote stream connectivity
Monitor golf course fertilizers for water quality impacts	Continue to implement all Reg. 72 requirements and all MS4 permit terms
Obtain reservoir sediment cores & evaluate for nutrient content/release potential	Continue watershed monitoring program to document PRF/stream reclamation results
Define measureable endpoints to determine beneficial use protection	Continue reservoir monitoring program
Monitor reservoir for parameters to support determination of beneficial use protection	
Evaluate loads from airport; recommend solutions	
Determine inputs for stream fate/transport model	
Evaluate potential adverse impacts of reservoir dredging on water quality & uses	
Make decision regarding which reservoir model(s) to develop in 2014	
Conduct other studies as needed for input to reservoir modeling efforts	

2014 Proposed Action Plan

Planning and Evaluation Tools	Implementation
Evaluate potential for releases of other chemicals from reservoir sediments	***Begin implementation of recommended reservoir model and/or sub-models***
Evaluate potential alternatives to dredging, including alum treatment & aeration	***Support stream buffer programs for riparian area protection***
Study potential impacts from water reuse and conservation on water quality	***Continue to implement CIP projects***
Develop stream buffer program (including stream barriers for animals)	***Continue to identify & implement stream reclamation projects before they "unravel"***
Develop recommendations to address riparian impacts from development & pumping	***Continue to identify & implement projects that promote stream connectivity***
Evaluate additional strategies for beneficial use protection	***Continue to implement all Reg. 72 requirements and all MS4 permit terms***
Monitor food chain in reservoir/coordinate with CPW	***Continue watershed monitoring program to document PRF/stream reclamation results; continue reservoir monitoring program***

2015 and Beyond Proposed Action Plan

Planning and Evaluation Tools	Implementation
Obtain data on numbers of agricultural animals in basin	Implement Reg. 72 requirements and all MS4 permit terms
Obtain data on other dog parks & usage; develop strategies if indicated	Implement recommendations to reduce pollutant loads from airport, as appropriate
Review data gap analysis conducted by MS4s; coordinate efforts if needed	Retrofit water quality and detention ponds for control of nutrients/pollutants
Identify area-specific solutions for problem ISDS spots	Implementation of either reservoir dredging or alternative for sediments
Determine the effectiveness of Authority lift station requirements	Possibility of WWTF-PRF trades for new WWTFs
Develop recommendations to address goose droppings	Encourage County ordinances and volunteer programs for animal wastes/impacts
Develop educational materials: nutrient reductions for agricultural operations	Support stream buffer programs for riparian area protection
Develop program to address de-icers, sand from roads	Continue to implement CIP projects
	Continue to identify & implement stream reclamation projects before they "unravel"
	Continue to identify & implement projects that promote stream connectivity
	Continue to implement all Reg. 72 requirements and all MS4 permit terms
	Continue watershed monitoring program to document PRF/stream reclamation results
	Continue reservoir monitoring program



Priorities & Implementation Strategy

How Does this Plan Get Us to Where We Are Going?

The Chapters are intended to take us through the key strategic planning questions, starting with "Where are we going?" and "Why do we exist?". Chapter 1 describes the strategic planning process and the Authority's vision and mission statements, which answer these two questions. Chapter 2 summarizes the history of the watershed and the formation of the Authority. In order to understand where we are going, we need to first understand where we came from.

***Where** are we going?*

***Why** do we exist?*

***What** must we accomplish?*

***How** we will achieve it?*

***What** are the measureable steps for success?*

The third chapter provides regulatory information, which defines, in more detail, what we must accomplish. Chapter 4 presents future conditions under which we must accomplish our job.

Chapter 5 presents numerous management strategies that can be used to achieve our goals. Funding considerations, which will impact how we fast we can achieve our goals, are summarized in Chapter 6.

The last chapter (Chapter 7) defined steps to get there. It includes a 3+ year action plan, with specific tasks to focus on each year. These steps should lead to successfully achieving our vision:

Water quality in Cherry Creek Reservoir and Watershed that optimizes beneficial uses for the public.

How Will We Know When We Get There?

How will we know when the goals are achieved? Perhaps the most important action item (recommended for the first year) is to define measurable endpoints for beneficial use protection. This may include biologic endpoints, water quality conditions, and/or use of other indicator parameters. This will have to be defined for all four of the designated beneficial uses: aquatic life, recreation, water supply, and agricultural uses. The models can then be used to evaluate control strategies under different future scenarios to determine how these endpoints can best be achieved. The initial action plans for the first few years are focused on obtaining information needed to be able to use the models and understand the complex interactions within the watershed and reservoir. Based on what is learned, we may need to review and revise our management priorities. The annual action plans must always be designed to achieve the water quality vision; they are not endpoints unto themselves.

When and How Will We Revisit and Revise the Plan?

Each Chapter should be regularly reviewed and revised to allow the plan to continually evolve. Each Chapter will have a different review period.

Chapter 1, including the vision, mission, goals, and objectives should be revisited approximately every 5 years, to ensure that the vision and mission are appropriately guiding the Authority's actions. Although this time frame is longer than the triennial review period for water quality standards, but the underlying aim of water quality to preserve and protect beneficial uses should not significantly change. Information regarding the History of the Authority, Chapter 2, need only be added after key events, such as statutory changes, occur. Information regarding Regulation 72, as described in Chapter 3, will need to be revised as changes are made to the regulation.

Existing and projected conditions in the watershed will constantly be changing. Revisions to Chapter 4 should be should be revised as new information on likely future conditions in the watershed becomes available; it should be reviewed by the regional planning entities such as the counties, etc., at least once every 5 years.

The management strategies investigated in Chapter 5 are a toolbox of options for improving water quality in the reservoir and watershed. As such, these should be revisited and revised as appropriate, at least once every five years, as technical information and additional strategies become available. Chapter 6 describing funding should be amended when significant trends are observed or there are significant changes in funding sources and practices. Finally, the priorities and implementation strategies defined in Chapter 7 should be updated annually, to reflect shifting priorities to needed to achieve the vision.

The Watershed Plan will guide the Authority's efforts in achieving water quality that optimizes beneficial uses in Cherry Creek Reservoir and its watershed.

Cherry Creek Basin Water Quality Authority

Acronyms

Watershed Plan 2012

AFO - Animal Feeding Operations

BMPs - Best Management Practices

CCBWQA or Board - Cherry Creek Basin Water Quality Authority Board of Directors

CDOT - Colorado Department of Transportation

CDPHE - Colorado Department of Public Health and Environment

CIP - Capital Improvement Plan

Corps - US Army Corps of Engineers

DOLA - Dog Off-Leash Area

DRCOG - Denver Regional Council of Governments

DUWS - Direct Use Water Supply

ISDS - Individual Sewage Disposal System

LID - Low-impact Development

N - Nitrogen

NRCS - Natural Resources Conservation Service

P - Phosphorus

PRF - Pollutant Reduction Facility

RMH - Rulemaking Hearing

SMWSA - South Metro Water Supply Authority

TAC - Technical Advisory Committee

TCHD - Tri-County Health Department

TMAL - Total Maximum Annual Load

WLA - Wasteload allocation

WQCC - Water Quality Control Commission

WQCD - Water Quality Control Division

WWTFs - Wastewater Treatment Facilities

WWTP - Wastewater Treatment Plants

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