FINAL REPORT

Project 97-IRM-5A | 2000

Watersheds and Ecosystems

Phosphorous Credit Trading in the Cherry Creek Basin: An Innovative Approach to Achieving Water Quality Benefits

Watershed-based trading is an innovative way for water quality agencies and community stakeholders to develop common-sensible, cost-effective solutions to water quality problems in their watersheds (U.S. Environmental Protection Agency (EPA), 1996). It is a flexible alternative that allows the communities within a watershed to grow and prosper while retaining a common commitment to water quality.

Communities, industries, and regulatory agencies around the country have shown great interest in watershed-based trading recently as an innovative approach to achieve water quality benefits in a more cost-effective manner than traditional approaches allow. Even with all the interest, actual implementation of trading programs has been largely missing. The *EPA Draft Framework for Watershed-Based Trading* (U.S. EPA, 1996) provides a strong overview of the trading concept, but potential trading partners need more hands-on guidance to transform this concept into a viable, working trading program.

Effluent trading, watershed-based trading, and trading water quality improvements are terms that describe efforts by watershed stakeholders to identify the pollutant sources within a specified area, examine loading reduction opportunities, and implement the load reduction opportunities to meet environmental objectives cost-effectively. In a trade, one source (the buyer) pays or arranges for another source (the seller) to reduce its pollutant load below a specified level. In exchange, the buyer receives credit toward its loading target, as if it had achieved the load reductions itself. The buyer may deal directly with the seller, or may work through a third party; the seller may or may not be subject to an effluent limit or load allocation depending on the type of program and how the parties agree to conduct business. Those involved in trading typically use the term trade to refer to a single transaction between two sources. The term trading project refers to one or a couple of trades, and the term trading program refers to a framework that can support numerous trades and trading projects over a long period of time.

There are three general approaches to trading open or market-based , closed , and full closed . Open trading is based on, and supplemental to, existing regulations, geared toward pre-Total Maximum Daily Load (TMDL), non-water quality limited segments. They are typically voluntary and often used to maintain ambient environmental standards and provide cost-effective means of complying with technology-based standards. Open programs can provide operational flexibility by allowing sources to compensate for production increases and offset growth in developing areas (Michigan Department of Environmental Quality (MDEQ), 1998). Closed trading sets a limitation or cap on effluent discharge for a geographical area and for a specified group of dischargers. Unlike open trading, a full closed trading system takes the closed trading concept and applies it to all effluent discharge sources in a given watershed. This TMDL-based approach sets the allocations for background, nonpoint and point sources equal to the total permissible watershed load (*Water Science Reporter*, 1997).

Open and closed trading programs offer tremendous opportunities for improving air and water quality at lower costs, providing operational flexibility, and encouraging the development of emerging technologies to control and measure/monitor discharges in the environment (MDEQ, 1998).

The Cherry Creek Basin Water Quality Authority s Trading Program, Denver, Colorado, offers a unique opportunity to comprehensively document development and implementation of a watershed-based trading program. This program will be highlighted as well as other trading programs. By identifying the similarities and differences in program design and linking those key elements to scientific, economic, and institutional conditions in the watershed community, we can highlight some lessons, guidelines, and patterns emerging from the growing field of trading.

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PHOSPHOROUS CREDIT TRADING IN THE CHERRY CREEK BASIN: AN INNOVATIVE APPROACH TO ACHIEVING WATER QUALITY BENEFITS

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Cherry Creek Basin Water Quality Authority

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BENEFITS

- Provides a sound technical and policy basis for trading.
- Defines a standardized approach to quantify water quality benefits of individual phosphorus removal projects and to track the overall benefits of the trading program.
- Provides an example of point-to-nonpoint source trades of phosphorus.
- Tests a framework for actual implementation of phosphorus trades.
- Includes a market analysis in which to define phosphorus credits, establishes a credit price, and determines the economic benefits of trading.

Keywords: Watershed-based trading, effluent trading, total maximum daily load, phosphorus, pollutant, water quality incentives.

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A viable solution to combat water quality problems is watershed-based trading (U.S. EPA, 1996). This cost-effective measure allows communities to grow and prosper while retaining a common commitment to water quality.

Attracting the attention of communities, industries, and regulatory agencies nationwide, watershed-based trading may be the answer to achieving water quality benefits in a more cost-effective manner than traditional approaches allow. Despite all the interest, actual implementation of trading programs has been largely missing. The *EPA Draft Framework for Watershed-Based Trading* (U.S. EPA, 1996) provides a strong overview of the trading concept, but potential trading partners need more practical guidance to make this concept a viable, working trading program. Comprehensive documentation of a successful demonstration program, its development and implementation, could play a significant role in helping to advance other trading programs around the country.

The Cherry Creek Basin Water Quality Authority watershed-based trading program offers a unique opportunity to comprehensively document development and implementation of a watershed-based trading program. The authority is a quasi-municipal corporation and political subdivision of the State of Colorado (Section 25-8.5-101 et seq., CRS), which is empowered to levy a limited tax on watershed residents, charge recreationists using the Cherry Creek Reservoir, and collect fees from wastewater treatment facilities and nonpoint sources. It has operated continuously since 1985 and is governed by a Board of Directors comprised of a representative from each of the member jurisdictions.

Due to the high level of phosphorus treatment already being achieved at Cherry Creek publicly owned treatment works and the incredibly high costs that would be associated with achieving additional reductions, the authority determined that no viable non-trading phosphorus reduction options existed for these facilities. Therefore, the authority did not further evaluate non-trading options for point sources.

The authority determined in 1996 that it was ready to develop and implement a watershed-based trading program. Effluent trading guidelines have also been developed for the Cherry Creek Basin. The authority's trading program is a full-closed TMDL (total maximum daily load)-based trading program established in 1997. To date, the authority has constructed and is operating, maintaining, and monitoring four pollutant reduction facilities (PRFs) in the watershed, which provide credits for trading. Since their construction, the authority has regularly monitored the projects to determine actual removal rates. The authority will continue to track these facilities to verify phosphorus and other pollutant removal capabilities.

The trading ratios determined for the four PRFs range from 1.3 to 3.0. The trading ratios were established based on the following three factors: uncertainty, net loading reduction, and an additional margin of safety. Based on the trading ratio and the average phosphorus load removal in pounds per year, 461 pounds of total phosphorus were determined to be available annually for use in the trading program. The trading program will not result in any exceedance of the total phosphorus TMDL, set at 14,270 pounds. A reserve pool of approximately 200 pounds of phosphorus and an emergency pool of 100 pounds of phosphorus have been set aside, providing additional margins of safety.

The development of the watershed-based trading program within the basin has been fully documented to provide a concise, consistent, comprehensive approach to trading on a national level. In addition, the trading program put together by the authority has analyzed specific technical factors, including economics and water quality. This document provides others with a practical guide that documents and evaluates this demonstration project, and discusses the lessons learned, beginning with the trading program development and continuing through the implementation and tracking of actual trades.

CHAPTER 1.0

INTRODUCTION

1.1 Purpose and Objectives

The purpose of this report is to evaluate and document the developmental stages of a watershed-based trading program using the Cherry Creek Basin Water Quality Authority's experience as a successful model and comparing with other programs' perspectives around the country, in part with input from the National Review Panel (NRP) and the project subcommittee (PSC).

Because consistent and comprehensive information about watershed trading initiatives and examples of actual implementation are lacking, this document will be vital for those who are intrigued by the possibilities of watershed-based trading but hesitate because there is no practical guidance at this time. This document is designed to provide others with a practical guide that documents and evaluates this demonstration project, and discusses the lessons learned, beginning with trading program development continuing through the implementation of actual trades.

The overall goal of this project is to generate and communicate useful information to support implementation of appropriate watershed-based trading efforts around the country. Specific objectives include the following:

- Develop a sound technical and policy basis for trading;
  - Define one standardized approach to quantify the water quality benefits of individual phosphorus removal projects within the watershed and to track the overall benefits of the trading program to the watershed;
  - Conduct a market analysis to define phosphorus credits, establish a credit price, and determine the economic benefits of trading;
  - Test a framework for actual implementation of phosphorus trades, and modify, as appropriate;
- Provide practical, hands-on guidance and information for others developing TMDL (total maximum daily load)-based trading programs. Other approaches such as non-TMDL-based trading will be different;
  - Document the developmental stages of the authority's trading program, including major challenges and successes, lessons learned, alternative approaches, and implications for others;
  - Share experience from other trading programs, in various developmental stages, through input from an NRP; and

— Develop a decision matrix/annotated menu for others developing watershed-based trading programs.

The authority's trading program provides several features that make it a strong demonstration project.

- Demonstrates an institutional framework for trading to occur, including agency roles, responsibilities and nonpoint source accountability.
- The key stakeholders within the watershed are strongly committed to ensuring the trading program is successful.
- The authority provides a long-standing, effective mechanism to address watershed-based water quality trading issues.
- Phosphorus is the constituent of concern and addressing overall nutrient loading to Cherry Creek Reservoir is the focus of the trading program.
- The trading program primarily addresses point/nonpoint source trades, but also authorizes long-term or short-term point/point trades.
- A phosphorus transfer of 40 pounds from the reserve pool to a point source discharger has occurred.

1.2 Background

Watershed-based trading is an innovative way for water quality authorities and community stakeholders to develop common sense, cost-effective solutions to water quality problems in their watersheds, while retaining a common commitment to water quality.

Watershed-based trading has been greeted favorably among communities, industries, and regulatory agencies around the country. It has been heralded as a positive alternative to traditional approaches in benefiting water quality more cost-effectively. However, actual implementation of trading programs has been slow despite all the interest. The *EPA Draft Framework for Watershed-Based Trading* (U.S. EPA, 1996) provides a strong overview of the trading concept, but potential trading partners need more hands-on guidance to transform this concept into a viable, working trading program. Comprehensive documentation of successful demonstration programs, from initial development through implementation stages, can help to advance other trading programs around the country.

Effluent trading, watershed-based trading, and trading water quality improvements all describe efforts by watershed stakeholders to identify the pollutant sources within a specified area. They also examine loading reduction opportunities and implement the load reduction opportunities to meet environmental objectives cost-effectively. In a trade, one source (the "buyer") pays or arranges for another source (the "seller") to reduce its pollutant load below a specified level. In exchange, the buyer receives credit toward its loading target, as if it had achieved the load reductions itself. The buyer may deal directly with the seller, or may work through a third party; the seller may or may not be subject to an effluent limit or load allocation — depending on the type of program and how the parties agree to conduct business. Those involved in trading typically use the term "trade" to refer to a single transaction between two sources. The term "trading project" refers to one or a couple of "trades," and the term "trading program" refers to a framework that can support numerous trades and trading projects over a long period of time.

The three general approaches to trading are "open" or "market-based", "closed", and "full closed". "Open" trading programs are based on, and supplemental to, existing regulations. They are typically voluntary and often used to maintain ambient environmental standards and provide cost-effective means of complying with technology-based standards. Transitional open trading programs can be used to encourage early reductions, achieve phased water quality improvements and obtain information required to establish a closed (cap and allowance) trading program. This program allows both regulated and unregulated sources to participate. This may be done by point sources modifying their permits to reflect an exchange of unregulated nonpoint source pollution reductions.

Control technology or water quality-based discharge limitations establish the baseline for the generation and use of credits. The baseline for reductions to generate credits may be calculated from actual discharges from point (regulated) and nonpoint (unregulated) sources over a designated time period. Surplus credits can be generated by making a real change to reduce discharge or loading levels beyond that which is required by law. The use of credits in open trading may be restricted to assure that water quality standards are not violated and to prevent adverse localized impacts. Open programs can provide operational flexibility by allowing sources to compensate for production increases and offset growth in developing areas. Open trading can provide better flexibility by allowing trades to take place by rule, instead of issuing permits for each trade. A greater environmental benefit than that which can be achieved under existing regulations may be built into an open trading program by permanently retiring a share of all the credits that are traded. In this way, emissions are not simply put back into the environment at different locations as occurs with effluent trading (MDEQ, 1998).

"Closed" trading sets a limitation or "cap" on effluent discharge for a geographical area and for a specified group of dischargers. The system allocates effluent control responsibility to individual group members in the form of allowances or "credits". After the allowances are distributed, discharge sources can trade as long as total effluent discharge within the system does not exceed the pollution cap (closed systems are often called "cap-and-trade" systems). The cap may be exceeded only if offset by effluent reductions from sources not under the cap. A "full closed" trading system takes the closed trading concept and applies it to all effluent discharge sources in a given watershed. This approach sets the allocations for background, nonpoint and point sources equal to the total permissible watershed load. All point and nonpoint source dischargers are then assigned an initial allocation of allowances. By including all sources under the cap, a full closed trading system is the most comprehensive application of the trading concept (Water Science Reporter, 1997). The authority's watershed-based trading program is an example of a full closed trading system.

Open and closed trading programs offer tremendous opportunities for improving air and water quality at lower costs, providing operational flexibility and encouraging the development of emerging technologies to control and measure/monitor discharges in the environment (MDEQ, 1998).

The Cherry Creek Watershed is located within one of the fastest growing areas in the country. The reservoir, located within the watershed and the surrounding state park, serve as an important recreational site that receives extensive use (Figure 1-1). The reservoir and surrounding area also serve as a wildlife habitat site. Growth in the watershed has contributed to increased urban runoff and instream erosion (nonpoint source), as well as point source contributions of phosphorus to the reservoir.

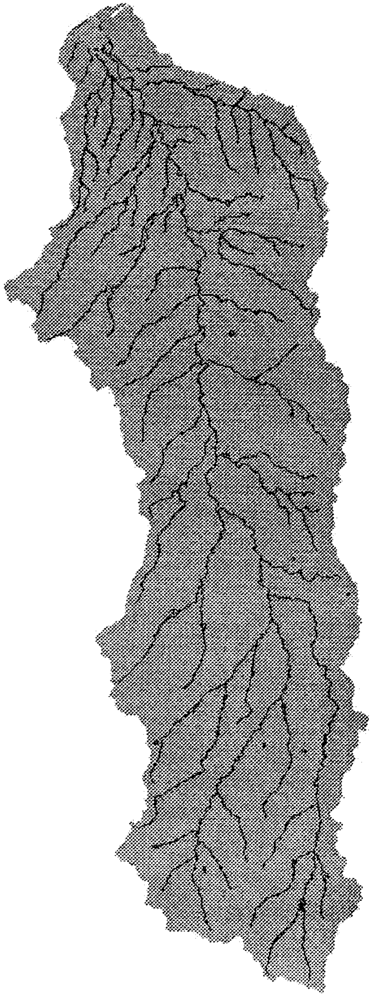


Figure 1-1. Location Map and Watershed/Reservoir Map.

In 1985, as the result of the 1982 Cherry Creek Clean Lakes Study, which identified phosphorus as a limiting factor for algae growth in the reservoir, the State of Colorado's administrative agency, the Colorado Water Quality Control Commission (WQCC) adopted a 35 µg/L total phosphorus standard to protect the reservoir from accelerated eutrophication (5 C.C.R. 1002-72). This phosphorus standard was approved to maintain summer chlorophyll α concentrations below the goal of 15 µg/L. The State of Colorado, through the WQCC, has been delegated the power to implement the Clean Water Act and National Pollutant Discharge Elimination System (NPDES) program in Colorado.

With the adoption of the 35 µg/L in lake total phosphorus standard, it was necessary to determine the maximum annual loads of phosphorus which could enter the reservoir annually while complying with the standard. An in-lake phosphorus model was used to define the maximum allowable annual load of phosphorus from all combined sources that would maintain the 35 µg/L phosphorus standard for the reservoir as 14,270 pounds (DRCOG, 1983). The annual load of phosphorus was allocated among wastewater treatment facilities (point sources), nonpoint sources, background, industrial, and septic loadings. (DRCOG, 1985).

Continued growth within the watershed, and increased point source and nonpoint source loading would require additional pounds of phosphorus removal credits in the future. The authority's watershed-based trading program provided an alternative that would allow for the continued growth in the watershed without further impacting the water quality of the reservoir.

1.3 Description of the Authority and Other Key Players

The authority is a quasi-municipal entity with primary responsibility for water quality planning and implementation of water quality control measures in the watershed. Currently, the authority is comprised of two counties, four cities, and seven special districts committed to promote and maintain water quality in the reservoir and watershed. After adoption of the phosphorus standard, governmental entities in the watershed collaborated to develop the first Cherry Creek Basin Water Quality Management Master Plan (DRCOG, 1985). The authority's members include: Arapahoe County and Douglas County; the City of Aurora, City of Greenwood Village, Town of Castle Rock and Town of Parker; Arapahoe County Water and Wastewater Authority, Cottonwood Water and Sanitation District, Inverness Water and Sanitation District, Meridian Metropolitan District, Parker Water and Sanitation District, Pinery Water and Sanitation District, and Lincoln Park Metropolitan District (Stonegate). In 1985, the WQCC approved the master plan and, concurrently, adopted the first version of the Cherry Creek Reservoir Control Regulation, which established the annual TMDL of 14,270 pounds phosphorus for the reservoir (*5 C.C.R. § 1002-72*). Although the control regulation has been amended several times since 1985, including the 1997 revisions establishing the trading program, the TMDL has remained unchanged.

To implement the master plan, the local governments in the watershed formed the authority in 1985 by intergovernmental agreement. At the request of the authority, the General Assembly of Colorado enacted the Cherry Creek Basin Water Quality Authority Act in 1988, establishing the authority as a political subdivision of the state, empowering the authority to, *inter alia*, (1) develop and implement plans for water quality controls in the watershed, (2) recommend and, if delegated the power, allocate wasteloads among sources in the watershed, (3) raise revenues through taxes and fees for the purposes of the authority, and (4) develop and implement programs for credits, incentives rewards for water quality control projects in the watershed. The authority's mission statement adopted in 1994 reflects their watershed goals:

> *To promote the preservation of water quality in the Cherry Creek Watershed through mitigation of urban impacts for the benefit of the public for recreation, fisheries, water supplies and other beneficial uses within the economic abilities of the authority.*

Entities that work closely with the authority include the Colorado Department of State Parks , Water Quality Control Division (WQCD), WQCC, Natural Resources and Conservation Service, and U.S. Army Corps of Engineers.

1.3.1 Parks

The Parks Department is responsible for the operation of Cherry Creek State Park which includes the reservoir and approximately 3,915 acres of surrounding property. The park is a major recreational facility providing for boating, swimming and fishing, as well as biking, walking, horseback riding, and bird/wildlife viewing.

1.3.2 Water Quality Control Commission

The WQCC is the state board responsible for adjudicatory and rulemaking decisions on water quality matters. Nine individuals, appointed by the governor and confirmed by the Colorado senate, from different geographic areas and political affiliations, who serve three-year terms, renewable once or twice, constitute the WQCC.

1.3.3 Water Quality Control Division

The WQCD is responsible for administering water quality programs in Colorado, such as issuing site approvals and NPDES permits, and serves as staff to the WQCC.

1.4 Trading — Why Now?

The authority occasionally had brief discussions of trading. The authority's counsel brought to its attention federal and local developments on other trading programs and the EPA's *Draft Framework for Watershed-Based Trading* (U.S. EPA, 1996). In 1996, one wastewater treatment plant seeking expansion within the watershed did not have a sufficient wasteload allocation (WLA) for expansion, nor was additional, long-term phosphorus available for allocation to them. Other wastewater treatment plants recognized that their next increment of expansion would be at or near their ultimate WLA. These authority members needed measures to obtain additional phosphorus WLA. Trading provided that option. In addition, trading provided a means for the authority to obtain credit for the substantial investments it had made in nonpoint source control projects within the watershed.

The authority also recognized that a process to reallocate phosphorus WLA would be time consuming and politically difficult until a new water quality standard and TMDL were completed. Although the authority intended to undertake those activities, the need for immediate phosphorus allocations and desire to obtain credit, in terms of phosphorus, for the authority's nonpoint source achievements were driving factors for the authority's decision to proceed with the trading program.

The reservoir is classified for recreation and aquatic life and not as a water supply. Therefore, this trading program did not address the effects on drinking water. Moreover, the nutrient being traded, phosphorus, was established to protect recreation and fish.

1.5 Report Overview

The development of the watershed-based trading program within the watershed has been fully documented to provide a concise, consistent, comprehensive approach to trading on a national level. This report provides others with a practical guide that documents (1) the trading program including its objectives, drivers, and framework, and steps to trading; (2) the technical basis for trading, including the controls to reduce watershed loadings and the scientific basis used in establishing the trading ratios; (3) the economic basis for trading including the pollutant reduction options with and without trading as well as a credit pricing structure: (4) the phasing and implementation of the trading program by the authority; and (5) an overview of the trading program and the key lessons learned.

CHAPTER 2.0

TRADING PROGRAM DESCRIPTION

The Cherry Creek Basin Water Quality Authority watershed-based trading program is a full-closed TMDL-based trading program established in 1997. The trading program includes point to NPS trading of phosphorus. To date, the authority has constructed and is operating, maintaining, and monitoring four pollutant reduction facilities (PRFs) in the watershed, which provide phosphorus credits for trading. Since their construction, the authority has regularly monitored the projects to determine actual removal rates. The authority will continue to track these facilities to verify phosphorus and other pollutant removal capabilities.

The trading ratios determined for the four PRFs range from 1.3 to 3.0. The trading ratios were established based on the following three factors: uncertainty, net loading reduction, and an additional margin of safety. Based on the trading ratio and the average phosphorus load removal in pounds per year, 461 pounds of total phosphorus were determined to be available annually for use in the trading program. The trading program will not result in any exceedance of the total phosphorus TMDL, set at 14,270 pounds. The TMDL has set aside a reserve pool of approximately 200 pounds of phosphorus and an emergency pool of 100 pounds of phosphorus, which provide additional margins of safety.

2.1 Basin Water Quality Objectives/Framework (Drivers)

While water quality and phosphorus loading in the reservoir and watershed is the current focus of ongoing studies, the basis of the reservoir phosphorus standard and allocation goal is the 1982 Clean Lakes Study. Based on the study, the Colorado Water Quality Control Commission (WQCC) established an in-reservoir total phosphorus standard of 35 µg/L for the reservoir. This standard would ensure that chlorophyll a levels in the reservoir were maintained at concentrations no greater than 15 µg/L as an average for the "growing season" (July through September).

Although phosphorus is the primary constituent of concern, the authority is also addressing other water quality parameters. Details of the authority's water quality framework are outlined below.

2.1.1 Reservoir Standards

The Water Quality Control Division (WQCD) collected data between November 1981 and October 1982 on the reservoir as part of their Clean Lakes Studies (The Denver Region Council of Governments (DRCOG), 1983) including chlorophyll α and total phosphorus. Summer

(June-September) mean concentrations of chlorophyll α and total phosphorus were 10.7 μg/L and 39.7 μg/L, respectively.

DRCOG published a report in 1983, recommending total phosphorus loading and chlorophyll α limits based upon the Clean Lakes Study. In this report, DRCOG proposed a limit of 20 μg/L for chlorophyll α during the growing season and a concentration of in-lake phosphorus of 44 μg/L. The proposed chlorophyll a limit of 20 μg/L was roughly twice the value of 10.7 μg/L measured by the WQCD in 1981 and 1982. In September 1985, at the WQCC hearing, a standard of 15 μg/L for chlorophyll α was adopted which apparently "split the difference" between chlorophyll α levels existing at that time and the level recommended by DRCOG (WQCC, 1984).

The Jones-Bachmann chlorophyll-phosphorus model was then used in 1984 to calculate a phosphorus standard for the reservoir to protect a goal chlorophyll level of 15 μg/L. This model predicted that a temperate lake would support an average chlorophyll a value of about 15 μg/L with an average total phosphorus of 35 μg/L during the summer season. This modeling is the source of the current 35 μg/L phosphorus standard for the reservoir (DRCOG, 1985), which is maintained throughout the year.

The Vollenweider phosphorus model was applied to relate in-lake phosphorus concentrations to total estimated annual loads. This model was the basis for establishing the maximum load of 14,270 pounds of phosphorus that could enter the reservoir annually and maintain the standard of 35 μg/L. The combination of point, nonpoint, septic, industrial, and background sources were used to define the annual phosphorus load to the reservoir. Each source was allocated an annual loading of phosphorus.

2.1.2 TMDLs

With the adoption of the 35 μg/L total phosphorus standard for the reservoir by the Colorado WQCC, it was necessary to determine the maximum allowable quantity of phosphorus that could enter the reservoir annually and comply with the standard. The Clean Lakes Study used the Vollenweider model (1969) to predict total phosphorus loading, the Canfield-Bachmann model to predict sediment coefficient, determined the actual (measured) sediment coefficient, and then modified the Canfield-Bachmann equation to re-estimate the sediment coefficient (CCBWQA, 1998a). Based upon the data collected by the study, a TMDL of 14,270 pounds of phosphorus was established.

Based on the TMDL, the phosphorus pounds were distributed among five major sources: nonpoint, point, septic, industrial, and background. The annual pounds allocated to these sources are summarized in Table 2-1.

Table 2-1. TMDL Allocation for the Cherry Creek Watershed (DRCOG, 1985)

Source	Pounds of Phosphorus
Point Sources	2,310
Nonpoint Sources	10,290
Septic Systems	450
Industrial Sources	50
Background	1,170
Total	**14,270**

The Cherry Creek Reservoir Control Regulations established annual phosphorus allocations for each wastewater treatment plant in the watershed. The pounds of phosphorus allocated to each plant were anticipated to be adequate for the plant's 1985 capacity plus the next increment of plant expansion.

2.1.3 Cherry Creek Basin Water Quality Management Master Plan

The authority is reevaluating the reservoir phosphorus standard. Based on data collected between 1992 and 1997, the DRCOG (1985) recommendations of the total phosphorus standard, 35 µg/L, and TMDL of 14,270 are being reevaluated. These values, however, serve as the basis for the current in-lake phosphorus standard and phosphorus load allocations. Data collected over the past six years, including a detailed physical survey of the reservoir (Knowlton and Jones, 1993), provide a better estimation of the actual values for in-lake modeling than those used in the 1980s.

2.2 Overview of Authority Pool Trades

The authority's trading program allows point source dischargers to receive credit for reductions of phosphorus at pollutant reduction facilities (PRFs). The trading program was approved by the WQCC in November 1997, as reflected in revisions to the control regulation. The trading program is administered by the authority consistent with the trading provisions in the control regulation and the authority's Water Quality Trading Guidelines (see Appendix A), adopted by the authority in March 1998. The guidelines are much more detailed and comprehensive than the control regulation and include the specific procedures, policies, and standards for trading in the watershed.

The trading program authorizes two types of trades — authority pool trades and in-kind trades. Because the authority is in the process of reevaluating the water quality relationships in the watershed and reservoir, the authority agreed to phase its implementation of the trading program. In Phase I, currently underway, the authority only will implement authority pool trades for the four existing authority PRFs — Shop Creek, Quincy Drainage, Cottonwood Creek, and East Shade Shelter Shoreline Stabilization Project (these four projects are described in more detail in Section 3.2) — until the reevaluation of the watershed and reservoir have been completed and the results reflected in an update to the Cherry Creek Basin Water Quality Management Master Plan). In Phase II of the trading program the authority may include additional projects, other than the initial four PRFs, into the trading pool, and the authority also may approve in-kind trades.

2.2.1 Authority Pool Projects

In authority pool trading phosphorus reduction "credits" from authority-controlled projects are allocated by the authority into a "trading pool." A qualified discharger may then apply to the authority and purchase trade credits from the trading pool for its wastewater treatment plant.

2.2.2 Steps to Trading

The authority has outlined four steps in the trading program: (1) quantifying project removals, (2) evaluating PRFs, (3) awarding credits to dischargers — "the trade", and (4) reevaluation of trade projects.

2.2.2.1 Step 1 — Quantifying Project Removals

Only qualifying projects are considered for inclusion in the trading pool. The authority only considers for approval those projects NPS that remove phosphorus "beyond required best management practices (BMPs)" in the watershed. BMPs in the watershed include temporary measures — primarily aimed at arresting and mitigating construction runoff (e.g., filter fences, hay bales, revegetation) and permanent measures (e.g., detention ponds, swales, and constructed wetlands). BMPs are required for new development and construction activities in the watershed. A model BMP ordinance was developed by the authority in 1985. The authority is updating the BMP requirements.

Authority members or interested third parties may nominate PRFs for inclusion in the trading pool. After a project has been nominated, the authority — with participation and consultation from the WQCD — reviews the project.

2.2.2.2 Step 2 — Evaluating PRFs

If approved, the authority determines the amount of pounds available for trading, or "discharge credits, " from the project that may be assigned into the trading pool. The phosphorus removed by a qualifying PRF is determined based upon modeling, documented performance of similar projects, and monitoring of the PRF. Initial quantification of phosphorus removals will be verified or modified, based upon monitoring of the project. The quantified removal is the average annual phosphorus removal for the facility. The calculations quantifying phosphorus removal and trading ratios are described in more detail in Section 3.5.

The Authority Review. The authority will review the proposed projects and determine whether the project should be included in the trading pool and for how many credits.

Trade Ratio Policy. Trade ratios are established for each PRF on a project-specific basis in the range of 1.3:1 to 3:1, meaning that for every 1.3 to 3 pounds of phosphorus removed by a PRF, one phosphorus wasteload allocation (WLA) pound — discharge credit — is available through trading for point source discharge. All trade ratios incorporate a baseline margin of safety, because all of the ratios are greater than 1:1. The range of ratios provides enough flexibility so that the authority may assign lower ratios to more established, stable projects, but higher ratios for projects that exhibit greater technical or institutional uncertainty.

Eight factors will be considered by the authority when establishing trade credits from a specific PRF: (1) reliability and certainty of calculating NPS phosphorus removals; (2) removal technology and efficiency; (3) technological specifications of the project; (4) extent and sufficiency of NPS controls on any development served by the project; (5) extent and sufficiency of NPS controls during construction of the project; (6) reliability of project maintenance and operations; (7) net effect of the project on overall water quality in the watershed; and (8) a margin of safety. In evaluating these criteria, the authority will arrive at an assessment of the technical, scientific, and institutional uncertainties associated with each PRF. See Section 3.5 for more detailed discussion on trade ratios.

2.2.2.3 Step 3 — Awarding Credits to Dischargers — The "Trade"

Once authority pool projects have been approved, and the authority — with the WQCD's consultation — has determined the pounds removed, trade ratio, and discharge credits for the trading pool, qualifying dischargers in the watershed may apply to authority to purchase a specified number of credits from the trading pool. Prospective purchasers of credits from the trading pool must satisfy several criteria, including a demonstrated need for the credits, compliance with effluent limitations, optimal wastewater treatment plant operations, and consistency with the master plan and control regulation.

Need. The concept of "need" by prospective purchasers is critical to the program, because it ensures that dischargers do not hoard credits and that only those facilities that need the credits from the collective trading pool receive the credits. To demonstrate need dischargers must establish satisfaction of the following criteria:

- Treated wastewater flows at the discharger's treatment facility must be approximately 70% of the wastewater treatment facility's design capacity;
- The discharger's phosphorus WLA must be insufficient to accommodate near term treated wastewater flows from the facility's expansion;
- The discharger's plans for facility expansion must be reasonable given current facility size, forecasts of population and employment in their service area, the proposed size of the incremental expansion, and timing of need and schedule for completion of new or expanded facilities; and
- The amount of discharge credits to be purchased must be reasonable and appropriate given the discharger's plans for facility expansion or operations, the discharger's current WLA, the actual and anticipated growth of other dischargers in the watershed, and the conditions of the reservoir and watershed.

Prices for Discharge Credits. The authority may establish prices for discharge credits from the trading pool based upon the following factors enumerated in the guidelines:

- The costs of authority-funded PRFs, including past development and capital costs; operating, monitoring and maintenance costs; and estimated future costs for construction and operation of new PRFs;
- The costs for the authority to establish, administer and oversee the trading program; and
- Dischargers' participation in the authority and contributions to authority-funded PRFs.

The authority may establish two levels of prices for discharge credits, one price for authority members and a second price, including a surcharge, for non-members.

Discharge Permits. Dischargers who are awarded trade credits in the trading program must secure appropriate modifications of their National Pollutant Discharge Elimination System (NPDES) permit limits from the WQCD *before* discharging the increased phosphorus allocated to them from the trading pool. No discharge based upon the award of phosphorus discharge credits from the trading program is permitted until the subject discharge permit is amended or issued, as appropriate, by the WQCD.

2.2.2.4 *Step 4 — Reevaluation of Trade Projects*

Authority Oversight. The authority retains oversight over all aspects of the trading program, including trades, trade projects, trade ratios, and discharge credits. The authority may modify or revoke an approved trade (including trade project, trade ratio, and discharge credit) at any time, at its discretion. This would be based on monitoring or modeling data, modifications or changes in PRFs, noncompliance with the guidelines, noncompliance with conditions imposed by the authority, inconsistency with the master plan or the control regulation, modifications of the trading program or any other significant change in circumstances.

Trade Credit Adjustments. Approved trade credits from a PRF remain contingent upon the continued effectiveness of the PRF, and project owners must operate and maintain projects into the future. Every three to five years the authority will reevaluate all approved trade projects, including estimates of phosphorus removals at each project, the basis for credits, and designated trade ratio. If the authority determines — after reviewing data or other information concerning an approved trade project — that the project is not removing as much phosphorus as projected in the trade approval, the authority may make appropriate downward adjustments to trade credits and/or trade ratio for the project.

If the PRF is an authority pool project, the authority will first reduce untransferred credits in the trading pool. If there are insufficient untransferred credits remaining in the trading pool to account for the decrease, the authority will notify all holders of transferred credits that *pro rata* decreases of their credits will be made unless, within three years, additional authority pool projects (and credits) are included in the trading pool to compensate for the proposed reductions. If after three years there remain insufficient credits in the trading pool for the necessary decrease, the authority will rescind and eliminate transferred credits on a *pro rata* basis.

CHAPTER 3.0

TECHNICAL BASIS FOR TRADING

3.1 Introduction

This section documents the technical basis for the watershed-based trading program. There were three objectives addressed in the development of this program:

- Develop a scientific methodology for determining trading ratios;
- Demonstrate the net impacts of trading on phosphorus loading to the reservoir; and
- Provide a framework for future tracking of water quality impacts associated with the trading program, through monitoring and data analysis.

The following provides an overview of existing PRFs, water quality monitoring of the facilities, and the technical basis for trading ratios to be applied to phosphorus removed by the facilities.

3.2 Controls To Reduce Watershed Loadings

A wide range of controls is applied to reduce pollutant loadings from nonpoint sources (NPS) within the watershed. As a first level of control, best management practices (BMPs) are applied throughout the watershed, both during construction and on a permanent basis. In addition, the authority has implemented PRFs that go beyond baseline BMPs to further reduce pollutant loadings. The pollutant reductions associated with the PRFs have been incorporated into a watershed-based trading program within the watershed (CCBWQA, 1997).

3.2.1 Baseline Best Management Practices

The concept of baseline BMPs has been discussed by many in the U.S. In general, baseline BMPs are controls that are required to be implemented when an area of land is used for a specific activity (e.g., industry, commerce, residences, agriculture, open space), regardless of the anticipated water quality benefit. A simple analogy is the technology-based controls, e.g., secondary treatment, that are required for point source dischargers under the Clean Water Act and implemented through the National Pollutant Discharge Elimination System (NPDES) program (CCBWQA, 1997).

The authority is coordinating with land use agencies in the watershed to facilitate more consistent review of development plans, to achieve more uniform BMP requirements among jurisdictions, and to develop strategies that will better ensure that BMPs are implemented and properly maintained. The authority is spearheading, with local entities, a Land Use and Storm

Drainage Quality Committee, which has drafted new BMP guidelines (Stormwater Quality Regulation, 1998).

3.2.1.1 Definition of Baseline

Baseline BMPs include temporary measures primarily implemented to arrest and mitigate construction runoff (such as filter fences, hay bales, and revegetation) and permanent water quality improvements required by drainage criteria and land use regulations for all new development (such as detention ponds, swales, and construction wetlands) (Authority, 1998a). They can be single or a series of facilities, which are considered minimum practices to achieve the goals of the master plan and the TMDL.

3.2.1.2 Baseline BMP Performance Goals and Objectives

The goal for baseline BMPs is to minimize pollutant generation at the source and/or detain pollution on site. Baseline BMPs for the watershed are practices that have proven effective in the Denver-metropolitan area and for which design criteria and standards have been prepared (CCBWQA, 1997).

The authority will evaluate each BMP, in part, on following minimum requirement that the BMP must be sized to capture and treat the 80th percentile storm event (in accordance with Urban Drainage and Flood Control District's (UDFCD) Manual, Volume 3).

Individual BMP performances may be measured to establish or confirm design requirements and removal efficiencies. However, literature values on performance will be relied upon most often for determining baseline BMP effectiveness (CCBWQA, 1997).

3.2.2 Pollutant Reduction Facilities

PRFs are acceptable mechanisms that provide nonpoint/stormwater pollutant reductions beyond the removals attained by the baseline BMPs.

3.2.2.1 Characteristics of PRFs

PRFs can be a single facility or a series of facilities, including the following:

- ♦ Detention/retention facilities:
  - — A facility that provides for extended detention of captured runoff (drain time of 12 hours or more of upstream water quality capture volume, as defined in the UDFCD's Volume 3);
  - — A facility that provides a permanent pool with a surface area greater than 0.1 acre; or
  - — A facility that provides a constructed wetland with a surface area greater than 0.1 acre.
- ♦ Other facilities or practices:
  - — A structure that stabilizes an existing erosion problem area and prevents future erosion along streambanks or the reservoir's shoreline;
  - — Property used to maintain a buffer for environmentally sensitive areas;
  - — Active participation in management of specific floodplain areas through cooperative agreements with landowners; or
  - — New practices, developed as techniques for managing NPS evolve (CCBWQA, 1998b).

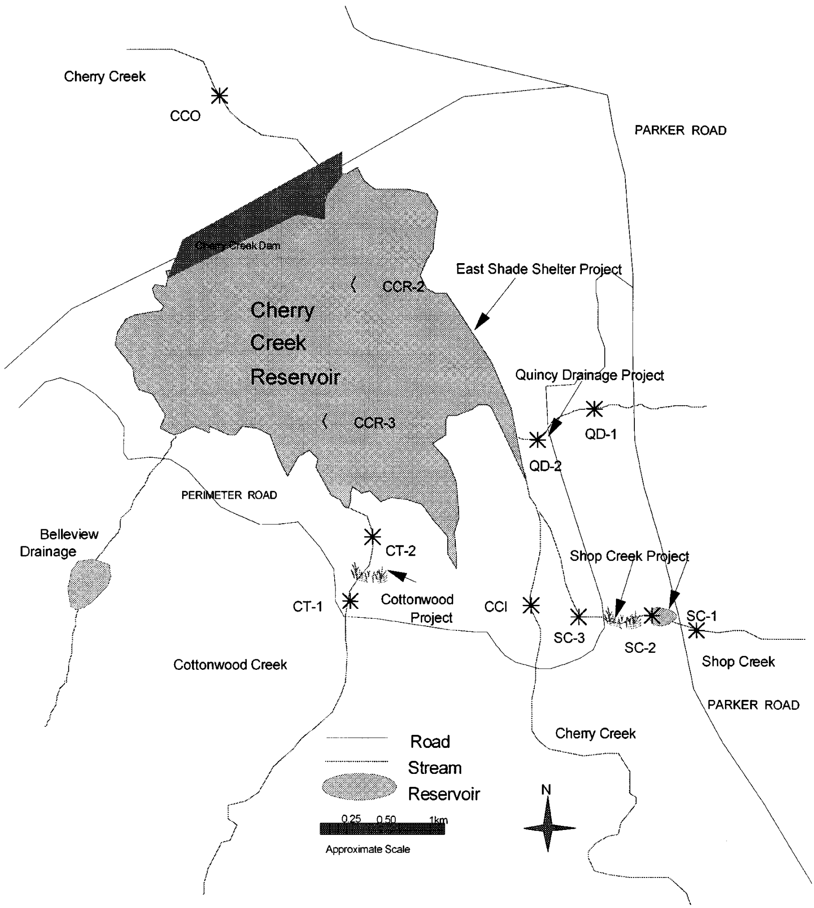
3.2.2.2 *Description of Existing PRFs*

Pollutant reducing facilities were categorized in two tiers. Tier 1 facilities consist of PRFs designed and constructed to remove pollutants adjacent to the reservoir where monitoring data have been collected. Tier 1 could include other facilities as determined by the authority in the future. The authority funded Tier 1 facilities in part or in whole. Tier 2 facilities consist of constructed PRFs located upstream in the watershed, frequently constructed for stormwater retention or other purposes which act to remove pollutants. Tier 2 facilities have been constructed generally by developers or entities other than the authority.

The authority has constructed and is operating, maintaining, and monitoring four major PRFs (Tier 1) in the watershed, as shown on Figure 3-1: Shop Creek (1990) retention pond and wetlands, Quincy Outfall (1996) extended detention facility, Cottonwood Creek (1997) retention pond and wetlands, and East Shade Shelter Shoreline Stabilization project (1996). These initial PRFs, which are described in Table 3-1 and depicted on Figures 3-2 through 3-5, will be included in Phase I of the trading program.

Table 3-1. Description of Cherry Creek Basin Water Quality Authority Pollutant Reduction Facilities

Location/Name	PRF Type	Drainage Basin Area (acres)	Water Quality Capture Volume (acre-feet)
Shop Creek[a]	Retention pond followed by 7 wetlands in series	520	9.1
Cottonwood Creek[a]	Retention pond followed by a single wetland	7,500	22.0
Quincy Drainage[a]	Extended detention pond	530	8.8
East Shade Shelter	Shoreline stabilization	400 lineal feet stabilized	N/A



Pollutant Reduction Facilities (PRFs) at Cherry Creek Reservoir

Figure 3-1. The Location of Pollutant Reduction Facilities and Monitoring Locations Within Cherry Creek Reservoir Watershed.

Figure 3-2. A View of One of Seven Wetland Ponds at the Shop Creek Pollutant Reduction Facility (July 1997).

Figure 3-3. A View of the First Year Seedlings Planted in the Wetland of the Cottonwood Creek Pollutant Reduction Facility (July 1997).

Figure 3-4. A View of Quincy Drainage Pollutant Reduction Facility (July 1997).

Figure 3-5. The East Shade Shelter Shoreline Stabilization Pollutant Reduction Facility (July 1997).

The four PRF projects provide a number of benefits, including detaining and filtering baseflows and stormflows, stabilizing stream corridors and reservoir shoreline, and enhancing the riparian zone with wetlands. The Tier 1 facilities removed a total of 2,716 pounds of phosphorus in 1997 and 1,333 pounds in 1998.

Prior to constructing these projects, the authority estimated phosphorus removal efficiencies. Since construction the authority has regularly monitored the projects to determine actual removal rates. The authority will continue to track these facilities to verify phosphorus and other pollutant removal capabilities.

Tier 2 facilities were identified based on interviews with staff from each land use jurisdiction in the watershed. Staff from Arapahoe County, Douglas County, the Town of Parker, and the Cities of Aurora, Castle Rock, and Greenwood Village each identified the Tier 2 facilities of which they were aware. A total of 35 Tier 2 PRFs were identified. The identified PRFs were in the Cherry Creek, Cottonwood Creek, and direct flow drainage areas. The Tier 2 PRFs exist within five of the six land-use jurisdictions.

Other PRFs may exist in the watershed of which the interviewed staff was not aware. If additional PRFs are identified in the future, or if other PRFs are constructed, it is recommended that they be added to this inventory. Facilities in the watershed such as ponds and natural wetland areas, even though not constructed as pollutant reducing facilities, may actually provide water quality benefits; these could also be added to the inventory in the future.

3.2.2.3 Tier 1 PRFs — Current Trading Program

Four Tier 1 PRFs are described in detail as follows.

1. ***Shop Creek Retention Pond and Wetlands.*** The purpose of the Shop Creek PRF (Figure 3-2) is to slow stormflows and baseflows from its 520-acre drainage area, allowing suspended particles to settle out. As a result, phosphorus, which is adsorbed to the suspended sediment, is also removed from the water column. The series of seven wetland ponds that follows the initial retention pond at Shop Creek further controls and polishes flows and allows for infiltration to groundwater. At times, according to the natural processes that occur in wetlands, phosphorus is removed from the water column as it moves through the wetland system. At other times, phosphorus can be added. While this cyclical phenomenon has been documented for individual sampling events, the Shop Creek PRF has always shown an annual net removal of phosphorus.
2. ***Cottonwood Creek Retention Pond and Wetlands.*** The Cottonwood Creek PRF (Figure 3-3) is essentially the same type of facility as the Shop Creek PRF with the purpose of slowing stormflows and baseflows. However, the initial retention basin for the Cottonwood Creek PRF is much larger than the Shop Creek facility's initial retention basin, to accommodate the additional runoff volume that results from its much larger drainage area — 7,500 acres. A second modification from the Shop Creek design is that the Cottonwood Creek PRF is followed only by a single wetland for polishing due to its proximity to the Reservoir.
3. ***Quincy Drainage Extended Detention Facility.*** The purpose of the Quincy Drainage PRF (Figure 3-4) is to contain baseflows and slow stormflows by allowing rapid infiltration into the sandy soils at the terminus of this 530-acre drainage. Captured runoff quickly infiltrates into the sandy alluvium when it is detained behind the downstream berm at the Quincy facility. Native grasses that are typical of a semi-arid climate populate the pond. Typically, no surface flow exits the Quincy Drainage PRF during baseflow conditions. Existing data is very limited for outflow even during precipitation/runoff events.
4. ***East Shade Shelter Shoreline Stabilization Project.*** The East Shade Shelter PRF (Figure 3-5) differs from the other three PRFs in its design and purpose. The East Shade Shelter PRF was constructed as a demonstration project to determine the effectiveness of shoreline stabilization projects. The project is on the reservoir shore immediately adjacent to a covered picnic area within the Cherry Creek State Park. Adjacent to the picnic area is a paved parking lot that has historically drained directly into the reservoir.

The constructed improvements of the East Shade Shelter PRF are compatible with a 400-foot length of picnic shelters. The improvements involved controlling pedestrian access, rerouting erosive storm drainage, grading the steep bank, and stabilizing the toe of the bank with a rock toe and willow plantings. A pedestrian ramp and two sets of steps were installed to direct users down the slope to a new rock path along the water's edge. The lower portion of the bank was heavily vegetated with willow and cottonwood plantings, and parking lot runoff was directed into shallow infiltration basins for water quality enhancement prior to release of the runoff water to the lake. Turfgrass sod was installed adjacent to the picnic areas to rehabilitate the existing sparse grass cover.

The East Shade Shelter PRF improvements have provided for water quality enhancement by repairing existing bank erosion, controlling pedestrian access, and infiltrating parking lot runoff. In addition, the improvements created an amenity for park users.

In summary, the four PRF projects provide a number of benefits, including detaining and filtering baseflows and stormflows, stabilizing the stream corridor, and enhancing the riparian zone with wetlands.

3.3 Existing Monitoring

Flow and water quality monitoring of the PRFs is performed both above and below the facilities in order to calculate removals.

The chemical parameters included in the water quality monitoring program for the PRFs in 1997 included total suspended solids (with volatile solids) and total phosphorus.

Monthly baseflow monitoring is performed, as well as stormflow monitoring, from April through October, at the sites described in Table 3-2 and illustrated on Figure 3-1. Table 3-2 describes the minimum monitoring frequency for the PRFs.

Table 3-2. Description of Cherry Creek Basin Water Quality Authority Monitoring of Pollutant Reduction Facilities

PRF	Monitoring Station[a]	Description	Minimum Frequency	
			Base-flow	Storm-flow
Shop Creek	SC-1	Immediately east of Parker Road on Shop Creek upstream of the storm water detention pond system to monitor water quality upstream of the Shop Creek PRF	monthly	3
	SC-2	At the outlet for the Shop Creek detention pond to monitor the effects of the detention pond on water quality	monthly	3
	SC-3	Downstream from the Shop Creek PRF and from the Cherry Creek Park perimeter road to monitor the PRF's effectiveness and the water quality of Shop Creek as it joins the Cherry Canal	monthly	3
Cottonwood Creek	CT-1	On Cottonwood Creek where the Cherry Creek Park perimeter road crosses the stream and monitors the water quality of Cottonwood Creek before it enters the reservoir	monthly	3
	CT-2	On the walkway bridge downstream from the Cherry Creek Park perimeter road	monthly	3
Quincy Drainage	QD-1	On Quincy Drainage, above the perimeter road wetlands, downstream of the outlet for the Quincy Road drain.	monthly	3
	QD-2	On Quincy Drainage at the outlet to the Quincy PRF in order to allow the PRF's effectiveness to be measured	monthly	3
East Shade Shelter Stabilization	Shoreline	Located on the eastern shore of Cherry Creek Reservoir by the East Shade Shelter	monthly [b]	n/a[b]

[a]These monitoring stations are shown on Figure 3-1.
[b]The East Shade Shelter is a shoreline stabilization structure that is located directly on the reservoir. Traditional monthly monitoring is therefore inappropriate. However, visual inspections of the facility occur on a monthly basis. The results of these inspections are recorded and kept with the other PRF effectiveness data.

3.4 Removal Effectiveness

For the Tier 1 PRFs, estimates were prepared of total suspended solids (TSS) and total phosphorus (TP) removals for each PRF. These estimates are intended to represent average annual removals over a number of years, recognizing that removals in any given year will vary and could be higher or lower than the average estimates, depending on hydrologic factors and watershed conditions. The estimates were prepared based on available data, and were supplemented with an empirical evaluation where data were limited. These estimates, intended to provide an initial quantification of removals associated with the PRFs, are generally on the conservative (low) side and are to be reassessed over time as more data are obtained.

3.4.1 Evaluation of Existing Monitoring Data

Flow, TSS and TP load data collected for Shop Creek, the Quincy Outfall, and Cottonwood Creek were evaluated. The raw data were examined and analyzed as the basis of preparing removal estimates for the PRFs, as opposed to using summaries of data or performance results provided by the authority's annual reports or monitoring summaries. Data collected included continuous flow measurements and periodic water quality samples for base flow conditions and discrete storm events. Inflow and outflow measurements and water quality samples were evaluated for the Shop Creek and Quincy Outfall PRFs. Only inflow measurements and samples were examined for the Cottonwood Creek PRF, since it was just constructed in December 1996. The monitoring period evaluated consisted of the following:

- Shop Creek — 1990, 1991, 1992, 1995, 1996;
- Quincy Outfall — 1996; and
- Cottonwood Creek — 1994, 1995, 1996

3.4.2 Percent Removal Estimation Procedure

Several steps were involved in determining the removal effectiveness of each of the PRFs. These steps are outlined below.

3.4.2.1 Initial Steps

The method of estimating loads entering and leaving the PRF is based on the following steps. More detailed discussion of this method can be found in *Cherry Creek Reservoir 1996 Studies* (CEC, 1997).

1. The influent and effluent to and from the PRF are measured for TP and flow rates.
2. A regression is established between the flow and TP concentrations. In an effort to improve the regression, flows may be grouped into stormflow and baseflow conditions. It should be determined whether or not this improves the predictive power of the equation. In the case of the Cherry Creek Basin PRFs, an improvement did not occur, so a single equation was used.
   If the regression equation is not statistically significant, the average concentration is used as a single estimate of quality.
3. For the period of interest (i.e., annual, seasonal, etc.), each daily average flow rate is used to estimate a TP concentration. With the flow rate and concentration, a daily load is calculated.
4. These daily loads are added to create an estimate of the annual loads entering and leaving the facilities. For periods when flows are not measured, these loads must be estimated. Chadwick Ecological estimated this unmonitored load as the portion of the baseflow load in relation to the precipitation that fell during the unmonitored period with respect to annual precipitation. Consideration was also given to the pattern of the loads observed during similar periods on either end of the unmonitored period.
5. The phosphorus-to-flow rate regression equation is reevaluated annually as additional monitoring data are collected.

As an example the following equations and loads were derived for Shop Creek Sites 1 (SC-1) and 3 (SC-3).

Shop Creek 1 ln(Pcon) (mg/L) = ln(Q(ft^3/sec)*0.296-1.672)
Shop Creek 3 ln(Pcon) (mg/L) = ln(Q(ft^3/sec)*0.286-2.048)

On October 1, 1995, 0.55 cubic feet per second (cfs) was measured at SC-1. Using the equation above, a concentration estimate of 0.157 milligrams per liter (mg/L) was made. With the concentration and a flow rate, the load is estimated at 0.467 pounds per day (lbs/day). On the same day, at site SC-3, a flow of 0.53 cfs was measured. Using the second equation, a concentration of 0.102 mg/L was estimated. With the flow value, the daily load was estimated to be 0.292 lbs/day.

3.4.2.2 Removal Efficiency Estimation

Removal efficiency is calculated as using the following equation: % Efficiency = (Load Entering PRF – Load Leaving PRF)/ Load Entering PRF

This was done using annual data. As an example, the following data were used to estimate the efficiency of the Shop Creek Facility.

Year	SC-1	SC-2	SC-3	Load Removed	% Reduction
1994	515	176	87	428	83%
1995	371	163	158	213	57%
1996	300	210	105	195	65%
Average	395	183	117	279	69%

Note: SC-1, SC-2, and SC-3 are Shop Creek sampling locations. See Figure 3-1 for the location.

This information is used subsequently in the estimation of the variability of the facilities from year to year.

3.5 Trading Ratios

A trading ratio specifies how many units of pollutant reduction a source must remove to receive credit for one unit of load reduction. Trade ratios are established for each PRF on a project-specific basis from 1.3:1 to 3:1, meaning that for every 1.3 to 3 pounds of phosphorus removed by a PRF, one phosphorus wasteload allocation pound — discharge credit — is available through trading for point source discharge. A ratio of 1:1 indicates an equal exchange between sources, generally a ratio greater than 1:1 will account for uncertainty, variability, and an additional margin of safety.

3.5.1 U.S. EPA's Perspective on Trading Ratios

U.S. EPA's *Draft Framework for Watershed-Based Trading* (U.S. EPA, 1996), which was intended as a conceptual guide to developing a trading program, states several reasons for using a trading ratio other than 1:1. These reasons include the desire to provide a margin of safety that accounts for institutional uncertainty and scientific uncertainty, and the desire for a reduction of net loading.

According to the U.S. EPA framework, a ratio of 2:1 could incorporate a margin of safety for NPS reductions that have greater uncertainty associated with them as compared to the uncertainty associated with phosphorus reductions from a point source discharger. It could also account for uncertainties about other factors mentioned in the U.S. EPA framework, such as differences in source location within the watershed, timing of pollutant load reductions, and/or the chemistry of pollutant loadings that may be traded.

The U.S. EPA framework suggests that a ratio of 3:1 could implement a net pollutant load reduction strategy, as well as a margin of safety. The three units of reduction traded for one unit of credit could be considered as follows: the first goes toward the credit; the second provides a margin of safety for NPS source reductions that have greater uncertainty associated with them than with phosphorus reductions from a point source discharger; and the third provides greater net loading reductions (U.S. EPA, 1996).

The U.S. EPA framework acknowledges that selection of the most appropriate factors to be incorporated into a trading ratio and refinement of trading ratios will vary according to the site-specific situation. The next section describes the site-specific approach used to quantify trading ratios in the trading program (CCBWQA, 1997).

3.5.2 Basis for Ratios Used in the Cherry Creek Trading Program

Developing the basis for ratios used in the trading program was a challenging task. Significant monitoring data was required to document phosphorus removed by pollutant reduction facilities. Each trading program PRF has a distinct trading ratio, based on consideration of the following factors: institutional uncertainty, scientific uncertainty, net loading reduction, and an additional margin of safety. The range of ratios provides enough flexibility so that the authority may assign lower ratios to more established, stable projects but higher ratios for projects that exhibit greater technical or institutional uncertainty. These considerations are described in detail in the sections below followed by an example calculation for the Shop Creek PRF.

3.5.2.1 Institutional Uncertainty

Institutional uncertainty is a function of the confidence that parties involved in the trading program have in the stability and capabilities of the coordinating entity. The institutional issues considered for the trading program include the following:

- Stability of the institutional framework that supports the trading program;
- Reliability of PRF operations and maintenance; and
- Extent and sufficiency of existing BMPs for development served by the PRF and controls during construction of the PRF.

The authority is a stable organization and has a long-term commitment to a trading program within the watershed, as well as the effective operation of baseline BMPs and PRFs. Therefore, there will be little or no institutional uncertainty associated with the trading program (i.e., institutional uncertainty trading ratio factor of 1.0). When PRFs not owned and operated by the authority are proposed for inclusion in the trading program, this factor will likely be increased to reflect the greater uncertainty associated with a third party.

3.5.2.2 Scientific Uncertainty

Scientific uncertainty addresses the question of whether a specific PRF will, in fact, remove the amount of phosphorus loading from NPS (in pounds per year) that are being traded for point source loadings. To answer this question it is necessary to characterize the variability of system function from year-to-year. Scientific uncertainty about a PRF can also be a function of what is unknown about the PRF because of data limitations, the additional time that may be required for the system to function optimally, and how the location of a PRF in the watershed may impact water quality in the reservoir.

For the Cherry Creek trading program, these issues have been characterized in a *variability factor* and a *best professional judgment (BPJ) factor*. The approach to determining these two factors is a function of the design and type of PRF being characterized.

The Variability Factor. The variability factor accounts for variability of phosphorus loading into the PRF and variability of phosphorus removal effectiveness. It has been set equal to the ratio between the average annual and the lower 95th percentile value of pounds of TP removed by the PRF. Application of the variability factor provides 95 percent certainty that the pounds being removed by the PRFs in a given year are as much or more than estimated. The method for calculating the variability factor is as follows:

1. Determine the distribution of phosphorus loading (pounds) into the system.
2. Determine the distribution of annual phosphorus removal efficiency by the system.
3. Combine these distributions to create a joint distribution of the total pounds of phosphorus removed each year.

   Technical Note — To combine the average and the distribution of the incoming loads and the removal efficiencies, a simulation program was used. @Risk is a simulation program that operates within an Excel spreadsheet. It allows the user to enter a value and distribution as input. Mathematical operations are detailed using the input cells. A large number of simulations are performed. For each simulation the program randomly selects values based upon each distribution and calculates an output value. The distribution of the output values may then be examined. In this fashion the effects of the variability of the incoming loads and system efficiency are accounted for in the distribution of the annual loads of phosphorus removed.

   To better reflect the reality of the system, limits were placed upon the incoming parameters: incoming loads cannot be less than zero, and efficiency cannot be greater than 100 percent. To view the response of the reservoir over a longer time period, a three-year average was examined. Using the information from above, 1,000 simulations were performed to create an output distribution for each of the three PRFs being studied.

4. Determine the average and the lower 95th percentile confidence interval value for the joint distribution curve.
5. Divide the average annual phosphorus load removed by the lower 95th percentile value. This number is the variability factor.

$$\textit{Variability Factor} = \frac{\textit{Average Annual Pounds of Total Phosphorus Removed}}{\textit{Lower 95th Percentile Value of Pounds of Total Phosphorus Removed}}$$

It is important to note that use of the lower 95th percentile value is relatively conservative. It means that 95 percent of the time the PRF will be removing at least the specified poundage of TP. Generally, the PRF will be removing much more than the lower 95th percentile value (CCBWQA, 1997).

This methodology requires the following general assumptions:

- ♦ The load of phosphorus removed is a function of the amount (expressed as a weight) of phosphorus entering the system and the efficiency of the system in reducing that load.
- ♦ An average value and an assumed normal distribution of the loads entering the system can be used to describe incoming loads (U.S. EPA, 1986).
- ♦ Both the loads entering the system and the removal efficiency of the system will vary from year-to-year and these factors function independently.

- To the best of our knowledge, uncertainty contains random errors (not biases); the system is as likely to underestimate loads as to overestimate loads. In time these values will average out. If one were to apply the uncertainty reductions to loads before applying removal efficiencies to them, the loads removed would most likely represent a very small fraction of the loads actually removed.
- A PRF and its drainage basin are relatively mature with respect to removal effectiveness and area development. Provided the system is maintained, the loads entering and removed by the system will remain relatively stable over time. (Note: uncertainties caused by the immaturity of a PRF and its watershed are accounted for as part of the BPJ Factor.)
- The efficiencies of a PRF and input load estimates follow a normal distribution.
- The infiltration of flow and phosphorus to groundwater that results because of detention within PRFs is assumed to result in 100 percent effective removal of that phosphorus from the Cherry Creek Reservoir watershed. The authority will monitor to assess the validity of this assumption.

BPJ Factor. There are several areas to consider in the BPJ factor such as: (1) data limits and assumptions, (2) establishment of the PRF, (3) equivalence, (4) timing of pollutant load reductions, and (5) chemistry of pollutant loads that may be traded. Each area will be discussed briefly below.

Data Limits and Assumptions. Normally, when calculating uncertainty, a system with little data would have wider confidence intervals and thus a larger variability factor. However, the variability for three of the PRFs for Phase I was calculated using data from Shop Creek to help extrapolate the shorter databases from the individual PRFs. The following assumptions were applied to the limited data from individual PRFs:

- For sites with only one year of data, the measured incoming load is considered to be equal to the average annual incoming load.
- The coefficient of variation (i.e., standard deviation divided by the average) of the incoming loads is the same for each site and is based on Shop Creek data.

To account for existing data limitations and assumptions, the BPJ factor includes a safety factor of 1.2 assigned to the Cottonwood, Quincy, and East Shade Shelter PRFs using BPJ.

Establishment of the PRF. Trading ratios are intended to represent the actual, long-term phosphorus removal by a PRF. Therefore, it is important to account for “noise” in the monitoring data collected at a PRF, which can be caused by the time required for vegetation to become established in a wetlands-type system. The establishment factor is intended to address this “noise”. PRFs that rely on established wetland vegetation for part of their removal efficiency (e.g., Shop Creek and Cottonwood) are believed to undergo an establishment period. The period is assumed to be at least one year until the newly planted vegetation establishes itself and the PRF functions at its intended level. Early data for the Shop Creek PRF indicate this period may be as long as two or three years when seeds are planted instead of a mix of seedlings and more mature plants. When seedlings and more mature plants are used, it is generally expected that wetlands will be functioning well within one to three years.

If there is no wetland in the system design or the wetland is more than one year old, the establishment value was set equal to 1.0. If the wetland system is less than one year old, the establishment value was set equal to 1.2. The magnitude of the establishment factor is based on the ratio of established performance shown by the Shop Creek PRF (i.e., from 1994 through

1996 when the Shop Creek PRF was considered to be "established") to its performance (i.e., from 1990 through 1992 when the Shop Creek PRF was not considered to be "established").

$$\text{Establishment Safety Factor for Immature Wetland Systems} = \frac{\text{Shop Creek PRF from 1994 through 1996}}{\text{Shop Creek PRF from 1990 through 1992}^{1}} = \frac{48\ \%}{41\ \%} = 1.17 \sim 1.2$$

[1]No data were collected in 1993.

Equivalence. Equivalence addresses the location of the PRF in the watershed relative to the receiving body or the reservoir. Currently, each of the PRFs proposed for use in the trading program are at the downstream end of their respective drainage basin, just before the water-body discharges to the reservoir. At this location any phosphorus removed from the system will directly reduce phosphorus loading to the reservoir so that no additional safety factor is required to address location. Pollutant load reductions and traded credits must be equivalent, or equal in spatial, temporal, and chemical terms. In the future, for PRFs that are established further from the reservoir, the BPJ Factor could be increased to account for phosphorus losses as water moves downstream through the watershed. This will be determined on a case-by-case basis.

Timing of Pollutant Load Reductions. The TMDL and trading program are based on annual pollutant loads. Therefore, the load reductions provided by the PRFs that are associated with both baseflows and stormflows will be equivalent to load increases for point sources for one year. Therefore, the NPS phosphorus trades with continuous point sources are considered equivalent from a timing perspective.

Chemistry of Pollutant Loads That May Be Traded. As water flows through detention/ retention/wetland-type PRFs, particulate phosphorus tends to settle out and dissolved phosphorus tends to pass through the system. In this way, dissolved phosphorus becomes the predominant phosphorus species leaving PRFs and some types of baseline BMPs. In addition, wastewater treatment plants discharge primarily the dissolved form of phosphorus in their effluents. The WQCD has expressed concern that since total dissolved phosphorus is more readily available than particulate phosphorus for algae uptake, such a shift could encourage algae growth.

To date, historic shifts in phosphorus forms within the reservoir have not been noted, even with increasing point source discharges and BMP and PRF implementation within the watershed. It is possible that other sources of sediment may continue to load the system and maintain a balance between particulate and dissolved phosphorus in the future. The authority is continuing to closely track the relationship between TP and dissolved phosphorus through its monitoring (CCBWQA, 1997).

3.5.2.3 Net Loading Reduction

U.S. EPA's framework states that increasing the trading ratio is one method of achieving a net loading reduction in the system where a trading program is being or has been established. The trading program will address net loading reduction in other ways within the watershed, rather than incorporating reductions into the trading ratio. With or without the trading program, the authority will continue to ensure that phosphorus loadings stay within the 14,270-pound limit set by the phosphorus TMDL established in 1985. In addition, the trading program will not result in any net increase of phosphorus loading to the reservoir. The estimation of pounds of phosphorus to be traded allows the authority to be at least 95 percent certain that they will achieve this goal during any given year. More likely, there will be net reductions in loading when the additional margins of safety are considered.

3.5.2.4 An Additional Margin of Safety

U.S. EPA guidance regularly states that a margin of safety is required for any calculations related to estimation of pollutant loads to a waterbody (U.S. EPA, 1991a; 1991b). However, U.S. EPA has no specific guidance concerning how a margin of safety must be determined. TMDL guidance specifies that a margin of safety is normally incorporated into the conservative assumptions used within calculations or models. Adding a margin of safety as a separate component, in addition to the use of conservative assumptions, can provide further assurances that water quality goals will be attained, but is not required (U.S. EPA, 1991a).

Other conditions within the watershed provide an additional margin of safety beyond that already included in trade ratios as listed below:

- Over 30 second tier, smaller PRFs are in place and operating but have not been included in the trading program. While phosphorus load reductions by these facilities has not been fully characterized, phosphorus load reductions has been estimated at approximately 150 pounds per year (CH2M Hill, 1997);
- Trading will not result in any exceedance of the TP TMDL, set at 14,270 pounds in 1985;
- The TMDL sets aside a reserve pool of approximately 300 pounds of phosphorus that provides an additional margin of safety; and
- Cherry Creek, its tributaries, and the reservoir will continue to be closely monitored to track water quality conditions to ensure that the reservoir remains healthy and continues to support designated uses.

3.5.3 Calculating Trading Ratios for Existing PRFs

The PRFs within the watershed were classified into three distinct categories so that the methodology described above could be applied to new PRFs according to their design. The categories are retention ponds and wetland systems, detention ponds, and shoreline stabilization structures.

The trading ratio calculation process will be discussed for the Shop Creek PRF. The other PRFs follow the same steps in calculating the trading ratio. Table 3-3 provides a complete summary of the trading ratio for each PRF, the value used for the factors used to develop the ratio, and the amount of TP that is proposed for use in the Cherry Creek trading program each year.

Table 3-3. Summary of Trading Ratios and Total Phosphorus Available for Trading

Pollutant Reduction Facility	Estimated Load Removed (lbs/yr)		Trading Ratio Components				Annual Pounds Available to Trade[d]
	Average	95th Percentile	Institutional Uncertainty[a]	Scientific Uncertainty[b]		Trading Ratio[c]	
				Variability Factor	BPJ Factor		
Shop Creek	261	190	1.0	1.4	1.0	1.4	186
Cottonwood Creek	517	245	1.0	2.1	1.4	3.0	172
Quincy Drainage	158	111	1.0	1.4	1.2	1.7	93
East Shade Shelter Stabilization[e]	(18)	(18)	1.0	1.5	1.2	1.8	10
Total	954	564					461

[a]Institutional Uncertainty is characterized by the *Institutional Factor*, which accounts for the reliability and stability of baseline BMPs and long-term operation and maintenance of PRFs. For facilities controlled by the authority, the factor is 1.0. For others, the factor will be determined on a case-by-case basis.
[b]Scientific Uncertainty is made up of the following two components, which are multiplied to characterize it.

The *Variability Factor* accounts for variability of phosphorus loads into the PRF and variability of phosphorus removal effectiveness and is calculated as = (Average Load Removed / 95th Percentile Load Removed).

The *BPJ factor* accounts for the following:
— New facilities where there is a limited data set for calculating input loads and efficiency, and for stabilization projects, where monitoring to assess performance is not possible;
— New facilities with wetlands or other treatment that require time to become established and therefore may not be performing optimally. It is based on the ratio of performance shown by the Shop Creek PRF from 1994 through 1996 (i.e., when the Shop Creek PRF was considered to be "established") to its performance from 1990 through 1992 (i.e., when the Shop Creek PRF was not considered to be "established".) = 48 %/41% = 1.17 ~ 1.2.
— The relative impact on reservoir water quality that a facility may have due to its location in the watershed. It is assumed that PRFs located closer to the reservoir will generally have a greater impact than PRFs located further away in the watershed. This factor is 1.0 for facilities within the immediate proximity of the reservoir. The other two factors are addressed outside of the trading ratio.
— The timing of pollutant load reductions (this issue is addressed outside of the trading ratio); and
— Shifts in the chemistry of pollutant loads (this issue is addressed outside of the trading ratio).

Scientific uncertainty = (variability factor * BPJ factor)
[c]Trading ratio = (institutional uncertainty * scientific uncertainty)
[d]Pounds per year available for trading = (average estimated load removed / trading ratio)
[e]The factors associated with this PRF are based on BPJ. The loads removed were estimated based on the potential for erosion and the concentration of phosphorus associated with the sediments.

Retention Pond and Wetland Systems — Shop Creek PRF. Figure 3-6 illustrates the data collected at Shop Creek from 1994 through 1996, which represent the stable or mature period for this system. The data are snapshots of the system's behavior. Although removal efficiencies of the Shop Creek PRF are not clearly related to flow, higher flows do tend to show higher phosphorus removals. Removal efficiencies vary greatly at the lowest flows. Figure 3-6 also illustrates that, at times, the Shop Creek PRF exports phosphorus, due to the natural cycling of nutrients in its wetlands. When summed over a year, however, the system consistently shows a net reduction of phosphorus loading. Figure 3-6 illustrates the importance of including both baseflow and stormflow removals in the analysis of PRF effectiveness, by showing the efficiency of the system under a variety of flow regimes.

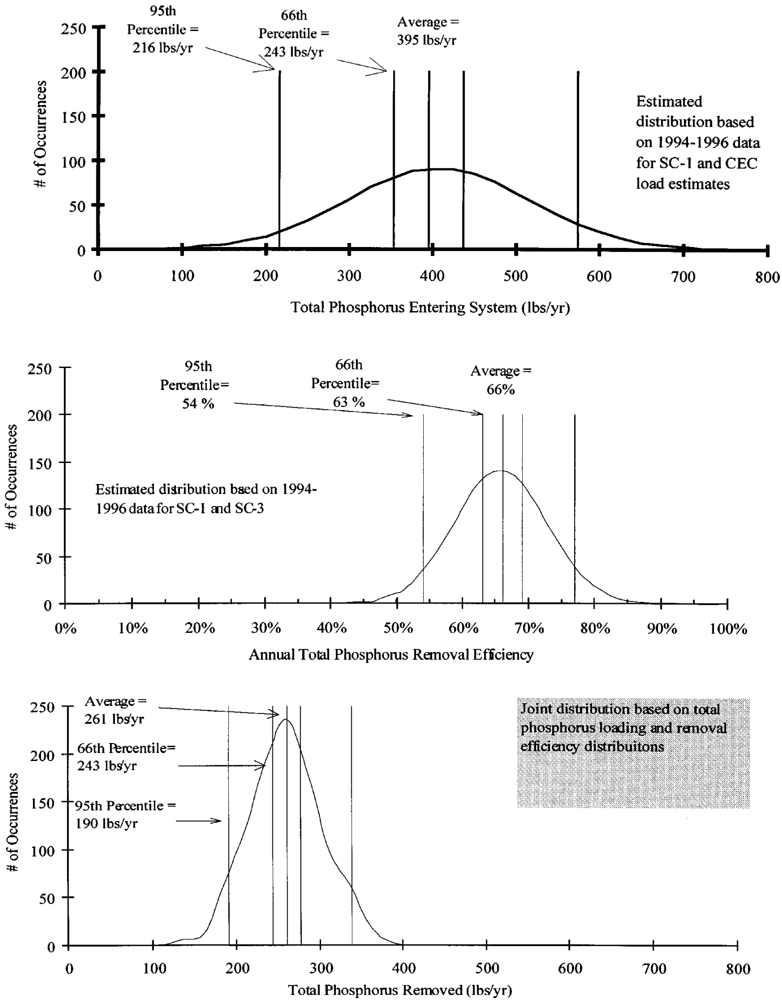


Figure 3-6. Basis for Determining the Variability Factor for Pounds Per Year of Total Annual Phosphorus Removed by the Shop Creek Pollutant Removal Facility.

Variability Factor. Recent Shop Creek data (1994 through 1996), representing stable conditions within the drainage basin and for facility effectiveness, were applied to determine the distributions of phosphorus loading (pounds) into the system and annual phosphorus removal efficiency by the system. These distributions were then combined to create a joint distribution of the number of occurrences of total pounds of phosphorus removed each year (Figure 3-6). The resulting distribution indicates an average TP removal of 261 pounds per year (lbs/yr) and a lower 95th percentile removal of 190 lbs/yr. The variability factor or ratio of the average to lower 95th percentile values is 1.37, rounded to 1.4.

BPJ Factor. The BPJ factor for the Shop Creek facility is equal to 1.0. This reflects the extensive database available for the site, its mature conditions, and proximity to the reservoir, as described below.

Trading Ratio. The trading ratio for the Shop Creek PRF is 1.4:1. This translates to a conservative value of 186 pounds of TP per year available for trading, which is only 70 percent of the estimated average of 261 pounds of TP removed per year.

3.5.4 Overview of Trade Ratios

Table 3-3 summarizes the factors that are accounted for when determining trading ratios for the four PRFs currently included within Phase I of the authority's trading program. The trading ratios determined for the four PRFs for Phase I range from 1.4 through 3.0. Based on the trading ratio and the average phosphorus load removal in pounds per year, 461 pounds of TP were determined to be available for use in the Cherry Creek trading program. This estimate includes a number of safety factors, as documented above.

CHAPTER 4.0

ECONOMIC BASIS FOR TRADING

4.1 Introduction

This chapter details the economic basis for trading in the Cherry Creek demonstration project and presents the economic analytical framework that Cherry Creek applied in evaluating and developing the economic and financial elements of its program. Economic implementation mechanisms include such things as credit pricing and administrative and transaction costs. Economic issues also interface with — and, in fact, often are significantly influenced by — technical and non-technical elements, including trading ratios, perceptions of equity and fairness, trading rules, and other endogenous and exogenous factors that define the political, financial, regulatory, and scientific framework in which trading takes place.

Economic issues, in tandem with water quality issues, are the reason why dischargers in Cherry Creek initially investigated trading opportunities. Stakeholders were looking for ways to cost-effectively meet the TMDL for the basin. Developing a strategy that would address nonpoint sources of pollution that otherwise would remain unaddressed, while at the same time alleviating pressure on point sources to make significant investment for small incremental gains, was critical to crafting an environmentally successful watershed management program for the basin.

4.2 An Overview of the Authority's Financial Structure

To date, the authority has paid for PRFs out of its general revenues. It has not issued debt to fund PRFs, nor has it issued any type of special assessment. The totals cost of each of the four PRFs in operation ranged from $125,000 to $668,000 and have annual operation, maintenance, and monitoring (OM&M) expenses ranging from $7,250 to $38,000. Together, the four PRFs represent a capital investment of $1.36 million and an ongoing operation and maintenance (O&M) expense of about $80,000 per year. PRF costs and expenses are discussed in more detail in Section 4.4.

4.2.1 Revenues and Sources

The authority is a quasi-municipal corporation and political subdivision of the State (Section 25-8.5-101 et seq., CRS). It is empowered to levy a limited tax on watershed residents, charge recreationists using the reservoir, and collect fees from wastewater treatment facilities and nonpoint sources. Historically, the authority has generated revenue through the following fees, charges, and taxes (rates are provided in parentheses for selected sources):

- Wastewater surcharges ($0.05/1000 g);
- Property taxes;
- Recreation fees ($1 per car);
- Disturbed land fees;
- Building permit fees ($50 sfr, $0.03/sq ft);
- Specific ownership taxes;
- Grading fees ($280 acre);
- Interest income; and
- Miscellaneous income.

As shown in Figure 4-1, from 1995 through 1998 the majority of the authority's revenues were generated by property taxes (46.1 percent). Other significant sources of revenue include building permit fees and recreation fees as well as wastewater surcharges, specific ownership taxes, and interest income. Total annual revenues have steadily increased from $759,000 in 1995 to $1.0 million in 1998.

(Note: Figure adds up to 99.8% due to rounding error.)

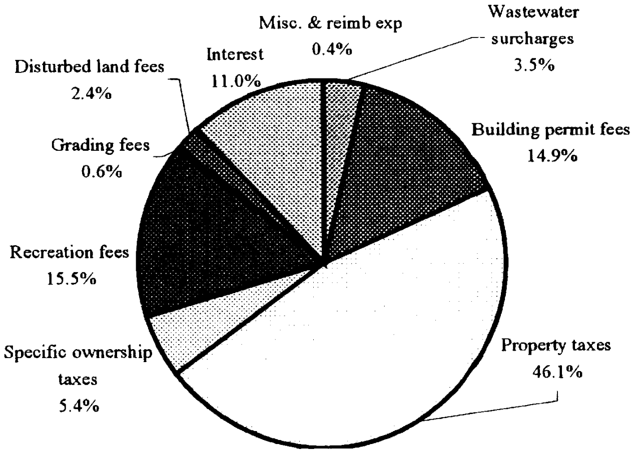


Figure 4-1. Total Revenues, 1995-1998.

In summary, the authority's revenues are subject to some fluctuation but are generally trending up, consistent with growth and development in the region. This is expected since many of the revenue sources are based on units that generate income in direct proportion to development (e.g., flow, property taxes, building permits, and grading fees).

4.2.2 Expenditures and Obligations

The authority's expenditures are driven primarily by the desire to preserve water quality in the reservoir and watershed. Some management activities are related to regulatory and planning requirements, including TMDL development and implementation, master planning, master plan implementation, and water quality monitoring. Other expenditures are voluntary and related to the trading program or other activities designed to maintain or enhance the environmental benefits the reservoir provides. For example, in 1998, the authority spent about 20 percent of its budget on master plan activities, about 25 percent on monitoring, about 10 percent on stormwater planning and implementation, and about five percent on nonpoint source projects, interpretive signage, publications, and other public outreach efforts. To date, the authority has operated exclusively on a pay-as-you-go basis — it does not incur debt to finance its activities, although it has occasionally transferred surplus monies in one year to reserve accounts for use in future years.

4.3 Non-Trading Phosphorus Reduction Options

An examination of opportunities for trading — from an economic perspective — typically begins with an assessment of the various non-trading pollutant loading reduction alternatives and their costs. These alternatives and costs establish a "base case," or possibly a series of "base scenarios" if numerous alternatives are viable. Trading options can then be compared to the base case(s) and a determination can be made as to whether trading is more or less cost-effective than non-trading options. Theoretically, if off-site reductions available for trading cost less than on-site reductions on a per unit basis (e.g., pounds, kilograms), accounting for transaction costs and assuming a sufficient quantity of reduction credits are available when needed, sources needing reductions will find trading more cost-effective than reducing loadings on site.

4.3.1 Non-Trading Control Options at Cherry Creek Publicly-Owned Treatment Works

Seven wastewater treatment plants currently discharge and/or land apply effluent in the watershed. The plants either provide secondary treatment followed by land application, or advanced wastewater treatment (AWT) with land application and/or direct discharge to Cherry Creek (direct discharge to fulfill flow augmentation requirements and beneficial reuse).

In general, AWT is designed to achieve phosphorus concentrations of 0.2 milligrams per liter (mg/L) or less. In combination with additional phosphorus reduction technologies and practices, such as land application, rapid infiltration basins, and biological membrane filtration, much lower concentrations of phosphorus in effluent reaching Cherry Creek can be achieved, i.e., 0.1 to 0.02 mg/L of phosphorus. For those using secondary treatment followed by land application, it is estimated that 25 percent of the phosphorus in the applied effluent actually makes its way to Cherry Creek. Notably, two dischargers that are currently not using AWT are in the process of designing AWT facilities.

Due to the high level of phosphorus treatment already being achieved at Cherry Creek publicly owned treatment works (POTWs) and the incredibly high costs that would be associated with achieving additional reductions, the authority determined that no viable non-trading phosphorus reduction options existed for these facilities and therefore did not further evaluate non-trading options for point sources.

4.3.2 Non-Trading Control Options at Cherry Creek Nonpoint Sources

Rainfall carries phosphorus to Cherry Creek and the reservoir in runoff at delivery rates that vary depending on soil type, vegetation, and slope. Typically, developed land generates more nonpoint source pollution than undeveloped land, because impervious surfaces do not filter or slow the runoff. A variety of best management practices (BMPs), tailored for site conditions, can reduce the amount of runoff that occurs during rainfall events and/or reduce the amount of pollutants transported to the waterbody.

The basin stakeholders have a plan in place to implement "baseline BMPs," which must be in place within a sub-basin before trading can be considered. In June 1997 members of the basin land use agencies and the authority formed the Stormwater Quality Committee to improve stormwater quality management within the basin. The committee developed a model stormwater quality regulation for land use agencies to adopt and incorporate into their own respective drainage program requirements to control the quality of stormwater runoff from private and public property and to reduce the loads of sediments and nutrients reaching Cherry Creek and reservoir. The model regulation also addresses monitoring and enforcement of BMP implementation.

The model regulation establishes minimum requirements for construction and permanent stormwater quality BMPs and identifies special requirements for land disturbances related to industrial and agricultural land use and in environmentally sensitive areas: phase construction; reduce stormwater runoff flow to non-erosive velocities; protect drainageways from erosion and sediment damage; control sediment before it leaves construction site; stabilize soils; and revegetate disturbed soils. Industrial facilities must meet the minimum requirements for permanent BMPs and also satisfy additional special requirements designed to prevent or reduce the amount of pollutants generated or released from an industrial development, including: implement source reduction practices; reduce exposure of materials with stormwater; and provide an emergency response plan for spills and leaks.

The model regulation requires that all permanent BMPs provide a water quality capture volume designed to capture and treat, at a minimum, the 80th percentile of small and frequent storms. The goal of the model regulation BMPs is to provide greater than 50-percent phosphorus reduction in the basin. The model regulation also encourages regional water quality facilities that can be more cost-effective and can be integrated into open space, parks, and golf courses.

4.4 Pollutant Load Reduction Options Under a Trading Program

On the point source side, there is limited to nonexistent capacity to reduce phosphorus loadings below that projected. On the nonpoint source side, baseline BMPs alone likely will not be enough to achieve water quality objectives in the watershed. Together, point and nonpoint sources account for 88 percent of the allocation under the 1985 TMDL. Septic systems and industrial sources only account for three and less than one percent of the loadings, respectively, and therefore trading options involving these sources were not considered.

Thus, it appeared there was an opportunity to create a second line of defense after baseline BMPs or PRFs, which go beyond baseline BMPs and were established with the goal of reducing phosphorus and other pollutants. Baseline BMPs must be implemented and operating effectively within the sub-basin served by a PRF before credits may be considered for the PRF under the trading program. Specific objectives of PRFs include the following:

- To increase or enhance the level of treatment from baseline BMPs within a specific sub-watershed of Cherry Creek;
- To provide water quality protection in a sub-watershed that lacks adequate baseline BMPs due to present levels of development; and
- To protect sensitive environmental areas within the reservoir watershed while enhancing water quality protection.

As discussed above and in earlier sections of this report, the initial phase of the trading program revolves around the four existing authority-funded PRFs that generate loading reductions and provide credits available for purchase by authority members to offset loadings above their individual loading caps. In subsequent phases of the program, the authority is likely to construct additional PRFs. Also, in later phases authority members themselves or third parties may be allowed to generate credits.

4.4.1 PRF Construction, Operation, and Maintenance Costs

The authority's four PRFs constructed to date — Shop Creek (1990), Quincy Outfall (1996), Cottonwood Creek (1997), and East Side Shade Shelter (1996) — have, by average estimates, reduced phosphorus loadings by a total of 954 pounds per year. By application of PRF-specific uncertainty factors (institutional, variability, and BPJ) and trading ratios (see Section 3.5), the four PRFs are estimated to generate a net 461 pounds of phosphorus credits annually.

The authority has paid for the PRF construction costs and is paying for ongoing OM&M costs. The capital cost and annual OM&M cost for the four PRFs are presented in Table 4-1 (in 1999 dollars). Using this cost information, the average annual phosphorus pounds reduced by each PRF and the net credits generated, the authority can calculate the annualized cost per pound of phosphorus reduced and the annual cost per credit generated. Note that these are *costs* — in this program, and in others, *prices* that traders pay and receive may differ somewhat or substantially from costs. Credit prices for the Cherry Creek program are discussed in Section 4.6.

Table 4-1. Net Credit Costs: Four PRFs Constructed to Date and Cost Derivation (1999$)

PRF	Capital Cost[a]	Annual OM&M Cost	Annualized Total Cost *(assumes 20 yr. PRF life)*	Average Annual Pounds Reduced	Annual Cost per Pound	Net Credits Generated (Pounds/ Year)	Annual Cost per Credit
Shop Creek	$668,286	$38,824	$72,238	261	277	186	$388
Cottonwood Creek	342,978	20,512	37,661	517	73	172	219
Quincy Drainage	218,672	13,144	24,078	158	152	93	259
East Shade Shelter Stabilization	125,759	7,520	13,808	18	767	10	1,381
TOTAL	**$1,355,695**	**$80,000**	**$147,785**	**954**	**N/A**	**461**	**N/A**
AVERAGE	**$338,924**	**$20,000**	**$36,946**	**239**	**$155**	**115**	**$321**

[a]Costs include engineering, design, and construction.

When calculating the annual cost per credit, the authority must allocate ongoing PRF OM&M costs. As shown in Table 4-1, it has been estimated that annual OM&M costs for all four PRFs are $80,000 (resolution of the Board of Directors, November 3, 1997). It is assumed that the authority allocates OM&M costs to each PRF based on construction cost. However, these costs could be allocated based on actual expenditures per PRF (if available), on average annual phosphorus pounds reduced, or on the total OM&M costs (i.e., $80,000) evenly across the four PRFs (i.e., $20,000 each).

These costs per credit are based on estimated reductions and trading ratios established for Phase I of the trading program (as discussed in Section 3). The authority intends to periodically reevaluate PRF reductions and trading ratios, and to the extent it revises these figures, cost per pound reduced and cost per credit also will require revision.

4.4.2 Other Trading-Related Costs

In addition to construction and OM&M costs, the Cherry Creek trading program has incurred administrative transaction costs and other trading-related costs, and will continue to incur such costs at some level moving forward. These costs, which have not been fully quantified and therefore have not been allocated to credit costs, include:

- Costs associated with developing trading program from 1985 through the present, as well as future program development costs;
- Administrative and tracking costs;
- POTW costs to identify and conduct trades (in Phase I, where the authority is the only seller and members are the only buyers, these costs are minimal); and
- General water quality monitoring costs (though PRF OM&M included in credit cost/price).

The authority has not segregated its administrative costs associated with the trading program from other general administrative expenditures. It has, however, recognized such costs exist and has established two fees to recover a portion of these costs. The authority will charge a one-time non-refundable *application fee* of $100 from a discharger to purchase credits as well as an annual *trading fee* of $100 from project owners in approved "in-kind" trades (which are contemplated under Phase II but are not occurring now under Phase I). Both fees will help cover some of the authority's administrative and other trading-related costs.

4.5 Economic Issues in Design and Implementation

Once the general framework for trading was selected — that the authority would construct PRFs to reduce phosphorus loadings and generate tradable credits — participants began examining a series of issues relating to the economic and financial aspects of trading. These issues and the authority's deliberations on each are summarized below.

4.5.1 Cost Recovery in Credit Prices

Under the trading guidelines, the authority may consider the following in establishing credit prices:

- Costs of authority-funded PRFs, including past development and capital costs, OM&M costs, and estimated future costs for construction and operation of new PRFs;
- The costs for the authority to establish, administer, and oversee the trading program; and
- Dischargers' (see Section 1.3 for complete list of dischargers) participation in the authority and contributions to authority-funded PRFs.

The authority identified four general approaches to recovering the costs of creating and maintaining PRFs through credit prices. They range from full subsidization through some programmatic mechanism, to full cost, including administrative and O&M expenditures. The authority recognized that transaction costs could be included in credit prices or attached as a surcharge or fee (see the application and trading fees discussed above). The four approaches are as follows:

- ***Free*** — The authority would not charge members for phosphorus credits, under a rationale that fees and taxes from authority members and citizens in the service areas already paid for the PRFs and that existing revenues should be used to support the trading program;
- ***Discounted*** — The authority would charge a price below the actual cost of each PRF credit that would not fully recover costs but would generate some additional revenues from credit sales that could be used to offset PRF construction and O&M costs;

- ♦ ***Full Cost*** — The authority would charge a price equal to the full and total cost of each PRF credit, inclusive of any design, construction, O&M, and other PRF-related costs, completely covering the cost of PRF construction and O&M through credit revenues; and
- ♦ ***Cost Plus*** — The authority would charge a price equal to the full cost plus a surcharge designed to offset administrative and/or regulatory expenses associated with trading (e.g., activity associated with tracking trades and reporting activity to the state regulatory agency), completely or almost completely recovering all the costs associated with creating and trading credits.

4.5.2 Equity and Fairness Perceptions

In Cherry Creek, the decision regarding pricing and cost recovery was decided largely on equity issues. Here, equity relates primarily to past and future financial contributions to the authority and past and future growth rates within the point sources' service areas. Members that have made relatively greater cumulative contributions have made arguments that maybe they should pay less per credit than members with lower cumulative historical contributions. Also, members with relatively lower historical population growth rates that are just now beginning to experience development don't want to pay more in the future per credit than their faster growing counterparts that will demand and purchase credits sooner.

Authority members have already contributed substantially to authority projects and reserves through the POTW, development, and land use-based fees discussed under Section 4.2. Thus, there was some merit to the position raised that authority members should not have to pay full cost for credits they buy in the future, because they already have financially contributed to the PRFs. The option of pricing credits at $0 came up in some discussions. Equity issues arise, however, if some authority members need and draw/purchase credits disproportionately to their financial contribution to the authority. This could easily be, and is in fact anticipated to be, the case. Therefore, members decided that credit prices should generally reflect full costs.

4.5.3 Pricing Tiers

The authority is considering establishing different prices for different classes of traders to address equity concerns associated with the fact that authority members make annual contributions to the authority's revenue base, as outlined in Table 4-2, while non-members make no such contributions. Specifically, authority members have made substantial cumulative contributions already to authority-funded PRFs and believe non-members should have to pay more per credit than members, essentially compensating for the lack of any historical contributions. A detailed analysis of pricing tier options has not yet been conducted because non-authority members are not eligible to trade in Phase I of Cherry Creek's program. In anticipation of non-authority members becoming eligible in the future, two tier systems (Options A and B) have been identified but not yet examined.

Table 4-2. Possible Pricing Tiers

	Members	Non-Members
Option A 2 Categories		
Option B 4 Categories	Member, Class 1 — *perhaps includes members that are discharging as of 1998, as their historical financial contributions to the Authority may be greater and their need for credits sooner than other classes*	Non-Member, Pollutant Source — *perhaps includes non-members that wish to purchase credits from the Authority, or even conceivably sell credits to Authority members*
	Member, Class 2 — *perhaps includes members that are not discharging as of 1998, as their historical financial contributions to the Authority may be less and their need for credits later than Member, Class 1*	Non-Member, Non-Polluter — *perhaps includes non-profit environmental groups, or local community organizations implementing projects that provide pollutant loading reductions from which credits could be created and sold to Authority members*

4.5.4 Credits: Attached to Specific Projects or Not

The Cherry Creek trading program involves multiple distinct projects that generate reduction credits, i.e., PRFs. Because of multiple PRFs, a critical issue arose whether loading reduction credits should be "attached" to a specific PRF or pooled into an "average" credit calculated over all or some individual PRFs. Under a system in which credit prices are calculated on a PRF by PRF basis, prices may more accurately reflect individual PRF costs, but such an approach may require considerably more technical analysis and record keeping. Additionally, if prices differed significantly between PRFs, buyers would want to purchase the cheaper credits first, shifting demand away from other credits. An alternative approach considered was to add up the costs of all operating PRFs, divide that value by the number of credits, and establish an average cost per credit. Prices would then be determined relative to that average cost. Under a hybrid approach, the authority could develop the average cost of credits created in any particular year (e.g., 1997 credits, 1998 credits, etc.), or group more than one PRF together to form a bundle or lot, selling the credits from different years or lots at different prices. More detail about the authority's deliberations and decisions on credit pricing is provided under Section 4.6. Trade-offs among the methods primarily involve balancing the level of precision needed against reasonable administrative effort and desires for pricing/revenue predictability.

4.5.5 Credit Purchases: Paid for All at Once or Over Time

The authority identified three payment methods: Lump Sum-All; Lump Sum Capital/ Annual O&M; and Annual-All. The methods differ primarily with respect to how much of the cost of a credit is paid for upfront, versus how much is paid over time — and consequently, the level of revenues the authority will receive upfront, versus over time. A lump sum-all payment is made all at once and is relatively large. A lump sum capital/annual O&M payment involves paying the capital portion of a credit's price upfront, with the annual O&M portion of the price paid on an annual basis. An annual-all payment annualizes the capital portion of a credit price and adds to the annual O&M portion of the price, creating an annual payment obligation with equal annual payments. The three methods also will differ in the cumulative or total price paid per credit, depending on inflation rates, interest rates, and the number of years over which payments are made. Methods employing fully or partially annualized prices will result in relatively greater cumulative payments compared to methods employing fully or partially lump sum prices. The extent of the difference depends on the effective interest rate and time period involved. More detail about the authority's deliberations and decisions on credit payment structures is provided under Section 4.6.

4.5.6 Revenue Stability

The Cherry Creek program faces two important issues relating to revenue stability, which refers to the consistency and predictability of trading revenues relative to trading-related expenditures. As already noted, the authority, to date, has paid for PRF design, construction, OM&M out of its general revenues, and has not issued debt to support the trading program or PRFs. This means the authority has paid for the creation of credits ahead of demand and ahead of any revenues credit sales will generate. While PRFs are an important component of the authority's watershed management strategy, there are other projects and programs that require funding and thus cannot indefinitely limit pay without collecting credit fees to offset past expenditures and fund future PRFs or other watershed management projects. Therefore, the authority has a financial interest in setting credit prices so that it can recoup its investment in a reasonable amount of time. This would tend to point toward a credit payment structure that front-loads payments, where all or a portion of credit costs are paid upfront in a lump sum.

However, the authority, like other jurisdictions in Colorado, is limited in the amount of revenues it can collect in any given year, compared to the year before. If, for example, this year's revenues exceed last year's by more than a certain percent (which can vary under the Tabor Amendment according to different interpretations of the restrictions), the excess over the allowed percent increase must be rebated to those that paid. This means that while the authority wants to generate sufficient revenues from credit sales to offset past expenses, cover current expenses, and perhaps set aside funds for future PRF investments, it does not want to set credit prices such that credit revenues will be at levels, when combined with credit demand, that push the authority over its Tabor Amendment limit in any given year. This consideration takes precedence over the interest in recouping trading costs quickly, and instead points to a credit payment structure that spreads payment out over the life of the credit by annualizing all or some portion of the total payment.

4.5.7 Economic Incentives and Credit Market Demand/Supply

The financial situation of buyers and sellers, the demands and opportunities for pollutant loading reductions they face, credit prices, and administrative framework (including transaction costs, trading rules, logistics, etc.) interact to create a market for trading. A market may be thin (i.e., few buyers and sellers and/or few transactions) or robust (i.e., many traders and/or trades). A market may be consistently predictable, or more volatile. Demand and supply may be very sensitive or not sensitive at all to prices — and sensitivity to prices can be similar or differ dramatically for demand (i.e., buyers) versus supply (i.e., sellers).

Cherry Creek's trading program is notable in that it is a closed program, as stated in Section 1. The implication of this arrangement for demand and supply is that the incentives to buy or sell credits may be driven less by cost comparisons at the unit level (i.e., pounds of phosphorus), and more by broader watershed management objectives to reduce nonpoint source loads to the reservoir. Under Phase I, only the authority and its members are allowed to trade. As a result, there should be fewer incentives — if any at all — to make a profit, and more incentives to create an equitable and sustainable program, than in a market where buyers and sellers are less intertwined from a financial and water quality management perspective. Under Phase II, if the authority approves in-kind trades where members or third parties may install or implement credit-generating projects, buyers will presumably compare authority pool credits to in-kind credits, on the basis of price, transaction costs, and perhaps location of reductions, to determine which credits are more attractive. Cherry Creek's relatively unique closed program may make it easier to make adjustments to trading rules, credit prices, etc., as necessary to ensure the program meets the needs of its participants, than might be possible in trading programs with wider market participation.

4.6 Credit Pricing: Analysis and Results

The authority has examined several alternatives for credit pricing and credit payment and has considered the effects of the alternatives on the parties involved. The authority realizes that both pricing and payment alternatives can have important effects on cashflow of credit purchasers, as well as on its own cashflow as it supports and administers the trading program. Stakeholders also kept in mind that circumstances of some or all of the parties involved may change over time and the best structure now may not be the best in the long term. Finally, as discussed in Section 4.5, limits on annual increases in revenue collected were (and will continue to be) a primary consideration for evaluating and selecting a payment structure.

4.6.1 Pricing and Payment Alternatives

As introduced in Section 4.5, the Authority initially identified two pricing alternatives and three payment alternatives, as detailed in Table 4-3.

Table 4-3. Pricing and Payment Alternatives

Pricing Alternatives	
Lots — Multiple groups of credits called lots are established and credit prices are calculated for each lot individually. Once a credit price is established for a particular lot, it does not change.	***Pooled*** — Only one group, or pool, of credits is established and credit prices are calculated for the pool based on its current composition. Credit prices can change over time as credits are purchased and new ones created.

Payment Alternatives		
Lump Sum-All — Buyers pay for each credit in a one-time, upfront payment. The credit price incorporates selected credit creation costs, including capital expenses and ongoing OM&M for the life of the project, into lump sum credit fee.	***Lump Sum Capital/ Annual OM&M*** — Buyers pay for the capital portion of each credit all at once and upfront but make annual payments to cover OM&M expenses.	***Annual-All*** — Buyers make an annual payment for the life of the credit. The annualized credit price includes both the capital portion and OM&M expenses.

These alternatives create six potential *pricing and payment structures*:

1. Lot Pricing and Lump Sum-All
2. Lot Pricing and Lump Sum Capital/Annual OM&M
3. Lot Pricing and Annual-All
4. Pooled Pricing and Lump Sum
5. Pooled Pricing and Lump Sum Capital/Annual OM&M
6. Pooled Pricing and Annual-All

4.6.2 Advantages and Disadvantages of Pricing Alternatives

A variety of factors determine which pricing method is best for a given program. Since stakeholders in different watersheds have different priorities, factors including anticipated demand, supply, trading pace (fast or slow), and characteristics of projects generating credits (numerous or few). Local perceptions of equity and fairness should also be considered for tailoring pricing methods to given situations.

Under a lot pricing system, the authority would assign one or more PRFs to each lot, and calculate the credit price per lot by dividing the total cost (including capital, annual OM&M expenditures) per lot by the total number of credits generated per lot. With lot pricing, the price per credit within a particular lot never changes. Therefore, as trading occurs it is necessary to not only track how many credits are traded, but from which lots credits are drawn as well as the credit balance remaining in any particular lot.

The primary advantage of lot pricing is the transparency of the price calculations and the predictability of prices. Also, because credit prices per lot are fixed, tracking sales and new credits may be relatively more simple than under a pooled system. However, a key disadvantage of lot pricing is that price can differ across lots, potentially significantly if not actively managed. For example, a situation could arise under lot pricing in which a newly created lot's credits are priced lower than existing lots. Prospective buyers would want to purchase credits from the newer, cheaper lot, leaving relatively more expensive credits from old lots as "inventory." Sellers could find this problematic, depending on what they think future demand for inventory credits will be.

To account for this potential problem, programs contemplating lot pricing systems may consider requiring that all credits from pre-existing lots be sold before credits from a new lot are made available for purchase. However, this could create perceived inequities among traders if someone "misses out" on the cheaper credits, fueling incentives to "game" the system (e.g., buying more credits than needed when believed "cheap"). As mentioned earlier, active management, if possible, which includes strategically assembling lots from individual projects so that the lot prices are relatively similar across lots and over time can mitigate potential equity issues that may be associated with this method.

Under the pooled pricing scenario, the program would assign all credits available for purchase to a single pool, and calculate the credit price by dividing the total cost of the credits in the pool by the total number of credits in the pool. The average price for a pool credit would need to be recalculated every time new credits are added to the pool, accounting for any credits that had been sold by adjusting the total number of credits assumed. Per credit prices will fluctuate to the extent that new credits placed in the pool are relatively more or less expensive than the average cost per credit of the previously calculated pool.

The primary advantage of pooled pricing is that it provides an opportunity to smooth credit prices over multiple projects and over time. However, two key disadvantages include the potential effort required to calculate credit prices for a large and dynamic pool as well as the potential for fluctuating prices in trading markets where supply and/or demand shift rapidly over relatively short periods.

4.6.3 Advantages and Disadvantages of Payment Alternatives

The advantages and disadvantages of the three payment alternatives considered relate to the resulting payment and revenue stream. In this regard, it is important to understand that what may be an advantage for a buyer, may be a disadvantage for a seller. For the seller, receiving at least the capital portion in one lump sum may be attractive, especially if the project has been paid for with operating funds (i.e., not debt financed). One drawback to the lump sum-all method, however, is the potential to underestimate OM&M costs, which would result in sellers facing funding shortfalls for OM&M expenses. One solution would be to incorporate the ability to levy surcharges (or give rebates) if OM&M expenses are more (or less) than originally estimated. If the seller took out a loan to construct the project(s) in the first place, receiving annualized payments may not be particularly burdensome, so long as the assumed rate incorporated into the credit price matches that for the loan (i.e., credit fee revenues match debt service payments). Additionally, to the extent longer payment periods increase demand for credits above what it would be under a lump sum plan, the annualized approach may be more economically viable.

For buyers, preferences for one payment method over another may be rooted in ability to pay as well as convenience. Some buyers may not have sufficient capital on hand to buy credits in one lump sum, making methods that annualize at least part of the credit costs more attractive. On the other hand, some buyers with sufficient cash may want to fulfill their payment obligation quickly and not be faced with the administrative issue of when the next payment is due. Additionally, some buyers might be able to use lump sum payments to their advantage with respect to taxes (e.g., depreciation).

4.6.4 Pricing and Payment Alternatives Selected for Further Evaluation

The authority generally prefers the pooled pricing method to the lot approach, believing the pooled method will result in smoother and more equitable credit prices. Under Phase I, this means that the "pool" will include the four PRFs discussed in Section 3.

With respect to payment plans, some members have expressed a preference for annualized prices, while others are not yet willing to rule out options that involve a full or partial lump sum payment option. As indicated earlier, the Tabor Amendment limitations point to a legal and administrative reason for favoring annualized payment options.

Additionally, some thought has been given to translating credit prices into tap fee surcharges. "Taps" represent new customers hooking up to (i.e., tapping into) a wastewater treatment plant collection system. A tap's impact on the system (e.g., flow and pollutant loadings) is sometimes evaluated in terms of single family equivalents (SFE) or dwellings. By calculating the loading impact of an SFE, credit prices per pound can be translated into credit prices per tap under any of the three generalized payment plans presented above. However, tap fees are typically levied as a one-time fee, paid at the time of development approval or actual connection, which points to an administrative preference for a lump sum-all tap surcharge to pay for needed credit purchases.

The authority is evaluating the credit price options presented in Table 4-4. Table 4-5 converts those options into per tap (i.e., per SFE) fees.

Table 4-4. Resulting Credit Prices for Various Payment Alternatives Using the Pooled Pricing Method, 1 Credit = 1 Pound of Phosphorus[a]

Basic Assumptions for All Methods in This Example	**Pool (as of 1999)** = 461 credits Total Capital Cost = $1,355,696 Est. Annual OM&M = $80,000		Credit Life = 20 years Inflation Rate = 2.5% Opportunity Cost = 4.5%
	Lump Sum-All	**Lump Sum Capital/ Annual OM&M**	**Annual All**
Credit Price Calculation	($1,355,696 + $1,600,000) ÷ 461 = $6,411	$1,355,696 ÷ 461 = $2,940 Lump $80,000 ÷ 461 = $174 Year 1 OM&M	$1,355,696 ÷ 461 = $2,940, Estimating opportunity costs of 4.5%, 20 even annual payments = $226/Year $80,000 ÷ 461 = $174 Year 1
Payment in Year 1	**$6,411**	**$3,114**	**$400**
Payment in Out Years	$0	**$178** in Year 2, estimating inflation at 2.5% per year, reaching $278 by Year 20	**$404** in Year 2-- $226 for amortized capital and $178 for OM&M, estimating inflation at 2.5% per year, total annual payment reaches $504 by Year 20
Cumulative Payments in Nominal Dollars	**$6,411**	**$7,385**	**$8,965**

[a]All figures based on 1999 dollars.

Table 4-5. Resulting Tap Fees Converting Pound Credits → Single Family Equivalents for Selected Authority Member POTWs

1 SFE = 250 gpd	Arapahoe		Lincoln		Parker		Pinery	
	1998	2008	1998	2008	1998	2008	1998	2008
Assumptions								
Effluent Phosphorus Concentration mg/l	0.07	0.06	0.05	0.05	0.018	0.015	0.066	0.053
SFE Phosphorus Load lbs/yr	0.053	0.046	0.038	0.038	0.014	0.011	0.050	0.040
1 SFE = ___ Credits	0.053	0.046	0.038	0.038	0.014	0.011	0.050	0.040
1 Credit = ___ SFEs	18.76	21.89	26.27	26.27	72.96	87.55	19.90	24.78
Tap Fee Range $/SFE *(1999$)*								
Lump Sum-All	**$342**	**$293**	**$244**	**$244**	**$88**	**$73**	**$322**	**$259**
Lump Sum Capital/ Annual OM&M	$157/ $9	$134/ $8	$112/ $7	$112/ $7	$40/ $2	$34/ $2	$148/ $9	$119/ $7
Annual All	$21	$18	$15	$15	$5	$5	$20	$16

In summary:

- Under the ***lump sum-all alternative***, traders would pay a one-time fee of $6,411 per credit, inclusive of all capital costs and 20 years of OM&M;
- Under the ***lump sum capital/annual OM&M alternative***, traders would pay a one-time fee of $2,940, and make annual OM&M payments of $174 (including in the first year a credit is purchased), though annual OM&M payments may increase as OM&M costs increase); and
- Under the ***annual-all alternative***, traders would pay $400 a year, although the OM&M portion (about $174) will increase over time as OM&M costs increase, as in the lump sum capital/annual OM&M option. Under this alternative capital costs are amortized, assuming an interest rate, or "opportunity cost" of 4.5 % (as of July 1999), and converted into fixed annual payments, similar to the way a mortgage is calculated, and then added to annual OM&M payments.

As discussed above and as presented in Table 4-4, alternatives that annualize all or a portion of the credit costs would reduce the amount buyers pay (and the authority receives) upfront but increase the total amount paid per credit, relative to alternatives that involve lump sum payments. The alternatives essentially boil down to: (1) pay now; (2) pay part now and part over time; and (3) pay it all over time. Notably, the authority's revenue stream from trading will match the payment streams.

4.6.5 Detailed Methodology for Calculating Credit Payment Plans

Lump Sum-All. The "lump sum-all" approach to credit payments establishes a credit price that includes all credit creation and OM&M costs (with surcharges or subsidies accounted for as determined by the program), rolling everything into a single payment that covers the established life of the credit (e.g., 5, 10, 15, 20 years — whatever is appropriate for the credit-generating project). It also would be possible to establish lump sum payments that cover multiple years of credit operation, but perhaps not the entire credit life, if for example a trading program wanted to match credit lives to permits or master plans. When calculating payments under the lump sum-all approach, or under one of the other two approaches discussed below, it is important to be aware of the year in which costs and prices are expressed. Costs from earlier years may need to be inflated to the current year, while anticipated future costs may need to be discounted.

Under this approach, capital costs for credit generating project(s), lots, or pools are tabulated and converted, if necessary, into current year dollars. OM&M costs are then tabulated or estimated on an annual basis and multiplied by the credit's useful life (in years). There is usually not a need to discount the OM&M costs because they are usually provided in current year dollars. Capital costs are added to total OM&M costs to establish a price per credit. If programs use this method, they may want to establish a trust fund or some other kind of reserve fund in which to place the portion of the credit price that represents the lump sum OM&M costs. Such an approach, if properly managed, allows the monies to earn interest while ensuring that funds will be available when needed.

Lump Sum Capital/Annual OM&M. Under this approach, first capital costs are tabulated into current year dollars. The current year value of capital costs is divided by the number of credits to calculate a per-credit cost, which establishes the upfront payment under this approach. Buyers then pay an annual per credit fee to cover OM&M costs. To estimate the amount of this annual payment, it can be assumed that OM&M costs will likely increase over time due to inflation. Therefore, to estimate total OM&M costs over the 20-year PRF life, a building cost inflation rate can be applied to the annual OM&M cost. According to the *Engineering News Record*, the building cost inflation rate as of July 1999 was 2.5% annually. Likewise, annual OM&M payments may be adjusted downwards, if OM&M costs are anticipated to decrease over time.

Annual-All. Under this approach, capital costs also are tabulated into current year dollars, but because sellers will pay for capital costs over time an adjustment for the seller's opportunity costs must be made. Applying an interest rate to the capital costs is an appropriate method to account for the opportunity costs for capital expenses the seller has paid for but not yet received trading revenues to cover. If the seller had received a lump sum payment, they could have invested it and earned interest — the loss of this interest income is the opportunity cost. It is assumed that the investment would earn the same rate as a 1-Year Treasury bill rate, which was 4.5% in July 1999. Capital costs are amortized over the 20-year PRF life so that equal annual payments are made each year. The OM&M portion of the credit price is calculated the same as in the Lump Sum Capital/Annual OM&M method. Amortized annual capital costs are then added to annual OM&M fees to establish a per credit price. Section 4.9 provides detail on how different inflation and interest rates can impact credit prices.

The tap fee-based credit systems mirror the credit pound payment alternatives in terms of whether more or less is paid upfront, versus over time, on a per unit basis. The difference is, of course, the size of the units traded. To illustrate the range in prices the Authority might charge under a tap fee-based credit system, prices were calculated for four of the seven dischargers. For these plants, one SFE equals between 0.014 and 0.053 credit pounds, depending on the concentration of phosphorus in a plant's effluent.

Under a tap fee-based credit system, the authority would charge these members between $88 and $342 per tap if prices were lump sum, between $40 and $150 upfront and $2 to $9 annually per tap if prices were lump sum capital/annual OM&M, and between $5 and $20 per tap annually if prices were annual all (in 1999 dollars). These credit prices could be passed on to the developers in the form of surcharges on existing tap fees.

As is evident in this discussion and in Table 4-5, fees will differ among member plants, in some cases dramatically, if calculated directly from actual and projected treatment efficiencies (i.e., effluent concentrations). Those plants that achieve lower concentrations will face lower per tap fees, while those with relatively higher concentrations will face higher per tap fees. As noted earlier, a lump sum-all tap surcharge would be consistent with current practices; but the other two options are shown below to be parallel with the presentation of credit prices in Table 4-4.

4.7 Economic Benefits of Trading

Evaluating the economic benefits of trading in Cherry Creek requires a slightly different analytical framework than would generally be applied because non-trading options are so limited. Ordinarily, one would compare the costs of treatment versus trading. In this case, however, "without trading costs" cannot feasibly be calculated. All of the Cherry Creek POTWs currently, or soon will, operate at extremely high treatment efficiencies.

Thus, the economic benefits of trading in Cherry Creek fall into three broad, but related categories: the value of the ancillary benefits provided by the PRFs; the value of recreational and aesthetic benefits maintained by continued good water quality; and the value of environmentally sustainable economic development in the region. Together, these benefits reflect the value of meeting the basin's TMDL and underlying wasteload and load allocations more cost-effectively and with more certainty than without a trading program.

Point-nonpoint source trading, as is being implemented in Cherry Creek, provides a range of environmental benefits beyond what reducing a pound of phosphorus from POTW effluent offers. Point source reductions generally only provide environmental benefits in the water column, and in some cases at the immediate shore edge. The PRFs constructed to date, and envisioned for the future, not only reduce phosphorus loadings to the reservoir, but also reduce sediment loadings in runoff, mitigate and/or prevent erosion, restore degraded areas, enhance habitat, and improve the visual aesthetics of the reservoir area.

These benefits translate into recreational benefits. By protecting and maintaining the water quality in the reservoir, as well as the ecological quality of the surrounding areas, the trading program will preserve the economic value of reservoir-based recreation to the community. One only has to see the long lines to enter the reservoir parking areas on weekends to see how important and valuable these benefits are to residents. In fact, it was the magnitude of these benefits that led stakeholders to begin considering trading alternatives that would take advantage of the multiple environmental enhancements nonpoint source projects can offer.

Finally, trading appears to provide basin stakeholders with an effective and flexible mechanism to manage phosphorus loadings under the TMDL. Without this ability, future growth and economic development in some or all areas around the reservoir could be threatened. Without trading, it would be technically more difficult, probably more expensive on average, and therefore less certain that authority members and other basin stakeholders would be able to meet the TMDL at all, much less cost-effectively and in a way that maximizes broader watershed benefits. The trading program is designed to preserve the environmental benefits, on which the local economy depends, and thereby preserve the economic value of the community as a whole.

4.8 Preliminary Conclusions and Recommendations

Basin stakeholders have several decisions to make concerning credit pricing and payment structures, how affordability issues can be balanced against future revenue needs, and how everything fits together into a flexible and well run program that meets environmental and economic needs. This section presents conclusions developed to date regarding these issues and several recommendations about moving forward.

4.9 Finalizing a Pricing and Payment System

Finalizing a pricing and payment system will depend primarily on the Authority and its members finding an equitable balance among affordability, cash flow, and financial planning issues. The authority has already indicated support for the full cost-pricing model, on which the alternative pricing systems presented in this section are based. And while a decision regarding payment structure has not yet been made, Tabor Amendment limitations appear to place the authority in a position of favoring an annualized payment option. It is worth pointing out to those in other communities considering trading that do not face such restrictions that the hybrid lump sum capital/annual OM&M option, more than the others, matches the stream of credit expenditures and revenues to the timing of the authority's construction and OM&M costs.

Notably, annualized prices decrease the immediate burden on POTWs to come up with potentially several thousand dollars to buy credits. But by spreading payments out over time, POTWs end up paying more overall per credit. Additionally, the annualized option represents the lowest relative revenue stream (from credit sales) among the three options examined. So far, the authority has paid for PRF construction and OM&M out of operating funds. In the long run, it may make sense to establish a dedicated account — similar to a revolving fund — where credit fees are deposited and from which OM&M expenses paid and new PRFs funded.

With respect to the tap-based pricing alternative, this method does not really change the amount a POTW may pay to offset phosphorus loadings above its cap, and it involves a finer level of calculation than may be practical to manage. To implement this approach, POTWs or the authority would have to document the number of new taps per month or per year, and levy a phosphorus credit surcharge on every tap fee. The authority will have to examine whether integrating a credit payment system with the existing tap fee system is more or less burdensome than developing a POTW-based credit payment and accounting system.

The inflation and interest rates in effect at the time the authority formally establishes prices could result in final prices that are higher or lower than those presented in this study. At the time of publication, the building cost index was 2.5% (*Engineering News Record*, July 2000). However, the 1-Year Treasury bill interest rate was 6.13% (8/8/00 GovPX, Inc. Prophesy Treasury Pricing). To the extent the rates are higher than those presented here, final credit prices calculated using the same methodology as detailed above would be higher in nominal dollars. Likewise if the rates are lower, prices will be lower. The authority could choose to set fixed credit prices using rates in effect at the time it finalizes prices, in which case changes in future rates would not impact credit prices. Alternatively, the authority could establish inflation and interest rate ranges that would trigger reevaluation of prices if rates went higher or lower than the established rate band. Finally, the authority could choose to peg prices to rates, in which case prices could fluctuate as rates change. Fixed prices likely will be easier to administer for the authority and simpler for the members' planning purposes.

Regardless of the pricing method chosen, several options exist for cash flow and credit reconciliation. For example, member plants could settle their accounts with the authority at or just after the end of the year, paying for those credits purchased according to whatever payment structure is ultimately selected. Alternatively, the authority could estimate credit needs for the upcoming year in December and ask for payment in January. At the end of the year, the authority and buyers could reconcile credit accounts, with the authority rebating or crediting any unneeded credits, and members making up any shortfall based on real loading data. Under a tap-based system, members could pay the authority as tap fees are collected, or on an annual basis, as discussed above. In contrast to annual payments, the authority and members could decide that monthly payments either better support the authority's cash flow needs, and/or better match members' financial management systems than an annual schedule. Whatever plan ultimately is selected, the authority and its members will keep in mind the record-keeping burdens each option imposes on the authority and/or members, and the trade-off between precision and simplicity.

4.10 Maintaining the Ability To Make Adjustments as the Trading Program Evolves

Establishing an adaptable economic framework for the Cherry Creek trading program is essential. Key issues and unknowns that could alter the economic framework include:

- ***The TMDL*** — Will the TMDL for phosphorus change in the future — increase, decrease? And if this happens, will the point source allocation change? And if so, how will the relative allocation among member plants change? Which plants will end up with more room, and which with less under their individual WLAs?
- ***Growth Rates*** — How closely will actual growth rates match those projected — for individual plants and for the region? Will rates be faster, implying heavier loadings, or slower, implying lighter loadings?
- ***Baseline BMPs*** — Will the target number of BMPs envisioned by the model stormwater regulation be implemented? If so, will they provide a 50% reduction in phosphorus loadings from those sources, as estimated? Will controversy erupt if sources in some sub-basins are not eligible to trade because they have not implemented baseline BMPs, while sources in other sub-basins have met their target and are eligible to trade?
- ***Trading Ratios*** — Will future monitoring data show that trading ratios developed to date are too low, too high, or just right? Adjustments in trading ratios may mean that credit prices would need to be adjusted, upwards or downwards, and reconciliation made between amounts paid and revised prices, either in the form of additional charges or rebates/credits toward future purchases.
- ***Timing of New Discharges*** — Among those communities that are members of the authority but not currently discharging from a point source, when will they come on line? And, at what loadings level?
- ***Technology and Innovation*** — Have Cherry Creek POTWs reached the limit of technology, achieving effluent phosphorus concentrations of between 0.016 and 0.06 mg/L? Is this level of treatment sustainable over time? Will new techniques be found to reduce concentrations even lower?

These unknowns could work to increase or decrease demand relative to that expected. Tracking these issues and maintaining ability to respond to and account for them will be essential in creating and sustaining a viable trading market that generates important and unique environmental benefits.

CHAPTER 5.0

TRADING PROGRAM APPROVALS AND IMPLEMENTATION

5.1 Net Water Quality Benefit

Another goal of the watershed-based trading program is to achieve a net environmental benefit within the Cherry Creek Watershed. The net environmental benefits will be achieved through the ancillary benefits associated with the pollutant reduction facilities (PRFs) that are constructed. These ancillary benefits include the following:

- Removal of pollutants other than phosphorus (e.g., total suspended solids and nitrogen);
- Improved aesthetics;
- Improved riparian habitat through channel stabilization and revegetation; and
- Increased acreage for wildlife habitat (CCBWQA, 1997).

Special design considerations to protect groundwater drinking water supplies are also incorporated. They include the following:

- Minimum setback from drinking water wells;
- Minimum separation from water table;
- Prohibition from wellhead protection areas; and
- Consideration of impermeable barriers.

These design considerations are discussed in further detail in the Stormwater Quality Model Ordinance (CCBWQA, 1999).

5.2 Accountability/Monitoring and Oversight

5.2.1 Accountability

Accountability is perhaps the key issue for many regulators when they hesitate to endorse trading in concept or practice. It is difficult to devise regulatory or nonregulatory mechanisms that clearly establish accountability and unambiguously authorize enforcement of appropriate remedies.

The accountability-enforcement issue is particularly cumbersome when dealing with point/nonpoint source trades that involve unregulated NPS. In the U.S. EPA's 1996 framework, U.S. EPA describes two options: (1) point sources are responsible for NPS reductions; or (2) the state is responsible for NPS reductions that are incorporated into a TMDL allocation, along with a plan for implementation. Programs under development and organizations commenting on the U.S. EPA framework had several other ideas about how to solve this issue. The authority has devised a unique approach in which the point sources as a group are not only responsible for NPS reductions, they also implement, operate and maintain the NPS management projects whose reductions are used in the trading pool.

5.2.2 Monitoring and Oversight

The authority is responsible for long-term operation and maintenance of its PRFs. The operation and maintenance of PRFs that are designed and implemented by entities other than the authority must be operated and maintained by those entities. Such activities are based on the recommendations of the Urban Drainage and Flood Control District's criteria manual, Volume 3 (1992).

The authority retains oversight over all aspects of the trading program, including trades, trade projects, trade ratios, and discharge credits. The authority may modify or revoke an approved trade (including trade project, trade ratio, and discharge credit) at any time, at its discretion. This is based upon monitoring or modeling data, modifications or changes of PRFs, noncompliance with the authority's water quality trading guidelines, noncompliance with conditions imposed by the authority, inconsistency with the Cherry Creek Basin water quality management master plan or the Cherry Creek Reservoir control regulations, modifications of the trading program or any other significant change in circumstances.

Approved trade credits from a PRF remain contingent upon the continued effectiveness of the PRF, and project owners must operate and maintain projects into the future. Every three to five years, the authority will reevaluate all approved trade projects, including estimates of phosphorus removals at each project, the basis for credits, and designated trade ratio. If the authority determines — after reviewing data or other information concerning an approved trade project — that the project is not removing as much phosphorus as projected in the trade approval, the authority may make appropriate downward adjustments to trade credits and/or trade ratio for the project.

5.3 Program Approvals

In order for the trading program developed by the authority to be approved and implemented, the consensus and approvals of the program by a number of state and federal agencies were necessary. First, and foremost, the authority had to agree on the basic structure and requirements for the trading program with its own membership. This also included coordination with ex-officio members such as the Colorado Department of State Parks. Developing the program, the authority used U.S. EPA's "Effluent Trading in Watersheds" draft guidelines as a guideline for the program and consulted with representatives of U.S. EPA's Region 8 who were supportive in the development and implementation of the Cherry Creek trading program. To secure approval of the Cherry Creek trade program, the authority needed to coordinate closely with the Water Quality Control Division (WQCD), present the proposed regulatory modifications at a hearing conducted by the Denver Region Council of Governments (DRCOG) (the 208 Planning Agency), and present the proposal at a public rulemaking hearing conducted by the Colorado Water Quality Control Commission (WQCC). These last three steps are discussed more fully herein.

5.3.1 DRCOG

The Colorado Water Quality Act required the authority to present the proposed trading program to DRCOG. In August 1997 the authority presented the proposed program to DRCOG's Water Resource Management Advisory Committee. The committee had numerous questions regarding the scientific methods for determining trade ratios and how trading programs could be established in other watersheds. The DRCOG committee voted to support incorporation of the trading program into the control regulation.

5.3.2 Water Quality Control Division

The authority worked closely with the WQCD, the agency that serves as staff to the WQCC and is responsible for administering water quality programs in Colorado. The authority coordinated with the WQCD in order to address the WQCD's concerns and to attempt to garner the WQCD's support for trading program. Moreover, because the WQCD would play such an integral role in program implementation, it was important to develop a mutually workable trading program and establish a good working relationship with the WQCD.

From December 1996 until the WQCC's hearing in October 1997, the authority and WQCD had several working sessions to discuss aspects of the proposed trading program. Some of the salient issues raised by the WQCD were: whether the WQCC legally could delegate trading decisions to the authority (rather than to the WQCD); whether the program was protective of Cherry Creek Reservoir water quality; how to assure that only trading projects beyond required BMPs could obtain trade credits; whether there was adequate scientific basis for the proposed trading ratios; whether the quantification of phosphorus reductions at trading pool projects would be adequately supported by monitoring or modeling; and whether the trading program included sufficient safety factors and institutional mechanisms to assure its success, even if individual projects failed. The authority responded to many of the WQCD's technical concerns by providing data and other evidence from NPS projects. The authority reconfirmed its commitment to the trading program and future watershed quality studies, including studies of NPS projects. The authority also modified the trading program by agreeing, *inter alia*, to provide a more significant administrative role for the WQCD; to phase the program (as described in more detail below); to modify the proposed range of trade ratios; and to strengthen and clarify certain aspects of the regulatory language.

5.3.3 Water Quality Control Commission

A rulemaking hearing to consider adoption of the modifications to Cherry Creek regulations to incorporate the trading program was held in October 1997. The parties to the hearing were the authority (as proponent), the WQCD, Happy Canyon Ranch (a developer in the watershed), and two representatives from other watersheds interested in trading programs: City of Westminster and Chatfield Watershed Authority. The parties, particularly the authority and the WQCD, submitted substantial evidence in the form of prehearing statements, expert testimony, and exhibits. Although the WQCD had been supportive of the trading program, information on exceedances of water quality goals in the watershed resulted in the WQCD's recommendation that the program not be approved.

Following the hearing, the WQCC deliberated, and on November 3, 1997, the WQCC approved the Cherry Creek trading program by adopting revisions to the control regulation, 5 C.C.R. § 1002-73 et seq. In approving the trading program, some commissioners commended the authority for assuming a strong leadership in the watershed and developing new programs. The WQCC's approval of the control regulation modifications granted Cherry Creek legal authority to proceed with implementation of Phase I of the trading program. The

WQCC's adoption of revisions to the control regulation was the final and most critical step in the approval process for the trading program.

5.4 Phasing and Implementation of Trading

The trading program is being implemented in two phases. For Phase I, currently underway, the trades are limited to pounds in the "trading pool" credits that are based on phosphorus reductions at the authority's four existing established PRFs: Shop Creek retention ponds and wetlands, Quincy Drainage extended detention facility, Cottonwood Creek retention ponds and wetlands, and East Shade Shelter Shoreline Stabilization Project. Phase II, allowing implementation of the entire program, will commence after the authority has completed its reevaluation of the reservoir, the watershed, phosphorus model, and TMDL, and after the authority has incorporated these findings into an update to the master plan. In Phase II, the authority may include pounds in the trading pool from additional PRFs — other than the four initial projects — and the authority also may approve in-kind trades from non-authority PRFs.

5.4.1 WQCD Approval of Initial Project

The trading program allows the authority to allocate credits from authority-controlled PRFs into a trading pool and to make those trading pool credits available for purchase by qualified dischargers in the watershed.

Soon after the trading program was approved in November 1997 the authority commenced the process for credits from the four initial PRFs — Shop Creek, Quincy Drainage, Cottonwood Creek, and East Shade Shelter — to be included in the trading pool. The authority had conducted a comprehensive review of the four projects, their phosphorus reductions, proposed trade ratios, and available trade credits for each project. In December 1997 the authority formally requested the WQCD's consultation on the award of 461 pounds from the four projects into the trading pool. In February 1998 the WQCD concurred with the authority's calculation of trade ratios and phosphorus removals for the four PRFs and supported incorporation of the projects and 461 trade credits into the trading pool. This action rendered those 461 phosphorus discharge credit pounds available for trading.

5.4.2 Trading Guidelines

Beyond the basic trading program outlined in the control regulation, more detailed guidelines were necessary to direct implementation of the trading program. The authority developed trading guidelines to enumerate, beyond the control regulation, the specific policies, procedures, and standards for trading in the watershed. Indeed, the WQCC's approval of the trading program was conditioned, in part, on the authority's adoption of trading guidelines. In March 1998, the authority adopted the trading guidelines, thus paving the way for implementation of the program. (See Appendix A).

5.4.3 Credit Prices

The guidelines provide that the authority may establish prices for authority pool credits, based on factors such as the cost of PRFs, dischargers' contribution to the cost of PRFs, and the costs of the trading program. The authority has decided to establish prices for credits but has not yet approved a pricing system.

5.5 Trades Completed

Two authority pool trades, both awarding credits to the Lincoln Park Metropolitan District (Stonegate) for a total of 40 phosphorus credits, have been approved. On two separate occasions in 1997, Stonegate requested to purchase additional phosphorus pounds — 20 pounds in each instance — from the trading pool.

The first Stonegate request for trade credits was triggered because Stonegate had reached 80 percent of treatment capacity and, thus, was required by state law to commence planning its next plant expansion. Stonegate proposed an expansion from 0.55 mgd to 0.8 mgd, but its existing phosphorus allocation of 53 pounds would be insufficient for the increased flows. Accordingly, Stonegate requested 20 pounds of trade credits from the trading pool, and the authority found that Stonegate had demonstrated the requisite need for such trading pool credits. Because the trading program (and the trading pool) had not yet been finalized or approved, the authority granted a temporary allocation of 20 pounds from the authority's reserve pool to Stonegate, with the agreement that as soon as the trading program were established, Stonegate's award would become a purchase of 20 pounds from the trading pool.

Stonegate later reevaluated its growth projections and determined that the facility would need to expand beyond its first proposal of 0.8 mgd to 1.1 mgd. In November 1997 Stonegate requested an additional 20 pounds (40 pounds total) from the trading pool to serve increased projected wastewater flows. The authority again determined that Stonegate has demonstrated the requisite "need" for the trade credits. The authority awarded another temporary allocation of 20 pounds to Stonegate from the reserve pool, with the understanding that those pounds would be replaced by credits from the trading pool. The guidelines have been adopted, but the authority has not yet finally determined the pricing structure for trade credits. After the authority has approved prices for credits, Stonegate will purchase 40 pounds from the trading pool, and the two trades will be complete.

CHAPTER 6.0

KEY LESSONS LEARNED FROM THE CHERRY CREEK BASIN TRADING PROJECT AND ALTERNATIVE APPROACHES USED BY OTHERS

6.1 Overview

The purpose of this discussion is to compare the Cherry Creek trading program with other trading programs operating or under development to better understand key factors in designing and implementing a successful program.

As discussed in Section 2, a total phosphorus standard and TMDL for phosphorus were established for the Cherry Creek Reservoir in 1984 to protect recreational and other beneficial uses. Trading NPS reductions that are not otherwise required for point source upgrades and reductions was identified as one way to accommodate growth under the TMDL loading cap and obtain additional environmental benefits that point source reductions alone would not provide (e.g., habitat restoration, flood control).

By identifying the similarities and differences in program design and linking those essential elements to scientific, economic, and institutional conditions in the watershed community, we can highlight some lessons, guidelines, and patterns emerging from the growing field of trading.

6.2 Cherry Creek — A Summary of the Key Elements

Before launching into a review of some other programs, it makes sense to benchmark the Cherry Creek trading program to establish a basis for comparison. Expected population growth and a TMDL for phosphorus created an incentive for the members of the Cherry Creek Basin Water Quality Authority to look for ways to reduce loadings to ensure sufficient room for growth existing under the cap. All of the treatment plants are already providing advanced treatment or land application, both relatively expensive, leaving reverse osmosis as the only reduction alternative for point sources. At the same time, member plants saw many opportunities to achieve reductions from NPS controls, best management practices (BMPs), and restoration projects. Consequently, it seems that trading is a viable water quality management option for the Cherry Creek Watershed.

6.2.1 Collaboration Among Entities With Diverse Interests

Although the agencies that make up the authority share many common interests, sometimes there are competing interests and issues that are divisive between some agency members. Despite disputes among local governments before and after the authority's formation, it has continued to function effectively. The authority has been able to maintain effective operations and develop progressive programs due in significant part to three factors. They are (1) carefully focused programs and issues linked to water quality concerns; (2) collective commitment to water quality goals; and (3) a balance of power among authority members.

6.2.1.1 Limited Programs and Issues

Generally, the authority has limited its issues and concerns about water quality matters. Each of the authority's agency members agreed that the authority's role and jurisdiction should be limited to water quality. This allowed the authority to significantly build on the members' collective support for enhanced water quality through reasonable and achievable water quality restrictions. Further, most members wanted to ensure that water quality would not impede continued growth in the region.

Notwithstanding the authority's limited jurisdiction, non-water quality issues arise and cause disputes among members. Concerns with growth, development, and territorial limits continue to be of concern and cause disputes among the members. Although these "other" concerns and disputes have caused tension among members and resulted in shifting alliances, they have not prevented the authority from proceeding with and implementing its water quality goals.

Having established a basic water quality focus, it has been impossible to completely separate water quality from land development and water rights issues. However, the authority has, even when considering other issues, restricted its review and involvement to water quality aspects. The authority reviews developments for compliance with stormwater quality criteria and provides its recommendation to the appropriate land use agency. However, it has not commented on the appropriateness of development. Prior to expansions of existing wastewater treatment plants or development of new wastewater facilities, the owner/operator must secure the authority's approval. Development in a particular area causes the need for additional wastewater treatment since such development is within the local government's jurisdiction. However, the authority's review primarily concerns only compliance with water quality requirements, sufficiency of the facility's wasteload allocation (WLA), and adequacy of the proposed treatment systems. These selective reviews have maintained the authority's integrity as the regional water quality agency, and kept the authority from being mired in related non-water quality disputes.

6.2.1.2 Collective Commitment to Water Quality Goals

Although the authority's emphasis has changed, the authority's main program directives have remained (1) water quality monitoring; (2) development of BMPs; (3) sufficient wastewater treatment; and (4) construction of NPS pollutant control projects. Reinforcing the mandate requiring quality monitoring (5CCR 1002-72), the authority recognized the importance of monitoring to verify the water quality standard for phosphorus or, alternatively, provide scientific evidence for a revised standard. The initial phosphorus standard was determined based upon only one year's data, so the members generally concurred that additional water quality monitoring was important. However, after a few years of monitoring, concerns were raised that the authority was spending significant resources on water quality monitoring but not water quality improvements. The authority had model BMP construction regulations that each land use agency was adopting, requiring stormwater quality controls for new construction.

However, the adoption of those BMPs varied widely among the jurisdictions. Although significant phosphorus loads were monitored from some disturbed land, no NPS pollutant control facilities to address existing loads had been constructed. The authority, along with one of its members, organized a pilot stormwater/NPS pollutant removal project — Shop Creek. It has proven so successful that the authority has constructed three more projects and has plans for four additional projects. The Shop Creek project received considerable attention because of its phosphorus removal capabilities and environmental improvements. After construction of Shop Creek, the authority returned to its monitoring programs and routine operation.

Colorado Department of State Parks became concerned that substantial money had been spent on studies and no new projects were being developed. To address parks concerns, the authority amended its fee collection agreement with parks to assure that a percentage of each annual budget would be used for the development and construction of improvements and guaranteed that parks had a role in nominating suitable projects. All agency members and ex-officio members have been proud of the authority's achievements with these projects.

6.2.1.3 Balancing of Voting Power

Prior to inception of the authority, members of the authority were concerned about the control that could be exercised by any one group of members (i.e., the counties, cities, or special districts). The extent of geographic areas represented by each type of member varied greatly, as did the jurisdictional powers of the different political entities. Counties could exercise land use controls for broad areas, directly provide some services, and provide for other services through authorization of service districts. Municipalities exercise land use controls and provide services, but for a significantly smaller area than the counties. Special districts provide special services and exercise some controls for discharges to their systems, use of services and land for water directly necessary for their service. The authority "committed" that consensus was important for decisions but recognized that not all decisions would be unanimous. To prevent polarization of the different member groups and assure broad support for decisions, the authority instituted "special majority voting requirements" for essential decisions. The important decisions are only permitted if approved by the following: (1) one of two counties; (2) two of four cities; and (3) four of seven special districts. Key decisions requiring such special voting majority include budgets; wastewater plans and amendments thereto; and site approvals for wastewater treatment plants. The special voting requirements were initially incorporated in the intergovernmental agreement creating the authority. However, three years later (1988) when the authority secured the special legislative authorization, it asked that the legislation also include the special majority voting requirements (Cherry Creek Basin Water Quality Authority Legislation, Section 25-8.5-101, et seq., C.R.S.).

6.2.2 Improved Relations with Regulatory Agencies

To function effectively, the authority has developed a strong, working relationship with Parks, WQCC, and WQCD. These regulatory agencies have given the authority power to maintain water quality in the watershed. The authority's success can be attributed, in part to (1) development of sound technical data to support monitoring programs; (2) including the various agencies in the authority's decisions; and (3) maintaining a dialogue with each agency.

6.2.2.1 Parks

The Cherry Creek legislation provided that parks' users would be assessed a fee to fund a portion of the authority's activities. Annually, the authority contracted with parks for them to collect the authority's fee at the entrance gates concurrent with collection of its own fees.

Through discussions with the parks staff and board, two actions were important in securing parks' continued cooperation. First, a percentage of the Cherry Creek State Park user's fee collected would be spent for water quality improvements within the park and that Parks could participate in selecting such park water quality improvement projects. Further, the projects constructed have been very successful for water quality improvements and enhancing the park for recreation, wildlife, migratory birds and aesthetics — all important improvements for Parks (see Section 3.2).

The authority's development and operation of projects within the park was important for fostering a better relationship. The authority's contractors invited Parks' suggestions and have designed projects that incorporate natural materials to blend with the park environment. In addition, all projects provided significant amenities, in addition to water quality functions, such as wildlife habitat, wetlands, and recreational improvements — enhancements that were noted and appreciated by parks.

6.2.2.2 Water Quality Control Commission

The WQCC was initially opposed to growth and development in the watershed, and evidenced such opposition in the early 1980s by imposing a moratorium on wastewater treatment plants in the watershed. The moratorium was illegal and, therefore, was invalidated.

By regulatory mandate, the authority has reported annually to the WQCC on water quality monitoring, compliance with reservoir water quality standards and compliance with load and WLA. This information showed that the phosphorus standard of 35 μg/L was not attained. Although the goal for chlorophyll α at 15 μg/L was frequently met, the phosphorus levels exceeded the adopted standard. Further, the authority showed this information during discussions with the WQCC and committed to investigations to determine whether other water quality standards are more appropriate for the system. The authority has developed a better working relationship with the WQCC, due in part to regional and national recognition of the authority's watershed protection programs and projects.

6.2.2.3 Water Quality Control Division

The WQCD is responsible for administering water quality programs in Colorado, such as issuing site approvals and National Pollutant Discharge Elimination System permits, and serves as staff to the WQCC. The WQCD and authority were adverse at several Cherry Creek and general rulemaking hearings before the WQCC.

Despite continuing differences with the WQCD, the authority attempted to maintain a dialogue with the WQCD. Not only did the authority listen to the WQCD's concerns, when feasible, the authority addressed their concerns. The authority continued to discuss proposals with the WQCD — explaining the rationale and basis, and the importance of each proposal. The authority improved respect for the technical proposals. The authority sought technical consultants with considerable expertise in specific water quality matters to improve credibility. The authority has water quality consultants with specific expertise to (1) construct and develop NPS projects; (2) develop water quality trading ratios, watershed planning and water quality monitoring; (3) conduct lake monitoring; (4) evaluate limnology; and (5) provide hydrogeologic evaluations. The diverse group of consultants includes leaders in their water quality specialties, benefiting the authority's programs and projects, and enhancing the authority's reputation. The authority's efforts to gain support of other agencies were also effective in slowly building support from the WQCD.

The improved dialogue between the authority and the WQCD was noted during the authority's establishment of the trading program. The authority, seeking WQCD concurrence and approval for the trading program, undertook numerous discussions with WQCD staff and policy lenders. The authority expended considerable efforts in addressing the WQCD's issues and concerns and provided them with both technical and policy resolutions. The discussions were open and constructive.

6.3 Other Trading Programs — A Summary of the Key Elements

Almost 30 initiatives, including Cherry Creek, are identifiable across the country as allowing some form of trading. They include feasibility analyses conducted in the 1980s, a few programs that are on the books but not active, six programs in development or implementation stages, and another dozen or so that are being contemplated and/or are in the earliest stages of development. For this comparison, we will focus on the half-dozen programs that are in the throes of design and/or implementation because these "real" programs provide the most practicable and applicable insights. The early feasibility analyses conducted during the 1980s were informative, but none led to a trading program. Several programs being contemplated may prove innovative and successful, but it is too early to pin down essential design elements. The programs examined and compared to Cherry Creek are:

- Kalamazoo River — WERF Demonstration Project;
- Long Island Sound — WERF Demonstration Project;
- Tampa Bay, Florida;
- Tar Pamlico, North Carolina; and
- Lake Dillon, Colorado.

6.4 Patterns and Insights From Examination of Trading Programs

Clear patterns emerge from the review of existing and developing trading programs. For the most part, key conditions that were identified by U.S. EPA and academic studies appear to still prevail. This examination strengthens and refines earlier indications about the ingredients to a successful trading initiative. These ingredients are briefly summarized below.

- ***Leadership — Champions are Needed.*** A core group with consensus-building skills and technical expertise is needed to educate participants and other stakeholders, answer critical procedural and scientific questions, and drive the design and implementation process forward.
- ***Specific Environmental Objectives — A Target and a Baseline***. Whether in the form of a TMDL or similar analysis, the environmental objective must be articulated in clear and measurable terms. Some programs have established a loading cap that they are now under and want to remain below. Others have set loading targets that they must achieve significant reductions in order to meet.
- ***Sufficient Reduction Capacity in Alternative Sources — Provides Tradable Reductions***. Unrequired reductions must be available for which trading is a politically feasible activity. These tradable options may be the only reductions being implemented in the area. More commonly, tradable controls supplement ongoing pollutant control efforts. Such "surplus" typically is found among NPS, but several programs are examining ways to take advantage of temporary or purposeful point source surplus. To date, agricultural sources are the most frequently identified.

- ***Favorable Economics — Creates Incentives to Trade.*** To generate interest in trading and support a workable program, the difference in control costs among some sources must be significantly different — significant enough so that when transaction costs and any operation and maintenance (O&M) costs are factored in, the trade is still a good deal. Point sources have typically found such differentials with NPS partners. While significant differentials between point sources have not been identified to date, point-point trading can offer opportunities to take advantage of timing and scheduling differentials, which translate into better financing deals and cost savings.
- ***Strong Data Collection and Monitoring Program — Measurable and Verifiable Results***. Sufficient data and monitoring are critical in establishing a baseline and evaluating the potential and actual impacts of trades on water quality. It is particularly important to have data on NPS loadings and BMP effectiveness rates to provide sufficient assurance that environmental benefits will result from point-NPS trades.
- ***Workable Regulatory Framework — Flexible but Firm***. Especially for point-NPS trading, accountability and enforceability have been sticking points and deal breakers. The programs examined represent several different approaches to solving this problem. Some rely on permit-based provisions alone and in combination with other mechanisms. Contracts and other binding agreements that specify roles, responsibilities, and recourse also are gaining acceptance.
- ***State Buy-In — As an Active or Passive Participant.*** Regardless of whether the state actively participates in program design and implementation, or plays a narrower role as regulator and observer, state acceptance has been a key component in each program examined. In many instances, state staff played an important part in conducting technical analysis and crafting viable solutions.
- ***Point Source Must See Benefits — That Outweigh Political and Technical Obstacles.*** So far, most trading has involved point sources "buying" reductions from NPS that do not face nearly the same regulatory requirements under which point sources operate. Politically, therefore, many point sources are reluctant to come to the table and discuss trading opportunities when they feel NPS have not been held accountable for "their fair share." Most point sources that have come forward have done so because of compelling economic opportunities, or because they believe that if something is not done, regulatory requirements are likely to become more stringent and new sources may be disallowed.
- ***Resources to Support Design and Piloting — Also Implementation.*** So far, no one can really say that getting a trading program off the ground is cheap. Most of the programs discussed here have, or will have, spent between a couple hundred thousand and one million dollars on data collection, technical analysis, development and design efforts (including workshops, education, and alternatives analysis) to support trading. As more trading programs come on line, people interested in trading will have significantly more information and models at their fingertips, and development costs should begin to come down.

6.4.1 Kalamazoo River, Michigan — WERF Demonstration Project

The Kalamazoo River water quality trading demonstration project is a voluntary, community-driven and incentive-based approach to improving water quality. Trading within the middle reaches of the watershed allows point sources to use NPS phosphorus reductions to meet water quality-based permit limits of participating dischargers.

The objectives of the Kalamazoo project are to demonstrate the effectiveness of voluntary, NPS control programs and the potential environmental and economic benefits of open, watershed-based nutrient trading. This will be accomplished by instituting an actual trade between point source dischargers using project-funded NPS reductions. Trading will thus provide operational flexibility and optimize point source costs of compliance with existing water quality-based effluent limitations.

Grant funding will be used to implement controls and management practices at agricultural, industrial, urban and other locations of NPS runoff. The project seeks to encourage voluntary reductions that promote sustainable agriculture, early compliance with stormwater regulations and improve water quality on a watershed basis. The Kalamazoo project is also being conducted to obtain design information for a statewide water quality trading program and a regional approach for protecting Great Lakes water quality.

One of the first actions taken by the original group of project stakeholders, which was formed to address local water quality incentives and area business needs, was the decision to formalize as a steering committee. From this initial group, local agricultural producers and an area-wide 'umbrella' environmental group (representing seven separate organizations with over 8,000 members) accepted membership to the steering committee.

A specific trading application was identified by the group when a local paper company expressed interest in purchasing phosphorus reduction credits. This interest was ultimately tied to an anticipated use of credits should their product orders necessitate production at all their operational capacity. At such a production rate, existing wastewater treatment capabilities would be exceeded. As additional end-of-pipe treatment was not feasible without costly facility expansion, NPS reduction credits represented a cost-effective alternative to accommodate business needs and permitting requirements. A targeted need of 6.8 kilograms (15 pounds) of phosphorus per day, or 2,495 kilograms per year (kg/year) (5,500 pounds per year) of relief was specified by the paper company for this point/NPS trade.

Since the inception of this project in March 1997, the steering committee has maintained a consistent and cohesive partnership of diverse organizations. All such participants have agreed to the formal framework and organizational structure established to implement all elements of a point/NPS trade. The composition of the steering committee provides representation from agricultural, municipal, industrial, environmental, the private sector and regulatory agencies from within the watershed and from around the State.

Organizations and agencies supporting the project include: The Forum for Kalamazoo County (nonprofit project administrator), the Kalamazoo River Partners Program (watershed group), the City of Kalamazoo Water Reclamation Plant, Crown Vantage Paper Company, Menasha Corporation-Paperboard Division, Keiser & Associates (project technical consultant), the Kalamazoo Environmental Council, Michigan Farm Bureau, Michigan Agricultural Stewardship Association, Michigan Department of Agriculture, Michigan Department of Environmental Quality (regulatory liaison to project), Natural Resources Conservation Service of the U.S. Department of Agriculture, and the Potowatami Resource Conservation Development Council.

Since 1997 the steering committee has debated and reached consensus agreements on critical issues and decisions such as: project communications and outreach, establishment of an equitable trading ratio, NPS site evaluation and monitoring protocols, and a banking and credit allocation strategy.

This 2 $^{1}/_{2}$-year project will demonstrate the environmental and economic benefits of point/NPS watershed-based phosphorus trading. It will promote voluntary NPS reductions, optimize point source compliance costs, increase public awareness and facilitate collaborative, community-driven watershed management initiatives for achieving water quality standards (Kieser, 1998).

6.4.2 Long Island Sound, Connecticut — WERF Demonstration Project

The Long Island Sound initiative, led by a group of municipalities, is being developed as an alternative to the management approach proposed by Connecticut and New York State environmental commissioners and U.S. EPA, represented by the Region 1, Region 2, and Long Island Sound Offices. The Sound's Comprehensive Conservation and Management Plan (CCMP) recommends reducing nitrogen loadings to increase dissolved oxygen levels and eliminate hypoxia. The two states and U.S. EPA have developed an implementation plan that reduces nitrogen loadings by 58.5 percent over 15 years. The plan also calls for an equal reduction in each of 11 management zones "despite differing levels of contribution and impact from each zone" (City of Norwalk, 1997).

Participants believe that point-nonpoint and point-point trading will offer opportunities to meet water quality objectives sooner, more cost-effectively and equitably. If successful, the demonstration could lead to a broader trading program that helps to optimize investments in controls. As it stands now, equal reductions in each zone will require new construction and upgrades at over 120 POTWs, and two major industrial dischargers as well as installation of significantly more controls and BMPs on 10.5 million acres. Without a more flexible approach, estimated costs for such nitrogen removal at POTWs range from $660 million to $5 billion.

The demonstration project involves four Connecticut municipalities. The cities of Norwalk and Stamford are expected to be credit sellers and the towns of Groton and Greenwich are expected to be buyers. NPS reductions also may be achieved in the immediate vicinity and added to the trading pool. Using trading ratios or credit definition techniques, reduction credits will be valued based on their relative water quality impact between the management zones. If successful, such trading will demonstrate that nitrogen reductions do not have to be equal across zones to achieve water quality objectives for Long Island Sound.

The following elements will be addressed during demonstration design and implementation:

- Rules necessary to create enforceable water quality targets and permit limits;
- Schedule and plan for point and NPS reductions;
- Credit accounting system, to define credit creation and credit life;
- Credit bank, role in setting credit value, auditing credit sites, managing interstate trading, administering buying/selling — credits/debits, and potential financing role;
- Distinction between credits created in whole or part with state or federal funds (e.g., State Revolving Funds);
- Accountability and enforcement mechanisms to enforce limits, trades, exact penalties for not creating sold credits, annual monitoring, and year-end reconciliation;
- Inter-zone trading, value credits based on location of buyer and seller and relative environmental impact of traded versus avoided reduction;
- Industrial source involvement, desirability and mechanisms for participation; and
- New source evaluations, impact and opportunities to offset through trades.

6.4.3 Tampa Bay, Florida

Participants in the Tampa Bay National Estuary Program (NEP) are implementing a cooperative watershed management approach that closely resembles trading. However, no “exchanges” actually take place, no monetary or in-kind payments are made, and credits and debits are not made on individual accounts. This initiative resembles trading in that some sources are making pollutant load reductions, offsetting increases at other sources, that they otherwise would not have been required to make. Also, maximum loading targets for bay segments have been established and all loading increases and reductions are debited and credited against those targets. Individual loadings and loading reduction responsibilities have been documented, and will be referred to if need be. For now, participants are judged on their performance as a group.

Stakeholders have adopted maximum nitrogen loading targets for Tampa Bay’s five bay segments, based on the water quality and related light requirements of turtle grass *Thalassia testudinum* and other native seagrass species. To “hold the line” against nitrogen exceedances, sources will have to offset the expected 0.5 percent annual increase in loadings (approximately 17 tons per year). Through an intergovernmental agreement addressing the issue of nitrogen load management, partners in the Tampa Bay NEP have committed to develop action plans detailing specific projects that will be implemented to ensure that nitrogen management targets are met.

Local government action plans will address that portion of the nitrogen target which relates to non-agricultural stormwater runoff and municipal point sources within their jurisdictions (loadings projected to increase 6 tons/year). In addition, a Nitrogen Management Consortium (comprised of phosphate mining and fertilizer handling companies, agricultural interests, local utilities, as well as the Tampa Bay NEP’s six local government partners and regulatory agencies) has developed a Consortium Action Plan to address the remainder of the controllable nitrogen load. This comes from industrial point sources, fertilizer shipping and handling, intensive agriculture, and atmospheric deposition (loadings projected to increase 11 tons/year).

The Tampa Bay NEP and several agency and local government members of the consortium have responsibilities for monitoring and tracking the impact of nitrogen management efforts on seagrass recovery and associated water quality. A separate “monitoring and tracking” element is included in the consortium action plan, itemizing specific monitoring actions by the Tampa Bay NEP office and others. Data show that Year 1999 reduction goals will be met if scheduled projects are implemented for all bay segments. The Tampa Bay NEP will review and revise nitrogen management goals every five years — or more often — if significant new information becomes available.

A significant portion of the consortium action plan will be implemented through an interlocal agreement, signed by participants on February 12, 1998. Through the agreement each local government and agency member of the Tampa Bay NEP Management Committee (which also are represented on the consortium) will commit to achieving the goals of the CCMP by developing and implementing individual action plans for their governmental units. The agreement calls for each party to incorporate appropriate elements of the consortium action plan into their individual action plans by May 1998. The private sector members of the consortium will pledge to implement projects for which they are solely or jointly responsible for through a resolution that will accompany this action plan.

6.4.4 Tar-Pamlico, North Carolina

A state-proposed nitrogen standard created the impetus for a group of POTWs — now the Tar-Pamlico Basin Association — to offer a more innovative alternative that relied on trading. The program is now in its second phase, under which the association’s state-approved trading strategy establishes an annual, collective loading cap for nutrients for the group of 14 point source dischargers that belong to the association. Under Phase II, the association's nitrogen cap is 405,256 kg/year and its phosphorus cap is 69,744 kg/year for 1995-2004. The association is treated as a single unit for nutrient reduction accounting purposes, as if under a "bubble," and no individual loading caps or reduction targets are set. The association may purchase NPS reductions to offset exceedances above its loading cap. Association members also may trade with each other, and a few point-point trades have occurred.

The Tar-Pamlico River runs for 180 miles from its headwaters in the Piedmont region to the Pamlico Sound and the Atlantic Ocean. Much of the land in the 5,440-square mile watershed is used for agriculture, including 246 registered swine, dairy, chicken, and poultry operations. NPS, including agriculture, account for about 92 percent of the nitrogen loadings to the river, while point sources, primarily municipal wastewater treatment plants, contribute eight percent.

The first phase of the trading strategy from 1989 to 1994 gave the association an annual loading cap for nitrogen and phosphorus, the two nutrients of concern. The nutrient cap decreased from 525,000 kg/year in 1991 to 425,000 kg/year in 1994, reflecting total reductions in nitrogen and phosphorus of 180,000 kg/year and 20,000 kg/year, respectively. Phase I also outlined a monitoring and water quality modeling effort to collect and analyze additional water quality data. Two signatories to the Phase I agreement — the Environmental Defense Fund (EDF) and the Tar-Pamlico River Foundation — did not endorse Phase II, citing concerns about the plan's ability to address NPS and the level of the nutrient cap for point source dischargers (EDF was instrumental in designing and implementing the Phase I program). The North Carolina Divisions of Environmental Management and Soil and Water Conservation endorsed both Phase I and Phase II of the nutrient reduction strategy.

If the association exceeds its annual loading cap, it purchases offsetting credits by contributing $29 per kilogram to the state agriculture cost share fund, which supports installation of BMPs on agricultural land. Credits are good for three or ten years, depending on whether they are for non-structural or structural BMPs. The State Division of Soil and Water Conservation regularly inspects cost share-funded BMPs and monitors BMP performance.

At the end of Phase I, the association had reduced nutrient discharges 28% despite an 18% increase in flow. The association achieved these reductions primarily through operational improvements. To date, only point-point trades among association members have occurred. Under Phase II, the association expects to purchase credits to meet its loading cap. Without trading, the association estimates it would cost its members an average of $7 million in plant upgrades to achieve a comparable level of nutrient reduction that a $1 million investment in NPS controls provides.

6.4.5 Lake Dillon, Colorado

Trading between point and NPS of phosphorus around Lake Dillon has been allowed since 1984, but only a few trades have taken place. Unanticipated conditions have refocused the trading program on developing a system to provide accounting, enforcement, and maintenance of equitable nonpoint-NPS trading. Further, many stakeholders believe the cooperative management approach that grew out of developing the trading option, along with the option itself, are key reasons why they have been able to maintain high water quality for more than 12 years in the face of population growth and development.

Lake Dillon is a prominent recreational area as well as a staging reservoir for Denver's drinking water system. Communities surrounding the Lake Dillon include Breckenridge, Copper Mountain, Frisco, Dillon, and Keystone. Wastewater treatment plants serving these towns are the primary point sources of pollution. Runoff from towns and ski areas is the main NPS of phosphorus, along with selected inadequately managed septic systems.

The concept of water pollutant trading in Colorado was first codified in the 1984 Dillon Control Regulation adopted by the WQCC. Two years earlier the state established a phosphorus concentration standard to maintain the Lake Dillon's high water quality. The regulation translated this standard into a total maximum annual phosphorus load of 4,610 kg/year. The 1984 regulation also allows point sources to receive 1 kilograms of credit for every 2 kilograms of NPS phosphorus removed. When point-NPS trades occur, point source discharge permits include the following information: a record of the credit amount; specified construction requirements for NPS controls; monitoring and reporting requirements for NPS BMPs; and O&M requirements for BMPs.

The Summit County Water Quality Committee coordinates Lake Dillon trading program. It identifies potential BMP projects and distributes phosphorus credits. It also assures trend monitoring is performed in the watershed and that ordinances designed to reduce NPS pollution are adopted and implemented (e.g., covering septic tanks). The committee reviews all activities in the watershed that may potentially impact water quality and reports to the WQCC on Lake Dillon water quality management efforts, including trading.

Between 1981 and 1991 Dillon POTWs point sources reduced their phosphorus loading from 3,748 kg/year to 529 kg/year through improved operating efficiency, achieving some of the highest phosphorus removal capabilities in the nation. At the outset of the trading program, a tap ban precluded treatment plants from adding new customers. Many stakeholders believe the promise of trading created an incentive to improve plant operations to serve new residents rather than rely on septic systems. In one trade, the town of Breckenridge generated 25 kg/year of credit, which it has not yet needed, when it sewered septic systems in one subdivision that had been loading 50 kg/year to Lake Dillon. Today, the trading program also provides a mechanism for new NPS to offset their water quality impacts by implementing additional BMPs at older NPS sites.

6.5 Trading Program Comparison Matrix

Table 6-1 provides an at-a-glance comparison of the key program elements for Cherry Creek, Kalamazoo Lake, Lake Dillon, Long Island Sound, Tampa Bay, and Tar-Pamlico.

Table 6-1. Trading Program Comparison Matrix

Program Element	Cherry Creek, CO	Kalamazoo-Lake MI	Lake Dillon, CO	Long Island Sound, CT	Tampa Bay, FL	Tar-Pamlico, NC
Pollutant(s)	P	P	P	N	N	N & P
TMDL	Under reconsideration	No—under development	No—loading cap established	No—reduction targets for 11 zones	Yes—loading caps for 5 segments > TMDLs in '98	No—loading caps established for both N and P
Types of Trades	p>np; p>p (through temporary and permanent transfers)	p>np; p>p	p>np, np>np	p>p, p>np	p>p, p>np, np>np	p>np, np>np
Traded Reductions	Variety runoff control and restoration BMPs not otherwise required	Agricultural, urban: capital, BMP, and restoration projects	Urban runoff controls, additional BMPs in lieu of POTW upgrades	Some POTWs will reduce lbs *sooner* and/or in *greater amounts*; np reductions also may be traded	All sources put proposed nonstructural and structural projects on table and add up reductions	POTWs trade with each other or buy agricultural reductions through state cost share fund
Eligible Parties	Basin Authority Members and others interested in the program	Paper mills A POTW	4 POTWs Lake towns	4 POTWs	6 govts. Private sources in Consortium	Tar-Pamlico Basin Assoc. Members
Trading Ratio(s)	Ranges from 1.3:1 to 3:1	2:1	2:1 for all types	Not yet established	1:1	BMPCrop = 3:1 Animal = 2:1
Credit Price	Not yet established	Not yet established	Project-specific	Not yet established	No buying or selling per se	$29/kilogram
Other Available Funding, Financing	CCBWQA $: property taxes; grading, bldg. Permit, and recreation fees; waste H_2O fees	State, federal funds for ag and urban BMP programs plus point source support	POTWs paid for operational improvements; local govts. fund some runoff controls	SRF: trading to be integrated with fund priorities and procedures	Local govts. Pay for p and np reductions, as do private sources	POTWs paid for operational improvements; state cost-share fund supports ag BMPs

Table 6-1. Trading Program Comparison Matrix (continued)

Program Element	Cherry Creek, CO	Kalamazoo-Lake MI	Lake Dillon, CO	Long Island Sound, CT	Tampa Bay, FL	Tar-Pamlico, NC
Banking, Other market mechanisms	Intend to bank credits in a closed-system	May bank verified credits; established a credit allocation protocol	Limited, some credits not yet being used	Will establish credit bank and banking rules	Bank-like: reductions tracked, extra good til needed	Credits created on-going basis, POTWs buy as needed
Stake-holders	CCBWQA & members, COG, state water quality regulators; Parks	FORUM for Kalamazoo Co., MI Depts. Ag. & Env. Quality, other farm orgs., local govts., env. groups	Summit Co. Water Quality Committee; Keystone, Breckenridge, Copper Mtn, Frisco, COG, state regulators	Norwalk, Stamford, Groton, and Greenwich, CT; this demo alternative to EPA-CT-MA-backed plan	NEP; Tampa, St. Pete, Clearwater; Pinellas, Hillsborough, Manatee Co., private firms; state, federal, local agencies	16 POTWs; NC Depts. of Env. Mgt., Ag., Soil & H_2O Consv. Environmental Defense Fund
Adminis-trative Roles	CCBWQA will oversee, incl. tracking and reporting	Well-defined; Project Steering Committee (SC) makes decisions (policy, proc., expend.). Various subcommittees participate in reviews of monitoring site selection. All decisions and funding must be approved by vote of SC	Summit Co. Water Quality Committee coordinates all	Cities to oversee, specifics not yet defined	Monitoring, tracking coordinated by NEP	State and Association split responsibilities

Table 6-1. Trading Program Comparison Matrix (continued)

Program Element	Cherry Creek, CO	Kalamazoo-Lake MI	Lake Dillon, CO	Long Island Sound, CT	Tampa Bay, FL	Tar-Pamlico, NC
Regulatory Context & Provisions	State reg. specific to basin estab. trading guidelines; trades written into permits	Special permit conditions to be negotiated w/MDEQ; contracts may supplement arrangements	NPDES permits reflect trades, incl. O&M and monitoring, reporting requirements	Rules to create enforceable water quality targets and permit limits under development	Reductions voluntary, Interlocal Agreement & Consortium Action Plan guide program	POTWs have duel w/ & w/o trading permit limits, loading cap is bubble over Assoc. members

6.6 How To Identify Trading Opportunities

Table 6-1 identifies the various aspects of the different trading programs discussed earlier. Those aspects considered include the pollutants traded, types of trades, the trade reductions, eligible parties, trading ratio, credit price, funding, banking, stakeholder, administrative roles, and the regulatory context and provisions.

CHERRY CREEK BASIN WATER QUALITY AUTHORITY WATER QUALITY TRADING GUIDELINES

A-1 Establishment of Trading Program

A.1.A Legal Basis

The Cherry Creek Basin Water Quality Authority is authorized to implement and maintain a program for nonpoint/point source phosphorus trading in the Cherry Creek Basin Watershed. The trading program and these water quality trading guidelines are developed pursuant to the Cherry Creek Basin Water Quality Authority Enabling Act, C.R.S. 25-8.5-101, et seq. and the Cherry Creek Reservoir Control Regulation, 5 C.C.R. 1002-72, § 72.4(8). These guidelines have been adopted by the authority by resolution of the Board of Directors. The authority will administer and oversee the trading program.

A.1.B Purpose

The trading program allows point source dischargers to receive phosphorus pounds for new or increased phosphorus wasteload allocations in exchange for phosphorus loading reductions from nonpoint source pollutant reduction facilities ("PRFs"). Only PRFs that remove phosphorus beyond mandatory BMPs will qualify for trading. The goal of the trading program is to allow those trades that will have a net water quality benefit in the basin and maintain the inlake chlorophyll a level of 15 µg/L.

A.1.C Scope

The trading program and these guidelines provide for two types of trading:

A.1.C.1 Authority Pool Trades

Pounds of phosphorus removed from the authority-controlled PRFs ("authority pool projects") will be quantified and designated as authority removal credits in the trading pool. A trade ratio will be established for each PRF on a project-specific basis and applied to the project's authority removal credits to determine the amount of phosphorus wasteload allocation pounds available in trading for point source discharges ("authority discharge credits"). Upon compliance with the requirements of these guidelines, the authority may authorize point source dischargers in the basin to purchase a specified number of authority discharge credits from the trading pool.

A.1.C.2 In-Kind Trades.

Project owners, other than the authority, that fund and operate PRFs in the basin may request that the phosphorus removed by such projects be quantified as in-kind removal credits. The trade ratio for each PRF will be determined by the authority on a project-specific basis and applied to the in-kind removal credits to calculate the amount of phosphorus wasteload allocation pounds available for point source discharges from the project ("in-kind discharge credits"). Recipients of in-kind discharge credits may use the credits for their own point source discharges or, subject to the authority's approval, transfer the in-kind discharge credits to another party that is a point source discharger.

A.1.D Definitions

All definitions contained in the Cherry Creek Reservoir Control Regulation at 5 C.C.R. 1002-72, § 72.2 shall apply to these guidelines and the trading program. The following definitions shall also apply:

1. ***Authority Discharge Credits*** represents a quantification, in pounds per year, of the actual number of phosphorus wasteload allocation pounds that may be used for point source discharges in authority pool trades.
2. ***Authority Pool Projects*** means designated PRFs funded by the authority, solely or jointly, and third party PRFs that are donated to the trading pool.
3. ***Authority Removal Credits*** are a quantification, in pounds per year, of nonpoint source phosphorus reduction achieved at authority pool projects.
4. ***Best Management Practices*** means "best management practices" as defined in the Control Regulation 5 C.C.R. 1002-72, § 72.2(11).
5. ***Cherry Creek Basin or Basin*** means the Cherry Creek basin as depicted on Figure 1 attached to the control regulation and defined at 5 C.C.R. 1002-72, § 72.2 (14).
6. ***Control Regulation*** means the Cherry Creek Reservoir Control Regulation, 5 C.C.R. 1002-72, § 72.1, et seq.
7. ***Empirical Modeling*** means a calculation, series of calculations, or model that quantifies the net nonpoint source phosphorus removed by a PRF.
8. ***In-Kind Discharge Credits*** represent the actual number of phosphorus wasteload allocation pounds that may be applied to a discharger's permit as the result of an in-kind trade.
9. ***In-Kind Projects*** means PRFs funded and operated by project owners other than the authority and approved by the authority for credit in in-kind trades.
10. ***In-Kind Removal Credits*** represent a quantification, in pounds per year, of nonpoint source phosphorus reductions achieved at in-kind projects.
11. ***Mandatory Best Management Practices*** ("mandatory BMPs") means required temporary measures primarily implemented to arrest and mitigate construction runoff (such as filter fences, hay bales, and revegetation) and permanent water quality improvements required by drainage criteria and land use regulations for all new development (such as detention ponds, swales, and construction wetlands).
12. ***Project Owner(s)*** means the party (or parties) responsible for funding the design, construction, operation and maintenance of non-authority controlled PRF in the basin. If there is more than one project owner for a PRF, the agreement between the project owners on allocation of the in-kind discharge credits shall be determinative.
13. ***Pollutant Reduction Facilities*** ("PRFs") means nonpoint source, phosphorus removal projects that provide phosphorus removal beyond the removals attained by mandatory BMPs.
14. ***Trade Ratio*** represents the pounds of nonpoint source removal credits required to establish one pound of discharge credit.
15. ***Trading Pool*** means the pool of authority pool projects, authority removal credits and authority discharge credits.

A.2 Trading Pool

A.2.A Authority Discharge Credits for Authority Pool Trading

The authority shall establish and maintain a pool of authority discharge credits from authority pool projects that will be available exclusively for purchase by point source dischargers in the basin approved by the authority.

A.2.B Removal Credits and Discharge Credits

Authority discharge credits shall be derived from authority removal credits.

A.2.B.1 Authority Removal Credits

Authority removal credits represent a quantification, in pounds per year, of nonpoint source phosphorus reduction achieved at authority pool PRFs ("authority pool projects"). Authority removal credits are not transferable to dischargers and shall be used solely to calculate authority discharge credits.

A.2.B.2 Authority Discharge Credits

Authority discharge credits, which are transferable to dischargers in authority pool trades, represent the actual number of phosphorous wasteload allocation pounds that may be used for point source discharges. Authority discharge credits are calculated by applying the appropriate trade ratio to the authority removal credits for each authority pool project.

A.2.C Trade Ratio

The trade ratio represents the pound(s) of authority removal credits required to establish one authority discharge credit.

A.2.C.1 Range for Projects

The trade ratio for authority pool projects will be established on a project-specific basis within the range of 1.3:1 to 3:1; for every 1.3 to 3 (three) pounds of authority removal credits approved for an authority pool project, one authority discharge credit will be available in the trading pool.

A.2.C.2 Criteria.

In determining the trade ratio for each authority pool project, the authority may consider, *inter alia*: reliability and certainty of calculating nonpoint source phosphorus removals, removal technology and efficiency, technological specifications of project, reliability of project operations and maintenance, extent and sufficiency of nonpoint source controls on any development served by the project, extent and sufficiency of nonpoint source controls during construction of the project, the net effect of the project on overall water quality in the basin, reliability of project maintenance and operations, and a margin of safety.

A.2.D Authority Pool Projects

The authority may establish a pool of authority removal credits and associated authority discharge credits from the following types of approved authority pool projects (approved in the manner set forth below at A.2.E).

A.2.D.1 Authority-Funded Projects

Reductions of nonpoint source phosphorus at authority-funded PRFs will be eligible for assignment to the trading pool.

A.2.D.2 Joint Projects

Reductions of nonpoint source phosphorus at PRFs funded jointly by the authority and third parties may be assigned to the trading pool. Unless otherwise agreed to by the authority in writing, all benefits and credits for phosphorus removal at joint projects shall be the property of the authority.

A.2.D.3 Third Party Projects

The authority may also accept donations of nonpoint phosphorus reductions to the trading pool from other public or privately-funded PRFs.

A.2.E Assignment of Credits to Trading Pool

The authority may assign authority removal credits and authority discharge credits to the trading pool in the following manner:

A.2.E.1 Project Nominations

The authority's Technical Review Committee ("TRC"), authority members, or non-authority third parties may nominate PRFs to be designated as authority pool projects and to form the basis for credits in the trading pool.

- *Existing Projects*. The authority has nominated four PRFs that it has constructed and operates in the basin: Shop Creek Water Quality Improvements, Quincy Outfall Water Quality Improvements, East Shade Shelter Shoreline Stabilization Project, and Cottonwood Creek Water Quality Improvements.
- *New Projects*. Upon its own petition or petition by authority members or third parties, the authority shall consider new PRFs for nomination as authority pool projects.
- *Qualifying Projects*. The authority will only consider for approval those PRFs that reduce phosphorus loadings over and above mandatory BMPs.

A.2.E.2 Project Proposal

For each nominated PRF, the authority's TRC or project owner shall recommend the project as an authority pool project and prepare a technical project proposal that includes the following information:

- Description and technical specifications of project;
- Estimated quantification of nonpoint source phosphorus reduction and technical basis for such quantification, including any monitoring data, if available, or empirical modeling, if monitoring data are unavailable;
- Recommended number of authority removal credits removed by the project;
- Recommended trade ratio, between 1.3:1 and 3:1, for the project and justification for the ratio;
- Recommended number of authority discharge credits, calculated from recommended authority removal credits and trade ratio, from the project;
- Recommended monitoring programs and commitments for maintenance and operation of the project; and
- Analysis of the net effect of the project on water quality in the basin.

A.2.E.3 Comments from Division

The authority shall solicit and consider comments and evaluation on project proposals by the Water Quality Control Division of the Colorado Department of Public Health and Environment ("division").

A.2.F Decision Criteria

When considering whether to approve project proposals for authority pool projects and credits, the authority shall consider:

1. The technical specifications of the project;
2. Estimated quantification of nonpoint source phosphorus reductions;
3. Reliability of project maintenance and operations;
4. Evaluation and comments of the division;
5. Consistency with the authority's trading guidelines, the Cherry Creek Basin Water Quality Management Master Plan and the control regulation;
6. The net effect the trade will have on the water quality of the basin; and
7. Any other factors the authority deems necessary to evaluate the proposal.

A.2.G Authority Decisions on Project Proposals:

A.2.G.1 Public Meeting

The authority shall provide an opportunity at a meeting for interested parties to provide comments on the project proposal and the proposed authority pool project.

A.2.G.2 Authority Vote

Voting on project proposals shall be governed by the voting requirements of C.R.S. § 25-8.5-107.

A.2.G.3 Authority Decisions

The authority may approve, conditionally approve or deny all project proposals.

A.2.G.4 Credits to Pool

In decisions approving or conditionally approving a proposed project as an authority pool project for inclusion in the trading pool, the authority shall specify:

- The authority removal credits for the trading pool based upon reduction estimates at the project;
- The trade ratio for the project; and
- Authority discharge credits to the trading pool from the PRF calculated from authority removal credits and trade ratio for the project.

A.3 Authority Pool Trades

A.3.A Restricted Sale of Credits from Trading Pool

Upon application, qualifying dischargers in the basin approved by the authority may purchase an approved number of authority discharge credits from the trading pool.

A.3.B Trade Criteria

Dischargers who wish to purchase authority discharge credits from the trading pool must demonstrate to the authority's satisfaction, compliance with the following criteria:

A.3.B.1 Need

In determining whether a discharger demonstrates an appropriate and timely need for authority discharge credits, the authority shall consider:

- ***Treatment Capacity***. Treated wastewater flows at the discharger's treatment facility must be approximately 70% of the wastewater treatment facility's design capacity.
- ***Wasteload Allocation.*** The discharger's phosphorus wasteload allocation must be insufficient to accommodate near-term treated wastewater flows from the facility's expansion.
- ***Growth Plans.*** The discharger's plans for facility expansion must be reasonable given current facility size, forecasts of population and employment in its service area, the proposed size of the incremental expansion, and timing of need and schedule for completion of new or expanded facilities.
- ***Quantity of Desired Authority Discharge Credits.*** The amount of authority discharge credits to be purchased must be reasonable and appropriate given the discharger's plans for facility expansion or operations, the discharger's current wasteload allocation, the actual and anticipated growth of other dischargers in the basin, and the conditions of the Cherry Creek reservoir and basin.

A.3.B.2 Treatment Efficiency.

- ***Current***. The discharger must demonstrate that its treatment facility is operated efficiently so that the facility achieves the optimal treatment results reasonably expected for the facility's wastewater treatment technology.
- ***Future***. The discharger must demonstrate that the treatment facility, even with the increased wasteload allocation from authority discharge credits, will be operated efficiently so that the facility achieves the optimal treatment results expected for the facility's wastewater treatment technology.

A.3.B.3 Compliance With Effluent Limitations.

- ***Current***. The discharger must demonstrate that it achieves the effluent limitations specified in the control regulation at 5 C.C.R. 1002-72, § 72.5 and the effluent limitations in its discharge permit.
- ***Future***. The discharger must demonstrate that its treatment facility is or will be designed or operated to meet the effluent limitations specified in the control regulation at 5 C.C.R. 1002-72, § 72.5, and the effluent limitations expected to be set in its discharge permit.

A.3.B.4 Consistency With Master Plan and Control Regulation

The discharger must demonstrate that its treatment facility, plans for expansion, and the proposed trade are or will be consistent with the Cherry Creek basin water quality management master plan and the control regulation.

A.3.C Application to Authority

Dischargers seeking to purchase authority discharge credits from the trading pool in an authority pool trade must apply in writing to the authority. Applications must include:

- Name and address of the discharger;
- Proposed number of authority discharge credits to be purchased;
- Descriptions of the discharger's plans for new or modified wastewater treatment facilities and the schedule for construction of the facilities;
- Sufficient evidence to demonstrate that the applicant satisfies each of the criteria for need, treatment efficiency, compliance with effluent limitations, and consistency with master plan and control regulation, as enumerated in these guidelines at A.3.B;

- Analysis of the net effect the trade will have on the water quality of the basin;
- A description of the financing arrangements, if any, used to fund the purchase of the authority discharge credits;
- If the applicant will be unable to pay the total purchase price for approved authority discharge credits within forty-five (45) days of the authority's application decision, as provided at A.3.H, a proposed schedule for payment and justification for such schedule;
- Such other information or data as the authority or the authority's TRC may determine is necessary to evaluate the request for authority discharge credits; and
- A non-refundable application fee of $100.

A.3.D Direct Application Costs

In addition to the $100 application fee, the authority may also charge the applicant for any additional direct costs incurred by the authority, including costs of consultants to review the application and advise the authority on every aspect of the application.

A.3.E. Decision Criteria

When considering applications for authority pool trades and determining the number of authority discharge credits, if any, to be authorized for purchase, the authority will consider:

- The sufficiency of the evidence to demonstrate satisfaction of each of the criteria for need, treatment efficiency, compliance with effluent limitations and consistency with master plan and control regulation enumerated in these guidelines at A.3.B;
- The completeness of the application;
- The reasonableness of the number of requested authority discharge credits;
- The reasonableness of the facility's plans for expansion;
- The net effect the trade will have on the water quality of the basin; and
- Any other factors the authority deems necessary to evaluate the application.

A.3.F Authority Decisions on Applications:

A.3.F.1 TRC

Applications for authority pool trades first shall be reviewed by the authority's TRC.

- ***Completeness Review.*** The TRC shall review applications for completeness. If the TRC determines that the application is incomplete or that additional information is necessary, the TRC may notify the applicant if, and in what respects, the application is incomplete or what additional information is necessary.
- ***Ex-Officios.*** The TRC shall solicit and consider comments and evaluation on trade applications by one or more ex-officio members of the authority.
- ***Recommendation to Board.*** Following completion of its review, including consideration of comments and evaluation by ex-officio members, the TRC shall recommend to the authority's Board of Directors whether the proposed authority pool trade should be approved, conditionally approved or denied. The TRC shall forward its recommendation regarding the proposed trade to the authority's Board at a meeting of the authority.

A.3.F.2 Public Comments

The authority shall provide an opportunity for the applicant and any interested agency or person to provide comments on the proposed trade.

A.3.F.3 Public Meeting

The authority shall consider the proposed trade at a regular or special meeting of the authority.

A.3.F.4 Authority Vote

Voting on trade applications shall be governed by the special voting requirements of C.R.S. § 25-8.5-107.

A.3.F.5 Authority Decisions

The authority may approve, conditionally approve or deny all applications for trades.

A.3.F.6 Reconsideration

Affected parties may file, within 30 days of an adverse authority decision on an application, for reconsideration of the authority's decision, and the authority shall reconsider the decision. Following the authority's vote on reconsideration, the authority's decision on the application will be deemed final.

A.3.G Prices for Authority Discharge Credits

The authority shall establish, by resolution, all prices for authority discharge credits.

A.3.G.1 Bases For Prices

When establishing prices, the authority may consider the following:

- ***Costs of Nonpoint Source Projects.*** The authority may consider the costs of authority-funded PRFs, including past development and capital costs; operating, monitoring and maintenance costs; and estimated future costs for construction and operation of new PRFs.
- ***Costs of Trading Program***. The authority may consider its costs to establish, administer and oversee the trading program.
- ***Contribution to Project Costs.*** The authority may consider dischargers' participation in the authority and contributions to authority-funded PRFs.

A.3.G.2 Existing and New Dischargers

The authority may establish two levels of prices for authority discharge credits, one price for those dischargers that were members of the authority prior to November 20, 1997, and a second price or surcharge for dischargers that were not members of the authority prior to November 20, 1997.

A.3.G.3 Review

The authority may, from time to time, reconsider and modify prices for authority discharge credits.

A.3.H Payment for Authority Discharge Credits

Unless otherwise approved in writing by the authority, dischargers awarded authority discharge credits must pay the total purchase price for the approved authority discharge credits within 45 days after notice from the authority awarding the discharger authority discharge credits.

A.3.I Discharge Permits

All trades are subject to the requirements of the applicant's discharge permit. It shall be the sole responsibility of the applicant to attain any approvals or modifications to their discharge permits necessary to allow increased or modified phosphorus discharges from their wastewater treatment facility.

A.3.J Trading Pool Status

A.3.J.1 Credits From Authority Pool Projects

The authority shall update from time to time, reflecting all authority pool projects including authority removal credits and trade ratio for each project and the total authority discharge credits assigned to the trading pool.

A.3.J.2 Available Credits

The authority shall updated from time to time, to reflect authority discharge credits that have been transferred to each discharger, by trade, and the balance of untransferred authority discharge credits in the trading pool available for future trades.

A.3.K Adjustments to Pool

A.3.K.1 Periodic Review

From time to time, the authority shall review the authority pool projects, including estimates of phosphorus removals for each project, the basis for authority removal credits, and designated trade ratio. If appropriate, the authority may make necessary adjustments to authority removal credits and trade ratio for each project, as well as any commensurate adjustments to authority discharge credits for each project and total authority discharge credits.

A.3.K.2 Downward Adjustments of Authority Discharge Credits

If the authority determines, based upon their periodic reviews pursuant to A.3.K.1 above, that the authority discharge credits should be decreased, the authority shall make any adjustments to decrease credits, as follows:

- ***Untransferred Credits First.*** The authority shall first eliminate any authority discharge credits that have not yet been purchased or otherwise transferred out of the trading pool.
- ***Insufficient Untransferred Credits.*** Second, if there are insufficient untransferred authority discharge credits remaining in the trading pool for the decrease to authority discharge credits, the authority shall notify all holders of transferred authority discharge credits that *pro rata* decreases of their authority discharge credits may be necessary unless, within three years, additional authority projects providing sufficient authority discharge credits to account for the decrease in authority discharge credits are included in the trading pool.
- ***Pro Rata.*** Lastly, if decreases in authority discharge credits remain necessary after the expiration of the three-year waiting period referenced at A.K.2.b above, the authority shall rescind and eliminate transferred authority discharge credits awarded to dischargers on a *pro rata* basis.

A.3.K.3 Reinstatement of Credits

If the authority rescinds and eliminates transferred authority discharge credits on a *pro rata* basis pursuant to A.3.K.2.c above, those dischargers shall have a priority if later authority discharge credits become available in the trading pool. Such authority discharge credits shall be reinstated on a *pro rata* basis, unless a discharger, due to changed circumstances, no longer satisfies the criteria enumerated at A.3.B of these guidelines.

A.4 In-Kind Trades

A.4.A Credits for Independently-Funded Projects

Upon application and approval by the authority, project owners who construct PRFs may receive in-kind discharge credits for their projects' phosphorus removals, and either apply the credits to their own discharge permits or transfer the credits to third parties.

A.4.B Removal Credits and Discharge Credits

In-kind discharge credits shall be derived from in-kind removal credits.

A.4.B.1 In-Kind Removal Credits

In-kind removal credits represent a quantification, in pounds per year, of nonpoint source phosphorus reduction achieved at in-kind PRFs ("in-kind projects"). In-kind removal credits are non-transferable and shall be used solely to calculate in-kind discharge credits.

A.4.B.2 In-Kind Discharge Credits

In-kind discharge credits, which are transferable to dischargers in in-kind trades, represent the actual number of phosphorous wasteload allocation pounds that may be applied to a discharger's permit as the result of a trade. In-kind discharge credits are calculated by applying the appropriate trade ratio to in-kind removal credits.

A.4.C Trade Ratio

The trade ratio for in-kind trades represents the number of in-kind removal credits required to establish one in-kind discharge credit.

A.4.C.1 Range for Projects

The trade ratio for in-kind projects shall be established on a project-specific basis within the range of 1.3:1 to 3:1; for every 1.3 to 3 (three) in-kind removal credits approved at an authorized in-kind Project, the participant shall receive one in-kind discharge credit.

A.4.C.2 Criteria

In determining the trade ratio for each in-kind project, the authority may consider, inter alia: reliability and certainty of calculating nonpoint source phosphorus removals; removal technology and efficiency; technological specifications of project; reliability of project operations and maintenance; financial and other assurances to maintain operation of project; monitoring plan; extent and sufficiency of nonpoint source controls during construction of project; extent and sufficiency of nonpoint source controls on any development served by the project; the net effect of the project on overall water quality for the Basin; and a margin of safety.

A.4.D Application to Authority

Project owners of PRFs seeking to receive in-kind discharge credits must apply in writing to the authority. in-kind trade applications must include:

- Name and address of the PRF's project owner(s) and adequate evidence of their status as project owner(s) of the PRF;
- Name and address of the party or parties to receive in-kind discharge credits;
- A non-refundable application fee of $100;
- A technical report that describes the proposed credit project and that includes, at minimum, the following information:
  - — Plans, design and specifications of the PRF;

— Estimated nonpoint source phosphorus to be removed by the PRF and the technical basis for such estimates, including any monitoring data, if available, or empirical modeling results;
— Proposed number of in-kind removal credits from the project;
— Proposed trade ratio, from 1.3:1 to 3:1 and justification for such trade ratio;
— Proposed number of in-kind discharge credits, calculated from proposed in-kind removal credits and trade ratio, from the project;
— Proposed BMPs to control project construction runoff;
— Schedule for completion of the PRF;
— Commitment of sufficient financial resources to complete the PRF on schedule;
— If the PRF is expected, in part, to reduce nonpoint source phosphorus from new development, a demonstration that implementation of BMPs will remove at least 50% of nonpoint source phosphorus from the new development;
— Proposed monitoring and reporting requirements (including regular reporting described at A.4.K of these guidelines);
— Proposed operation and maintenance protocols to maintain nonpoint source controls at the project into the future; and
— Analysis of the net effect of the trade on water quality in the basin, including the following information:
  - Empirical modeling or calculations that demonstrate the net effect of the trade on phosphorus loading to the Cherry Creek Reservoir, based upon consideration of the following factors:
    • The quantity of phosphorus estimated to be removed at the proposed in-kind project on an average annual basis;
    • The quantity of phosphorus estimated to be discharged at the proposed point of discharge on an average annual basis;
    • The proximity of the point of discharge to the proposed in-kind project and the proximity of each to the reservoir;
    • The hydrologic characteristics of the watershed between the proposed in-kind project site and the reservoir, and between the point of discharge site and the reservoir, respectively; and
    • The relative assimilative and absorptive capacities of the watershed/stream network for phosphorus between the proposed in-kind project and the reservoir and between the point of discharge and the reservoir, respectively.
  - Effect of trade on water quality parameters other than phosphorus.

♦ A technical report describing proposed new or modified wastewater treatment facilities of the party(ies) to receive in-kind discharge credits that includes, at a minimum, the following information:
— Sufficient evidence to demonstrate that the party(ies) proposed to receive in-kind discharge credits under the trade satisfies each of the criteria for treatment efficiency, compliance with effluent limitations and consistency with master plan and control regulation enumerated at A.3.B.2 to A.3.B.4 of these guidelines;
— Descriptions of plans by the party(ies) proposed to receive in-kind discharge credits for new or modified wastewater treatment facilities and the schedule for construction of the facilities; and
— A demonstration that implementation of BMP will remove or control the in-flow of at least 50% of nonpoint source phosphorus from the new development if proposed new or modified wastewater treatment facilities are expected, in part, to serve new development;

♦ Financial capability and a commitment to operate and maintain the PRF;

- An agreement among project owners or other parties for the allocation of the in-kind discharge credits; and
- Such other information or data as the authority or the authority's TRC may determine is necessary to evaluate the request for in-kind discharge credits and the proposed in-kind trade.

A.4.E Direct Application Costs

In addition to the $100 application fee, the authority may also charge the applicant for any additional direct costs incurred by the authority, including costs of consultants, to review the application and advise the authority on every aspect of the application.

A.4.F Comments from Division

The authority shall solicit and consider comments and evaluation by the Water Quality Control Division of the Colorado Department of Public Health and Environment ("WQCD") on applications for in-kind trades.

A.4.G Decision Criteria

When considering applications for in-kind trades and determining the number of in-kind discharge credits, if any, to be transferred to the applicant, the authority shall consider:

- Satisfaction by the project owner and/or party(ies) receiving discharge credits of the qualifying criteria enumerated at A.3.B.2 through A.3.B.4 of these guidelines;
- The completeness and technical soundness of the application, including technical reports;
- The reasonableness of the number of requested in-kind discharge credits;
- Evaluation and comments of the WQCD;
- Reliability of project maintenance and operations;
- The net effect the trade will have on the water quality of the basin; and
- Any other factors the authority or the authority's TRC deems necessary to evaluate the application.

A.4.H Authority Decisions on Applications:

A.4.H.1 Consultation

Applicants for in-kind trades are strongly encouraged to schedule with the authority's TRC, or its designee, a pre-application conference to consider the in-kind trade and the applicability of these guidelines.

A.4.H.2 TRC

Applications for in-kind trades first shall be reviewed by the authority's TRC.

- ***Completeness Review.*** The TRC shall review applications for completeness, and if the TRC determines that the application is incomplete or that additional information is necessary, the TRC may notify the applicant if, and in what respects, the application is incomplete or what additional information is necessary.
- ***Ex-Officios.*** The TRC shall solicit and consider comments and evaluation on trade applications by one or more ex-officio members of the authority.
- ***Recommendation to Board.*** Following completion of its review, including consideration of comments and evaluation by ex-officio members, the TRC shall recommend to the authority's Board of Directors whether the proposed in-kind trade should be

approved, conditionally approved or denied. The TRC shall forward its recommendation regarding the proposed trade to the authority's Board at a meeting of the authority.

A.4.H.3 Public Comments

The authority shall provide an opportunity for the applicant and any interested agency or person to provide comments on the proposed trade.

A.4.H.4 Public Meeting

The authority shall consider the proposed trade at a regular or special meeting of the authority.

A.4.H.5 Authority Vote

Voting on trade applications shall be governed by the special voting requirements of C.R.S. § 25-8.5-107.

A.4.H.6 Authority Decisions

The authority may approve, conditionally approve, or deny all applications for proposed trades.

A.4.H.7 Reconsideration

Affected parties may file, within 30 days of an adverse authority decision on an application, for reconsideration of the authority's decision, and the authority shall reconsider the decision. Following the authority's vote on reconsideration, the authority's decision on the application will be deemed final.

A.4.I Continued Effectiveness of Nonpoint Source Project

All in-kind discharge credits shall be subject to the continued effectiveness of the in-kind project.

A.4.J Water Quality Improvement

The authority shall only approve PRFs that reduce phosphorus loadings over and above mandatory BMPs. The authority shall not approve in-kind discharge credits for projects that merely establish BMPs or stormwater drainage controls.

A.4.K Regular Report

Participants in approved in-kind trades must regularly submit a report to the authority that demonstrates the continued effectiveness of the subject in-kind project.

A.4.L Trading Fee

Project owner(s) in approved in-kind trades must pay an annual fee of $100 to the authority. Funds from trading fees will be used to administer the trading program.

A.4.M Trade Documentation

Trades approved by the authority shall be incorporated into these guidelines.

A.4.N Discharge Permits

All trades are subject to the requirements of the discharge permit of the party(ies) receiving in-kind discharge credits. It shall be the sole responsibility of the applicant and party(ies) receiving credits to attain any approvals or modifications to their discharge permits necessary to allow increased phosphorus discharges.

A.5 Administration

A.5.A Oversight

All approved trades, trade projects, trade ratios, and discharge credits remain subject to authority oversight indefinitely. The authority may modify or revoke an approved trade (including trade project, trade ratio, and discharge credit) at any time, at its discretion, based upon monitoring or modeling data, modifications or changes at PRFs, noncompliance with these guidelines or any conditions imposed by the authority, inconsistency with the Cherry Creek reservoir master plan or the control regulation, modifications of the trading program or any other significant change in circumstances.

A.5.B Duration of Credits

Authority discharge credits and in-kind discharge credits received in approved trades shall otherwise remain valid in perpetuity subject to modifications or revocation by the authority, actions or decisions by any other state or federal governmental body or court, or changes in state or federal law.

A.5.C Not a Property Right

Authority discharge credits and in-kind discharge credits are not a property right. Authority discharge credits and in-kind discharge credits are not owned by the discharger and may be modified or revoked.

A.5.D Review of Guidelines

Upon motion by authority and consistent with the control regulation, the authority may review and propose revisions to the trading program or these guidelines.

A.5.E Triennial Review

The terms and conditions of the trading program, as reflected in the control regulation, are subject to the triennial review process under 5 C.C.R. 1002-21, § 21.3(M)(7).

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