

1.0 Introduction

This memorandum documents the findings of a feasibility evaluation for a proposed project to construct additional wetlands within Cherry Creek State Park to reduce the phosphorus load in Cherry Creek. The constructed wetlands would be targeted toward reducing the relatively high concentrations of phosphorus in the shallow alluvial flows that are conveyed beneath the sand bed of Cherry Creek into the reservoir.

This feasibility evaluation was undertaken for the Cherry Creek Basin Water Quality Authority as a first step in the design process to define the general configuration and cost of the proposed improvements, verify that the project is technically feasible and can meet the phosphorus reduction goals estimated by the Authority, and investigate ancillary issues such as permitting, water rights, and park impacts.

The memorandum addresses the following topics.

- ? Original Project Concept
- ? Evaluation of Original Project
- ? Summary of Findings
- ? Alternative Design Concept
- ? Phosphorus Reduction
- ? Coordination with Parks
- ? Permitting
- ? Water Rights
- ? Opinion of Probable Costs
- ? Schedule
- ? Conclusions and Recommendations

1.1 Original Project Concept

The Cherry Creek State Park treatment wetlands were originally envisioned as a 37-acre complex of constructed wetlands located west of a large ox-bow bend of Cherry Creek in the southern portion of the park. Inflows of water to the wetlands were anticipated to be conveyed through a slotted pipe installed under the creek near the Piney Creek confluence and a 4000-foot-long pipeline leading from the intake to the wetland site. Treating subsurface flows, it was concluded, would reduce the need for sediment removal from the wetlands, since the subsurface inflows would be fairly free of suspended sediment. The wetlands were planned to be constructed using a series of shallow spreader ditches to distribute flow and were projected to reduce phosphorus loading to Cherry Creek by approximately 630 pounds per year.



Original concept was to create 37-acres of treatment wetlands in this upland area adjacent to the creek.

1.2 Evaluation of Original Project

The original project concept was evaluated based the following criteria.

- Adequacy of Water Supply
- Water Rights and Augmentation Requirements
- Phosphorus Reduction
- Wetland Viability
- Parks Acceptance
- Environmental Permitting
- Probable Costs

The lack of a dependable water supply in Cherry Creek at the original project site jeopardizes the viability of the proposed wetlands.



Adequacy of water supply

Throughout the duration of the feasibility evaluation, surface flows in Cherry Creek were non-existent adjacent to the project site. Concern about adequacy of natural creek flows led to a review of historic flow records at the project location (monitoring site CC-8). The records showed that this reach of creek is dry during the summer growing season in most years. This lack of a consistent surface baseflow translates into limited alluvial flows just under the surface of the creek bed. The lack of a dependable water supply jeopardizes the viability of the proposed wetlands, and is expected to worsen in the future as a series of new shallow alluvial wells come on line this year to serve East Cherry Creek Valley Water and Sanitation District irrigation needs.

Water Rights and Augmentation Requirements

Increased evapo-transpiration losses associated with the proposed treatment wetlands comprise water depletions that will need to be replaced through a decreed augmentation plan. Alternate sources of replacement water need to be obtained to augment Cherry Creek flows in an amount matching the depletions.

Several possible replacement water sources for augmentation have been identified, although each has limitations to continue to evaluate.

1. Denver Wholesale Florists Property. Assuming the acquisition of this parcel becomes a reality, an existing deep well on the property may provide a total of 42 acre-feet of augmentation water. This may be able to be increased to 52 acre-feet with a new well in the Laramie-Fox Hills aquifer. Water court approval will be required to use this water in an augmentation plan.
2. Cherry Creek Water Users Association. This group is in the process of applying for an adjudicated augmentation plan, although it needs to confirmed whether any augmentation water may be available for the Authority's project purposes.
3. Division of Parks. The State is has its own sources of replacements water, but this water was developed to meet the State's augmentation needs, so is not thought to be available for other purposes.

A present-worth opinion of probable cost associated with developing 100 acre-feet of augmentation water from the above two sources for a treatment wetland is \$655,000. Details of this cost opinion are shown in a memorandum prepared by Leonard Rice Engineers, provided in Appendix A.

Phosphorus Reduction

Although wetlands treatment is a viable technology to reduce phosphorus concentrations in the alluvial groundwater, the lack of consistent flows at the project site limits the total amount of phosphorus that can be immobilized. A month-by-month analysis of potential phosphorus reduction in a 37-acre cell-type treatment wetlands was undertaken using estimates of flow and phosphorus inputs that could be delivered at the project site. Such a system is estimated to be able to remove up to 360 pounds of the inflowing phosphorus on an average annual basis. This magnitude of phosphorus removal is less than the goal of 630 pounds removal originally identified for the project by the Authority. The details of the wetlands treatment analysis are shown in a memorandum prepared by CH2M HILL, provided in Appendix B.

Wetland Viability

The limited amount of flow projected to be available to support the wetlands during most growing seasons will stress the wetlands and increase the likelihood of weedy species and reduced plant diversity. Drying out deeper pool areas will expose muddy areas and create unfavorable aesthetics for park users. Concerns about adequacy of a consistent water supply in the project location translate into a concern about the overall viability of the wetlands.



Parks staff indicated a reluctance to see this upland prairie landscape converted to wetlands.

Parks Acceptance

The area planned for the original wetlands is currently upland in nature with vegetation characterized by native grasses and several stands of trees. Construction of the proposed treatment wetlands will require the conversion of this upland area to a wetland. Although the creation of wetlands could provide a unique amenity for the park oriented toward waterfowl viewing and educational and interpretive opportunities, park staff have indicated a reluctance to see the character of the upland area change as drastically as the original concept would dictate.

Environmental Permitting

Threatened and endangered species issues that will need to be considered during final design include Preble's Meadow Jumping Mouse and Ute Ladies' Tresses Orchid evaluations. Habitat for both species are present, so field surveys (generally scheduled between June 1 and August 31) are thought to be needed; this will be confirmed with US Fish and Wildlife Service staff.

Any work in Cherry Creek will require consideration of permitting under Section 404 of the Clean Water Act. If a nationwide permit is not determined by US Army Corps of Engineers staff to be applicable, an individual permit will be necessary.

Probable Costs

Order-of-magnitude probable costs for the proposed 37-acre treatment wetland are projected to be in the range of \$1.6 to \$2.4 million, including augmentation, based on a comparison of cost data from similar projects. Average annual operational and maintenance costs are anticipated to be about \$25,000.

1.3 Summary of Findings

The findings of the feasibility evaluation are summarized below.

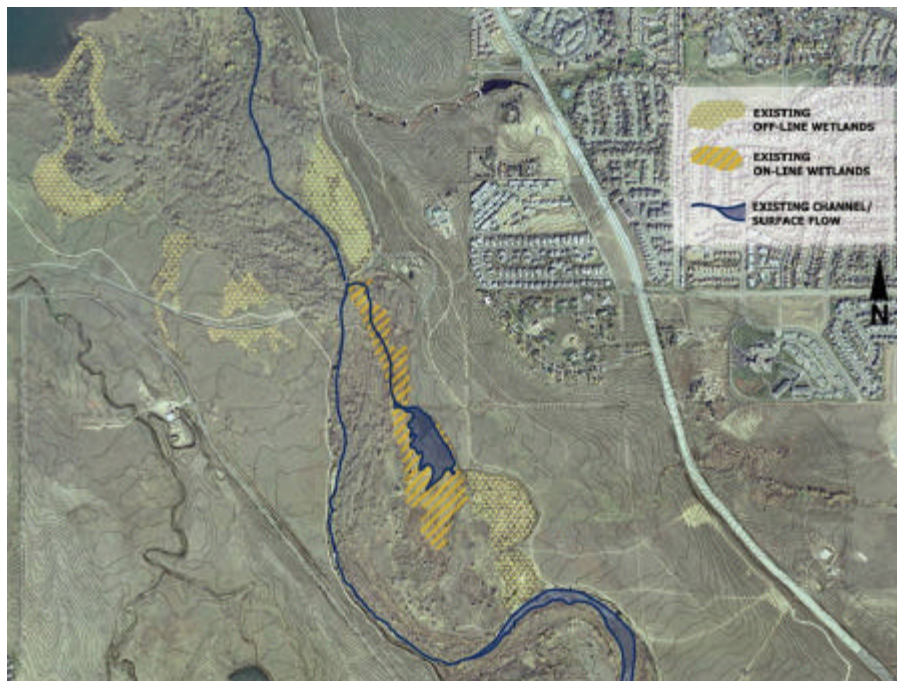
Feasibility Evaluation Findings	
Evaluation Criteria	Finding
Adequacy of water supply	Insufficient
Water rights and augmentation requirements	Achievable, but expensive
Phosphorus reduction	Less than goal
Wetland viability	Questionable
Parks acceptance	Undetermined
Environmental permitting	Feasible
Probable costs	\$1.6 - \$2.4 million

Based on these findings, the project as originally envisioned was judged not feasible. However, an alternative project to reduce phosphorus in Cherry Creek flows was evaluated. This alternative project is described in the following section.

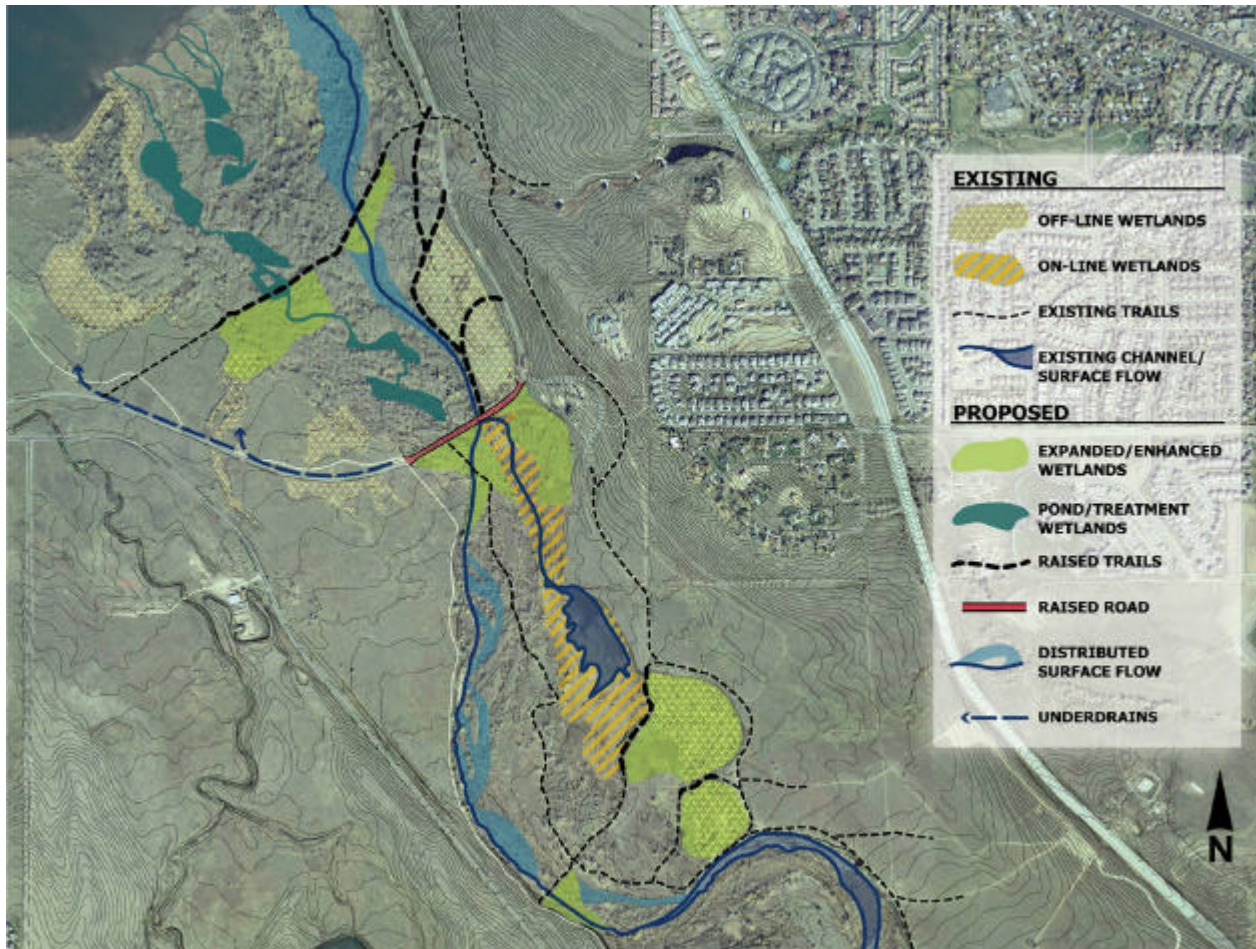
1.4 Alternative Design Concept

The alternative design concept proposes to improve flow distribution in the existing riparian corridor upstream of the reservoir to expand and enhance natural wetlands treatment in the park. This approach takes advantage of existing hydrology to treat alluvial flows that surface naturally throughout the park instead of constructing a subsurface intake and pipeline.

Raising selected park trails is also envisioned to create treatment “cells” to promote settling and infiltration of Cherry Creek storm flows, similar to the improvements that the Authority constructed at the Quincy Outfall several years ago. The trail improvements will also help to address trail erosion and other maintenance problems, preserving park infrastructure.



Existing conditions along Cherry Creek upstream of the reservoir provide opportunities to expand and enhance natural treatment processes.



Proposed water quality improvements along Cherry Creek include expanded and enhanced wetlands, raised trails to detain storm flows, better distribution of surface flows through existing wetlands complex, and selected roadway and culvert improvements.

The alternative design concept calls for creation of additional wetlands, but uses a more surgical approach than the original concept -- fitting the improvements into areas that reduce impacts to the existing landscape -- thereby reducing construction impacts and the long-term visibility of new construction. Water quality features in the alternative concept are individually smaller in scale, but as a whole more distributed and widespread than the original treatment wetlands concept, and can be phased over a period of years if desired.

Specific strategies proposed as part of the alternative design concept include:

- Maintaining and improving the plugged culvert crossings at the Park Perimeter road so the creek is no longer forced to concentrate at one culvert crossing. This will redistribute Cherry Creek flows across the flood plain and will increase wetland area and functionality.
- Improving the distribution of surface flows in the existing incised reach of Cherry Creek (downstream of the perimeter road) by raising the invert of the creek and promoting more frequent overtopping of storm runoff into the adjacent floodplain, increasing treatment through bio-filtration and infiltration.

- Creating impoundments within the flood plain by raising the elevation of selected trails. These impoundments would temporarily capture and detain storm flows and promote phosphorus reduction through settling, infiltration, and wetland treatment. Such improvements will balance cut and fill so that there will be not net loss in storage in the reservoir area.
- Creating additional wetland treatment cells. These cells would be excavated in small open areas within and adjacent to the existing cottonwood woodlands, and, for a given area of wetlands, would reduce phosphorus to a greater extent than the original design concept due to a greater, more consistent inflow of water and phosphorus.



Additional settling and treatment of Cherry Creek flows may be able to be achieved by raising and improving selected park trails.

1.5 Coordination with Parks Uses

The alternative water quality improvements will be carefully coordinated and developed with the input of the Park staff, and will need to conform with the overall park management plan. In general, impacts to the park will be reduced from the original wetland concept. Water quality features can be integrated more seamlessly into the existing landscape, and in most cases will improve the habitat quality, diversity, and the visual quality of the corridor.

Construction operations need to be carefully managed to reduce disturbance to the park. This will be taken into account during the preliminary and final design phases so that construction documents and specifications are clear about access, limits of work, and project staging areas. In addition, an operation and maintenance plan must be prepared to ensure that any facilities that are constructed are maintained appropriately. Park staff have indicated that a maintenance agreement with the Authority will need to be developed.

Other strategies for reducing park impacts include the following:



Wetland treatment cells will be carefully located to take advantage of existing hydrology and reduce impacts to the park.

- Trail impoundments: Properly locating trails is an important management tool for the Park staff to direct use away from sensitive areas, and limit impacts by recreation use. Any trails that will be incorporated into an impoundment design will need to be approved by the parks staff to assure the suitability of the trail in that particular location. Raising the trails will create some temporary impacts, and will require tight control of construction activities to reduce damage to adjacent areas.
- Distributing surface flow: Improvements need to be designed to avoid creating erosive conditions in the over-bank that undermine the benefits of diverting the flows out of the main channel.

- Creating wetland treatment cells: Cells need to be located in close coordination with park staff to avoid sensitive areas. Construction access into the pond areas will need to accommodate heavy excavation and hauling equipment, and will need to be carefully planned.



Raised trail impoundments like this one at the Quincy Outfall will reduce phosphorus from storm flows through settling, wetlands treatment, and soil filtration.

1.6 Phosphorus Reduction

Like the original treatment wetlands, the alternative design concept is expected to reduce the relatively high phosphorus concentrations associated with alluvial flows. The more consistent nature of these flows in the area around the perimeter road enable more pounds of phosphorus to be treated and removed on an annual basis. Also, the alternative improvements are anticipated to provide vegetative filtering and microbial action, plus some measure of increased infiltration and settling of runoff in the wide natural floodplain. Finally, like the Cottonwood Creek reclamation project, some phosphorus reduction will be accrued from stabilizing the slightly incised reach of Cottonwood Creek downstream of the perimeter road.

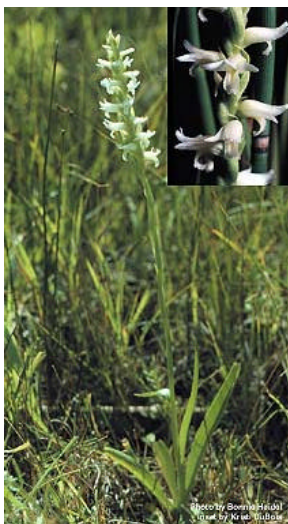
Initial estimates of long-term average annual total phosphorus reduction from the project are summarized as follows.

Phosphorus immobilization due to reduction of stream erosion:	10 - 20 lbs
Phosphorus reduction from baseflow wetlands treatment:	400 - 800 lbs
Phosphorus reduction from storm flow settling and infiltration:	<u>200 - 400</u> lbs
Total	600 - 1200 lbs

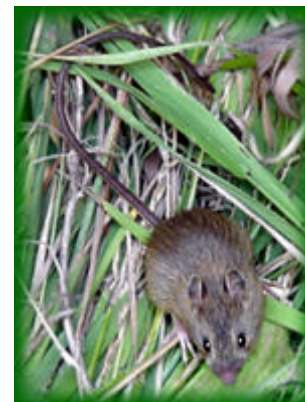
Wetlands treatment estimates for the alternative design concept are documented in Appendix B.

1.7 Permitting

Like the Cottonwood Creek restoration project, the work envisioned on Cherry Creek will enhance the value of the riparian ecosystem by creating more diverse habitat types and by improving water quality. There is a possibility that some of the work may be able to be covered by Nationwide Permit No. 27, *Stream and Wetland Restoration Activities*, under Section 404 of the Clean Water Act. The Nationwide Permit system is the simplest and least time-consuming permitting process available under the Clean Water Act.



The alternative project will have the same threatened and endangered species issues that will need to be considered as the original treatment wetlands concept. Preble's jumping mouse and Ute Ladies Tresses orchid evaluations will be coordinated with US Fish and Wildlife Service staff.





1.8 Water Rights

Water rights issues will be similar to those associated with the original concept, although certain elements of the proposed work, such as the temporary detention facilities, may not require augmentation flows. Also, much of the project area where water quality enhancements are proposed already has a wetland character, meaning that any increases in evapo-transpiration will be smaller than the original concept's conversion from upland prairie to wetlands.

Enhancement of existing wetland processes will reduce the magnitude of any increases in evapo-transpiration.

1.9 Opinion of Probable Costs

An order-of-magnitude opinion of probable costs has not yet been prepared for the alternative design concept, as the ultimate project configuration still needs to be worked out with park and Authority representatives. However, by eliminating the need for a water supply intake and pipeline, reducing, at least slightly, water augmentation requirements, and looking for opportunities to “piggy-back” on planned park road and trail improvement projects, the alternative water quality improvements will be more cost effective than the original concept. In addition, a greater potential for phosphorus reduction is expected, yielding a favorable cost per pound of phosphorus immobilized.

1.10 Schedule

It is anticipated that the next step in the design process will be to work closely with Authority and park staff, the Corps of Engineers, and Division of Wildlife to refine the alternative water quality improvements in concert with the park's master planning update. Specific projects will be identified and a phasing schedule developed. This work can be undertaken immediately following this feasibility evaluation.

Depending on the size of individual projects and the park's schedule for implementing planned infrastructure improvements, a small early phase of construction may be beneficial in 2003, but in general, work is anticipated in 2004 and beyond.

1.11 Conclusions and Recommendations

Although the Cherry Creek State Park wetlands concept originally envisioned was judged not feasible due to concerns about an adequate water supply, an alternative design concept was identified that holds promise for increased phosphorus reduction at greater cost efficiency. The alternative concept proposes to enlarge and enhance existing natural treatment processes along the creek and to reduce phosphorus in baseflows and storm runoff through settling, soil filtration, and wetlands treatment. The improvements are proposed to be distributed throughout the riparian corridor and carefully located to take advantage of existing trails and other infrastructure and reduce impacts to the park. The overall concept has the potential to remove 600 to 1200 pounds of phosphorus or more on a long-term average annual basis.

The following action items are recommended.

1. Undertake the Phase 1 Design of water quality improvements in Cherry Creek State Park to refine and prioritize the alternative design concept and identify a phasing schedule for specific projects. The work will require close coordination with Authority and park staff, the Corps of Engineers, and the Division of Wildlife.
2. Clarify augmentation requirements of the project and continue to evaluate alternative sources of replacement water for possible acquisition.
3. Conduct limited geotechnical sampling within project area, characterizing soils horizons and properties, to assist in determining favorable sites for treatment facilities.
4. Consider, as an independent task, collect representative soils and flow samples in the project area and conducting laboratory testing of soil-phosphorus equilibrium. This could shed light on the treatment potential of various areas within the park and will assist in determining favorable sites for treatment facilities.
5. After the Phase 1 Design, identify one or more first projects and undertake final design and construction.



A potential ancillary issue to investigate is the equilibrium condition between phosphorus and representative soils types in Cherry Creek State Park.