Cherry Creek Basin Water Quality Authority
Technical Advisory Committee Meeting Agenda
Thursday, December 7, 2023, 9:00 a.m.

In-person attendance is encouraged due to audio limitations in the meeting room.

In-Person: SEMSWA
7437 S. Fairplay St.
Centennial, CO 80112

Virtual: Zoom
https://us06web.zoom.us/j/87425775963 Passcode: CCBWQA
Phone (646)931-3860 Mtg ID: 874 2577 5963# Passcode: 815374

TAC Meeting Documents can be found online at the link below.
https://drive.google.com/drive/folders/12BoEhmFbnnMCxivnpjY2l7T5TzP8AzIq?usp=sharing

1. Call to Order *(9:00) (5 minutes)*
    a. Introduce Laura Kindt, Castle Rock Water's new Stormwater Manager who will eventually replace David VanDellen.
2. Meeting Minutes from November 2, 2023 (enclosed)
3. Highlights from the November 16, 2023 Board Meeting (Clary) *(9:05) (5 minutes)*
4. Action Items *(9:10) (15 minutes)*
    a. Acceptance of Project Summary Reports (Borchardt, enclosed)
        i. Happy Canyon Creek upstream of I25
        ii. Dove Creek from Otero Avenue to Chambers Road
5. Discussion Items *(9:25) (50 minutes)*
    a. 2024 TAC Chairman and Vice Chairman Positions (Erickson)
    b. 2024 TAC Appointments (Erickson/Endyk, enclosed)
    c. Lone Tree Creek Master Drainage Plan Update (Clary, enclosed)
    d. Annual WQ Monitoring Report Status Update (Stewart, enclosed)
    e. USACE Reservoir Release Proposal (Katie Seefus, USACE, enclosed)
    f. Regulation 38 Site Specific Standards Letter to CDPHE and Updated Hydros Technical Memorandum (Clary/Hawley, enclosed)
6. Presentations *(10:15) (15 minutes)*
    a. Runoff Reduction Study Update (Chris Olson)
7. Updates *(10:30) (20 minutes)*
    a. Cherry Creek Stewardship Partners (Davenhill)
    b. TAC Members
    c. TAC Subcommittees
        i. Modeling Subcommittee
        ii. Watershed Plan Subcommittee
        iii. Cherry Creek Reservoir to Lakeview Drive Alternatives Analysis Subcommittee
    d. Contractors
        i. Water Quality Update and (Stewart)
        ii. Pollution Abatement Projects
            a. CIP Status Report (Borchardt, enclosed)
            b. Wetland Harvesting (Stewart)
        iii. In-Park PRF and RDS Maintenance and Operations (Goncalves)
        iv. Regulatory (DiToro)
        v. Land Use Referral Tracking (Endyk)
    e. Manager (Clary)
        i. CU-Boulder Landscape Transformation Proposal

ii. Peoria Pond
iii. PAPM RFQ (New! RFQ for Pollution Abatement Project Manager - Cherry Creek Basin Water Quality Authority)
iv. July TAC Meeting (Currently on July 4th)

8. Adjournment

Board Binder

Cherry Creek Basin Water Quality Authority
Minutes of the Technical Advisory Committee
Thursday, November 2, 2023, 9:00 a.m.

TAC Members Present
Alex Mestdagh, Town of Parker
Ashley Byerley, SEMSWA
David Van Dellen, Town of Castle Rock
Diana Rashash, Board Appointee, Arapahoe County Public Health
Jacob James, City of Lone Tree
Jessica La Pierre, City of Aurora (zoom)
Jim Watt, Board Appointee, Mile High Flood District (zoom)
Jon Erickson, TAC Chair, Board Appointee, Colorado Parks and Wildlife
Michelle Seubert, Board Appointee, Cherry Creek State Park (zoom)
Rebecca Tejada, Board Appointee, Special Districts, Parker Water and Sanitation District
Rick Goncalves, Board Appointee
Ryan Adrian, Douglas County (zoom)

Board Members Present
Tom Downing, Governor's Appointee (zoom)

Others Present
Alan Leak, RESPEC
Brent Dinkel, USACE (zoom)
Erin Stewart, LRE Water
Jane Clary, Wright Water Engineers, CCBWQA Technical Manager
Jessica DiToro, LRE Water
Kat Hoffman, CDOT (zoom)
Katie Seefus, USACE (zoom)
Michael Smith, Brownstein Hyatt Farber Schreck
Richard Borchardt, R2R Engineers
Steve Chevalier, Arapahoe County Public Health
Val Endyk, CCBWQA

1. **Call to Order**
   a. **Introduce Diana Rashash, Senior Water Quality Specialist with Arapahoe County Public Health replacing Steve Chevalier on the TAC effective November 1, 2023**
   b. **Introduce Laura Kindt, Castle Rock Water's new Stormwater Manager who will eventually replace David VanDellen.**

   Jon Erickson called the meeting to order at 9:00 am and introduced Diana Rashash. Introduction of Laura Kindt will take place at a future meeting.

2. **Meeting Minutes from October 5, 2023**

   David VanDellen moved to approve the meeting minutes from October 5, 2023. Seconded by Jacob James. The motion carried.

3. **Highlights from the October 19, 2023 Board Meeting**
Jane Clary provided an update on actions taken at the October 19, 2023 Board meeting. Minutes from the meeting can be found here.

4. **Action Items**

a. Recommendation on 2023 Annual PRF/PAP Observation and Maintenance Report (moved to below 4b)
Rick Goncalves provided the TAC with a report on the 2023 Annual Inspection of Pollution Reduction Facilities (PRFs) at Cherry Creek State Park. The purpose of the annual field observation is to assess whether the PRFs are functioning as designed and to identify routine restorative and rehabilitative maintenance requirements. Rick explained that restorative and rehabilitative maintenance is the responsibility of CCBWQA, and routine maintenance is the responsibility of CCSP. Further information including general assessments from the field observation report, photos, and a summary of O&M costs are included in the report.

Conclusions from the report:

- All the In-Park PRFs appear to be performing their functions well, with the potential exception of the 12-mile Park projects.
- The field observation general assessments include thoughts on maintenance, monitoring and planning efforts for future capital projects.
- The summary of the maintenance work identified for consideration and budget estimates is shown in Appendix A of the report. The operations and maintenance costs developed from the 2023 Annual Field Inspection are $143,296 for Restorative and Rehabilitation work, and $12,500 for weed control.
- Concerns and issues that were located outside limits of the original PRF or require additional analysis and study beyond the engineering already done on the original PRF were suggested as planning efforts. These planning efforts should include identification of the capital project, the priority, identification of the water quality benefits, and estimated costs. The identified planning efforts are detailed in the report.

TAC recommended that the memo to the Board be updated to include additional information that states that the recommended studies included in the report could utilize funding from the enterprise fund if the CCBWQA wishes to pursue these efforts.

David VanDellen moved to accept the 2023 Annual In-Park PRF Observation and Maintenance Report and forward to the Board with a recommendation for approval. Seconded by Alex Mestdagh. The motion carried.

b. Recommendation on 2024-2033 CIP (moved to before item a)
Rich Borchardt provided the TAC with the 10-year Capital Improvement Program and accompanying user information for the Capital Program budget spreadsheet and noted the changes made after the October TAC and Board meetings.
Jane Clary noted that Reservoir Destratification System concept design to replace and optimize in-lake distribution is in the enterprise fund (and not the pollution abatement fund) in the 2024 budget so this item will be removed from the CIP.

Rich noted the following revisions will be made to the CIP in order to match the 2024 budget.

- $10K for PRF reseeding and mowing at CCSP is included in the 2024 budget.
- $65K for RDS Utilities is increasing to $72K in the 2024 budget.
- $10K for tree/shrub planting and fence repair is included in the 2024 budget.

Rich will amend the 2024-2033 CIP as described before submitting to the Board.

David VanDellen moved to recommend that the Board approve the 2024-2033 Capital Improvement Program as described. Seconded by Ashley Byerley. The motion carried.

c. Recommendation on CCBWQA 2024 Draft Budget

Jane Clary provided the TAC with the 2024 Draft Budget and noted the changes made after the October TAC and Board meetings.
Several TAC members requested access to the working spreadsheet staff use to create the expense budget for CLA. A link to this file was provided to the TAC for review prior to the meeting.

Jane noted that while some budget items are routine tasks, other items require TAC review and Board approval before spending is authorized. Additionally, the Executive Committee reviewed the 2024 budget and is in the process of reviewing draft scopes for 2024 consultant agreements.

Ashley Byerley moved to recommend that the Board approve and adopt the CCBWQA 2024 Budget. Seconded by Jacob James. The motion carried.

d. Recommendation on Position on Regulation 72 Dewatering Proposal

i. Revised Regulation 72 Dewatering Proposal

ii. TAC Communication to Board Regarding Technical Merits of Revised Proposal

Parker Water and Sanitation District provided the TAC with a copy of the revised proposal submitted to the Water Quality Control Commission for consideration of the adoption of revisions to the Cherry Creek Reservoir Control Regulation 72. Revisions proposed by PWSD, along with the proposed Statement of Basis, Specific Statutory Authority and Purpose are attached as an exhibit to the notice. Michael Smith, Brownstein Hyatt Farber Schreck, and Rebecca Tejada, PWSD, presented to the TAC and provided three examples of construction dewatering phosphorus loading analysis in response to questions raised at prior CCBWQA meetings.

As part of discussion, Jane Clary noted that PWSD had been responsive to the questions raised by CCBWQA and noted that the revised proposal added practice-based requirements instead of an exemption. Additionally, PWSD plans to add monitoring to the proposal in its Proponent's Prehearing Statement. Ashley Byerly had some questions regarding how "feasible" would be interpreted, which would ultimately be a decision by CDPHE as the entity issuing dewatering permits.

Jane Clary provided the TAC with an Action Item Memo which summarizes possible positions/actions that could be taken by the CCBWQA.

Rick Goncalves moved that the TAC provide a recommendation to the Board to file for Party Status in the Regulation 72 rulemaking hearing by December 5, 2023. Additionally, the TAC recommended that CCBWQA file a brief Responsive Prehearing Statement by December 19, 2023 stating that CCBWQA does not oppose PWSD's proposal in the Regulation 72 dewatering rulemaking hearing based on the technical merits of the proposal discussed at the November 2, 2023 TAC meeting, including required protections to water quality added to the proposal during the stakeholder process. Seconded by David VanDellen. The motion carried.

5. Presentations (moved to before item 4c)

a. USACE Reservoir Release Proposal

Brent Dinkel and Katie Seefus with the US Army Corps of Engineers presented the USACE reservoir release proposal to the TAC.

USACE will provide a draft of the detailed proposal to CCBWQA staff and coordinate further to prepare for the December TAC meeting.
USACE requested feedback from the TAC by the end of 2023.

6. Discussion Items

a. Modeling Subcommittee Recommendations

Alan Leak provided the TAC with a memo regarding supplemental watershed model scenarios as directed by the TAC Modeling Subcommittee. RESPEC's modeling scenarios focus on wastewater treatment improvements based on input from the wastewater treatment providers regarding feasible TIN concentrations in treated effluent and

retrofits to existing development. The consensus from RESPECs conversations with the wastewater treatment providers is detailed in the memo.

b. Monitoring Discussion (Stewart, enclosed)

i. SAP Considerations

Erin Stewart provided the TAC with a memo explaining that no major updates to the SAP were identified by the TAC, Board, watershed and reservoir modelers, or LRE Water during the WY 2023 monitoring program. However, the analyst that has been completing analysis for phytoplankton and zooplankton at Cherry Creek Reservoir passed away and the lab will not be able to continue completing services. LRE Water has identified two potential labs that may be able to complete similar analysis. Once the evaluation has been completed, a recommendation will be provided to the TAC regarding future SAP updates.

ii. Monitoring Report Update and Schedule Considerations

Erin Stewart provided the TAC with a memo identifying factors that will impact the availability of some flow and biological monitoring information that is used for water balance calculations. The evaluation of plankton dynamics analyses will not be available for a few months for reasons described above. This will delay the completion of certain portions of the draft WY 2023 Monitoring Report. Reg 72 reporting requirements will still be met on schedule.

c. 2024 TAC Chairman and Vice Chairman Positions (postponed)

d. 2024 TAC Appointments (postponed)

e. Regulation 38 Site Specific Standards Letter to CDPHE and Updated Hydros Technical Memorandum (Clary/Hawley, enclosed)

Jane Clary provided the TAC with the letter to the WQCC stating that the Authority may propose site-specific total phosphorus and total nitrogen standards for Cherry Creek Reservoir at the June 2025 Regulation 38 Rulemaking Hearing with a delayed effective date after 12/31/2027.
Jane also provided the updated Hydros memo to the TAC for review.

Discussion postponed to December.

7. Updates (enclosures only; no verbal updates provided)

a. Cherry Creek Stewardship Partners (Davenhill)

October Update (postponed)

b. TAC Members

c. TAC Subcommittees

i. Modeling Subcommittee

ii. Watershed Plan Subcommittee

iii. Cherry Creek Reservoir to Lakeview Drive Alternatives Analysis Subcommittee

d. Contractors

i. Water Quality Update and (Stewart)

ii. Pollution Abatement Projects

a. CIP Status Report (Borchardt, enclosed)

b. Wetland Harvesting (Stewart)

iii. In-Park PRF and RDS Maintenance and Operations Report (Goncalves, enclosed)

iv. Regulatory (DiToro)

v. Land Use Referral Tracking (Endyk)

e. Manager (Clary)

i. CU-Boulder Landscape Transformation Proposal (enclosed)

ii. Regulation 38 Site Specific Standard Update

iii. Peoria Pond

iv. PAPM RFQ

v. **RPA Runoff Reduction Study**

8. **Adjournment**

Jon Erickson adjourned the meeting at 11:26 am.

ACTION ITEM MEMORANDUM

To: CCBWQA Technical Advisory Committee (TAC)
From: Richard Borchardt, Pollution Abatement Project Manager
Date: December 7, 2023
Subject: Project summaries for stream reclamation on Happy Canyon Creek upstream of I-25 and Dove Creek Phase 1 from Otero Avenue to Chambers Road

Request: The TAC recommends that the Board accepts the project summaries for stream reclamation on Happy Canyon Creek Stream upstream of I-25 and Dove Creek Phase 1 from Otero Avenue to Chambers Road.

Project/Issue: CCBWQA and its partners completed stream reclamation on Happy Canyon Creek upstream of I-25 and Dove Creek Phase 1 from Otero Avenue to Chambers Road projects in 2023. The attached project summaries describe the background and purpose, existing conditions, design approach, construction, funding, and water quality benefits of each project. Once CCBWQA's TAC and Board accept the project summaries, they will be included in CCBWQA's 2023 Annual Report.

Budget: N/A

Motion: **I move to accept the project summaries for stream reclamation on Happy Canyon Creek upstream of I-25 and Dove Creek Phase 1 from Otero Avenue to Chambers Road.**

R2R ENGINEERS

RIFFLES TO RIPPLES

MEMORANDUM

DATE:	November 15, 2023
TO:	Jane Clary, Wright Water Engineers, CCBWQA Technical Manager
CC:	Jon Erickson, CCBWQA Technical Advisory Committee Chairman
FROM:	Richard Borchardt, PE & CFM
SUBJECT:	Happy Canyon Creek upstream of I25 - Project Summary

Background and Purpose:

In 2013, Douglas County (Douglas) and the Mile High Flood District (MHFD) began stream reclamation on Happy Canyon Creek located upstream of I-25 (Project), shown with the white line in **Figure 1**, about 11.3 miles upstream of Cherry Creek Reservoir. In 2021 the Cherry Creek Basin Water Quality Authority (CCBWQA) and in 2022 the City of Lone Tree (Lone Tree) were added to the Project.

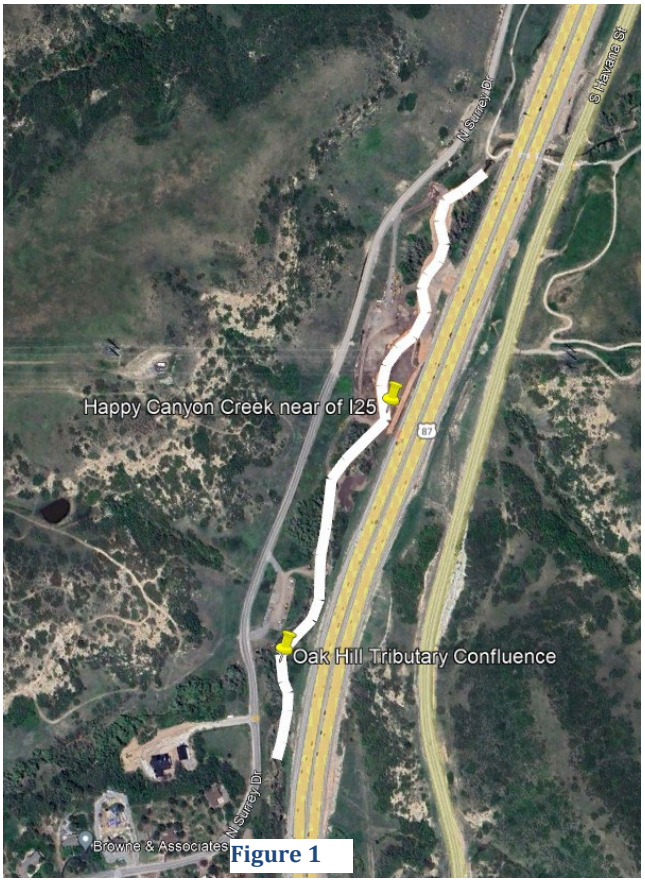

Figure 1

Existing Conditions:

Urbanization of the watershed upstream of the Project results in increased rate, frequency, and magnitude of storm flows in Happy Canyon Creek. The stream incised 4-10 feet with steep eroded banks up to 16 feet tall within the Project, evidence of bed and bank erosion. Although wetland and riparian vegetation existed; it was distressed due to the lowering of the groundwater table from the incised stream (see **Photos 1-3)**.

Photo 1 – near downstream end of project

Photo 2 – near middle of project

Photo 3 – near upstream end of project

Design Approach:

The goals of the design were to create a healthy stream, well connected to the adjacent wetland and riparian vegetation, and promote the natural and beneficial functions of filtration and infiltration to improve water quality. Muller Engineering Company (MEC) is the design consultant. MEC proposed a stream planform that raises the incised channel, promotes natural stream features, and includes engineered bed and bank protection. This approach created a multi-stage stream section that provides for sediment transport from base flows through minor flood stages (i.e. 2-year recurrence interval) and conveys the larger storms (i.e. from 2-year to 100-year recurrence intervals). This stream reclamation minimizes long-term maintenance and provides an environmentally sound and sustainable practice. MEC designed the Project using a combination of grade control structures (Riffle, Boulder Cascade, and Sculpted Concrete drop structures), bank protection (Void Filled Riprap and Vegetation), and grading to create overbanks, providing a wider stream corridor which reduces erosion potential. The Project includes stream reclamation of approximately 3,000 linear feet.

Construction:

Construction was started on the Project in February 2023, completed in November 2023, done by Naranjo Civil Constructors. **Photos 4-6** show the constructed stream reclamation. **Photo 4** highlights a few of the riffle drop structures, **Photo 5** shows the raised stream bed connected to the overbanks and the wetland and riparian plantings, and **Photo 6** shows the sculpted concrete drop structure.

Funding:

MHFD, Douglas, CCBWQA, and Lone Tree are partners on the Project. The Intergovernmental Agreement and Amendments include $5,441,427 with CCBWQA's participation being $500,000 or about 9%. MHFD's current project budget report shows a remaining balance of about $612,000 after construction, which will be used to establish vegetation and clear permits, afterwards any remaining balance if any would be refunded to the partners according to their participation level, and the final project cost will be known.

Photo 4– near downstream end of project

Photo 5 – near middle of project

Photo 6 – near upstream end of project

Water Quality Benefits:

The Project includes stream reclamation which provides water quality benefits for the stream and ultimately Cherry Creek Reservoir[1]. Stream reclamation reduces erosion and immobilizes nutrients (including phosphorus and nitrogen) in the soil, reducing the nutrient concentrations in the water. The Project immobilizes an estimated 51 pounds of phosphorus per year[2]. The water quality capture area (**Photo 7**) that treats runoff from I-25 provides additional water quality treatment above the estimated 51 pounds of phosphorus per year.

Photo 7 – water quality capture area for runoff from I-25

Summary:

Water Quality Benefit is reduction of ≈ 51 pounds of phosphorus per year
Total Project Cost = $5,441,427[3]
CCBWQA's Share = $500,000[4]
Engineer: Muller Engineering Company
Contractor: Naranjo Civil Constructors

Additional information for the Project can be found on the websites below.
MHFD website link: https://mhfd.org/resources/mapping/
CCBWQA website link: https://www.cherrycreekbasin.org/library/

[1] CCBWQA Stream Reclamation, Water Quality Benefit Evaluation – Interim Status Report; CCBWQA Technical Advisory Committee; June 16, 2011.
[2] CCBWQA 2024-2033 Capital Improvement Program Supporting Data, Board Final Review, November 16, 2023
[3] Final total project cost won't be known until after final vegetation establishment, permits are cleared, and any remaining balance if any refunded to partners.
[4] Final CCBWQA's share won't be known until after final vegetation establishment, permits are cleared, and any remaining balance if any refunded to CCBWQA.

R2R ENGINEERS

RIFFLES TO RIPPLES

MEMORANDUM

DATE:	November 30, 2023
TO:	Jane Clary, Wright Water Engineers, CCBWQA Technical Manager
CC:	Jon Erickson, CCBWQA Technical Advisory Committee Chairman
FROM:	Richard Borchardt, PE & CFM
SUBJECT:	Dove Creek Phase 1 from Otero Avenue to Chambers Road - Project Summary

Background and Purpose:

In 2021, the Southeast Metro Stormwater Authority (SEMSWA) and Cherry Creek Basin Water Quality Authority (CCBWQA) began stream reclamation on Dove Creek from Otero Avenue to Dove Creek Pond D-1 (Project), shown with the white line in **Figure 1**, about 5.2 miles upstream of Cherry Creek Reservoir. In 2022, the project was broken into 2 phases for construction, with Phase 1 being between Otero Avenue and Chambers Road and scheduled for construction in 2023, and Phase 2 being between Chambers Road and Dove Creek Pond D-1 with construction anticipated in 2024.

Figure 1

Existing Conditions:

Urbanization of the watershed upstream of the Project results in increased rate, frequency, and magnitude of storm flows in Dove Creek. The stream incised up to 6 feet with steep eroded banks within the Project, evidence of bed and bank erosion (see **Photos 1-3)**.

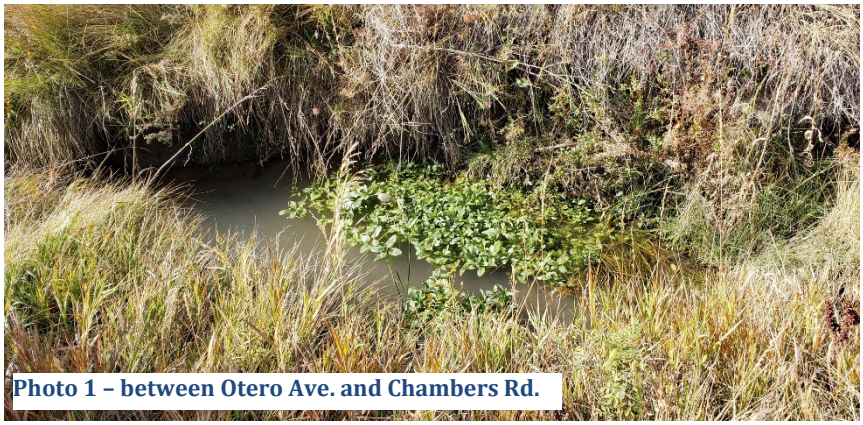

Photo 1 – between Otero Ave. and Chambers Rd.

Photo 2 – downstream of Chambers Rd.

Photo 3 – between Chambers Rd. and Pond D-1

Design Approach:

The goals of the design were to create a healthy stream, well connected to the adjacent wetland and riparian vegetation, and promote the natural and beneficial functions of filtration and infiltration to improve water quality. RESPEC is the design consultant. RESPEC designed stream reclamation which created a multi-stage stream planform that provides stability and conveys storm flows up to the 100-year recurrence interval. RESPEC designed four sediment capture areas based on Mile High Flood District's forebay criteria to capture coarser sediments entering the stream and the bank-full channel (aka active or low flow channel) to transport the smaller sediments. This stream reclamation and sediment capture/transport minimizes long-term maintenance and provides an environmentally sound and sustainable practice. RESPEC used step pool structures for grade control, bank protection (Void Filled Riprap, Soil Lifts, and Vegetation), and grading to create overbanks providing a wider stream corridor which stabilizes the stream and reduces erosion potential. The Project includes stream reclamation of approximately 2,700 linear feet.

Construction:

Construction of Phase 1 from Otero Avenue to Chambers Road was started in February 2023, completed in July 2023, and done by CEI. **Photos 4-6** show the constructed stream reclamation. **Photos 4-5** highlight the step pool structures, the graded overbanks, and the areas seeded with wetland and riparian vegetation. **Photo 6** shows the sediment capture area downstream of Otero Avenue.

Photo 4– looking downstream towards Chambers Rd.

Funding:

SEMSWA and CCBWQA are partners on the Project. The Intergovernmental Agreement and Amendments for design of the Project and construction of Phase 1 include $2,800,000 with CCBWQA's participation being $238,000 or about 9%. SEMSWA's current project budget update shows a remaining balance of about $89,000 after construction, which can be used to establish vegetation and clear permits, afterwards any remaining balance if any would be refunded to the partners according to their participation level, and the final project cost will be known.

Photo 5 – looking at step pool structure

Photo 6 – looking upstream at sediment capture near Otero Ave.

Water Quality Benefits:

The Project includes stream reclamation and sediment capture areas that provide water quality benefits for the stream and ultimately Cherry Creek Reservoir[1].

Stream reclamation reduces erosion and immobilizes nutrients (including phosphorus and nitrogen) in the soil, reducing the nutrient concentrations in the water. The Project's 2,700 linear feet immobilizes an estimated 46 pounds of phosphorus per year[2]. Phase 1 is 1,300 linear feet or 22 pounds of phosphorus per year.

The four sediment capture areas included with the Project provide additional water quality treatment above the stream reclamation. Phase 1 constructed the sediment capture area downstream of Otero Avenue (**Photo 6**); SEMSWA has cleaned it out three times between June and early September 2023 where they estimated a total of 100 cubic yards of sediment removed, which is a significant sediment reduction that also provides some degree of phosphorus reduction. The Project's sediment capture areas were designed similarly to MHFD's forebay criteria, which represent different assumptions than those used in CCBWQA's historical phosphorus reduction estimates[3] (mostly extended detention basins and water quality ponds with 40-hour drain times). Because the Project's sediment capture areas are not designed with a 40-hour drain time to allow for the broader range of sedimentation, they will be most effective at removing larger particle sizes (gross solids) and less effective for finer particles (clays) that tend to have higher phosphorus concentrations. CCBWQA's consulting staff is working on updated phosphorus reduction estimates for the Project's sediment capture areas and will provide an update once completed. This estimated benefit can be included in the Project Summary associated with the Phase 2 construction.

Summary:

Water Quality Benefit of reduction of ≈ 22 pounds of phosphorus per year
Total Project Cost = $2,800,000[4]
CCBWQA's Share = $238,000[5]
Engineer: RESPEC
Contractor: CEI

Additional information for the Project can be found on the websites below.
SEMSWA website link: https://www.semswa.org/our-work/
CCBWQA website link: https://www.cherrycreekbasin.org/library/

[1] CCBWQA Stream Reclamation, Water Quality Benefit Evaluation – Interim Status Report; CCBWQA Technical Advisory Committee; June 16, 2011.
[2] CCBWQA 2024-2033 Capital Improvement Program Supporting Data, Board Final Review, November 16, 2023
[3] CCBWQA 2024-2033 Capital Improvement Program Supporting Data, Board Final Review, November 16, 2023
[4] Final total project cost won't be known until after final vegetation establishment, permits are cleared, and any remaining balance if any refunded to partners.
[5] Final CCBWQA's share won't be known until after final vegetation establishment, permits are cleared, and any remaining balance if any refunded to CCBWQA.

MEMORANDUM

To: CCBWQA Technical Advisory Committee
From: Val Endyk - CCBWQA Administrative Assistant
Date: December 1, 2023
Subject: Current TAC Members

Alex Mestdagh	Town of Parker
Ashley Byerley	SEMSWA, representing City of Centennial
Caitlin Gappa	Board Appointee, Douglas County Health
Casey Davenhill	Board Appointee, Cherry Creek Stewardship Partners
Cayla Cappello	City of Greenwood Village
David Van Dellen	Town of Castle Rock
Diana Rashash	Board Appointee, Arapahoe County Public Health
Gene Seagle	Board Appointee, US Army Corps of Engineers
Jacob James	City of Lone Tree
Jeremiah Unger	Board Appointee, CDOT
Jessica La Pierre	City of Aurora
Jim Watt	Board Appointee, Mile High Flood District
Jon Erickson	2023 TAC Chair, Board Appointee, Colorado Parks and Wildlife
Joseph Marencik	City of Castle Pines
Lisa Knerr	2023 TAC Vice Chair, Arapahoe County
Michelle Seubert	Board Appointee, Cherry Creek State Park
Rebecca Tejada	Board Appointee, Special Districts, Parker Water and Sanitation District
Rick Goncalves	Board Appointee, RG Engineers
Ryan Adrian	Douglas County
Wanda DeVargas	Board Appointee, E-470

WWE

MEMORANDUM

To: CCBWQA Technical Advisory Committee
William P. Ruzzo, P.E., CCBWQA Executive Committee
Via email

From: Wright Water Engineers, Inc.
Maggie Lewis, P.E.
Andrew Earles, P.E., Ph.D., D. WRE

Date: December 1, 2023

Re: CCSP Lone Tree, Windmill, and Cottonwood Creeks Master Plan – Summary of TAC Subcommittee Recommendations

Wright Water Engineers, Inc. (WWE) has prepared this memorandum to summarize the results of a online meeting of the Technical Advisory Committee (TAC) Subcommittee meeting of the Cherry Creek Basin Water Quality Authority (CCBWQA) held November 30, 2023 regarding the Major Drainageway Plan (MDP) for the Lone Tree, Windmill, and Cottonwood (LWC) Creek watersheds. Attendees included:

- William Ruzzo, P.E., CCBWQA Executive Committee
- Casey Davenhill, Cherry Creek Stewardship Partners
- Ashley Byerley, Southeast Metro Stormwater Authority (SEMSWA)
- Richard Borchardt, P.E., CFM, R2R Engineers
- Rick Goncalves, P.E., RG Engineers
- Jim Watt, P.E., CFM, Mile High Flood District (MHFD)
- Shawn Krier, Colorado Department of Natural Resources
- Michelle Seubert, Cherry Creek State Park
- Jon Erickson, P.E., Colorado Parks and Wildlife
- Jane Clary, LEED AP, CPESC, Wright Water Engineers
- Andrew Earles, P.E., Ph.D., D. WRE, Wright Water Engineers
- Maggie Lewis, P.E., Wright Water Engineers

This memorandum provides information as a project update for the December CCBWQA TAC meeting. The intent of this memorandum is to update the TAC on the results of this meeting and present a list of recommendations for selection of project alternatives.

The following topics were covered in the meeting:

- Hydrologic model methods and results.
- Public and stakeholder outreach strategy.
- Selection of project alternatives for recommendation to TAC.

From that discussion, five alternatives were selected for inclusion as recommendations in the Master Drainage Plan corresponding to the locations on the figure in Attachment 1:

1. The Lone Tree Creek Pond embankment is recommended to be left "as-is" with its condition allowed to evolve, using an adaptive management approach. Signage will be installed to warn the public about possible flash flooding downstream.
2. Channel stabilization measures are recommended in anticipation of how the pond upstream will evolve in the future. (Maintenance-level repairs below the embankment were also discussed and will be managed by CPW.)
3. The Lone Tree Creek split flow area and wetland complex upstream of the pond will remain as-is.
4. The ICON design will be recommended for implementation in its entirety including at the Caretaker Road crossing.
5. The MDP update will propose a shorter segment of storm pipe in the Family Shooting Range debris fall zone than had previously been proposed.

Additional TAC input on development and selection of project alternatives can be provided following this schedule:

- This summary memorandum be presented at the December TAC meeting with opportunity for input.
- A draft MDP report will be provided to the TAC by December 31, 2024.
- Comments on the MDP will be due by January 31, 2024.
- The final report will be completed by March 31, 2024.

Attached are the materials presented to the TAC Subcommittee at this meeting. We welcome discussion and feedback on these recommendations during the December TAC meeting.

Attachments:

- Attachment 1 – Figure
- Attachment 2 – PowerPoint for Working Group and Meeting Materials

cc: Jane Clary, WWE

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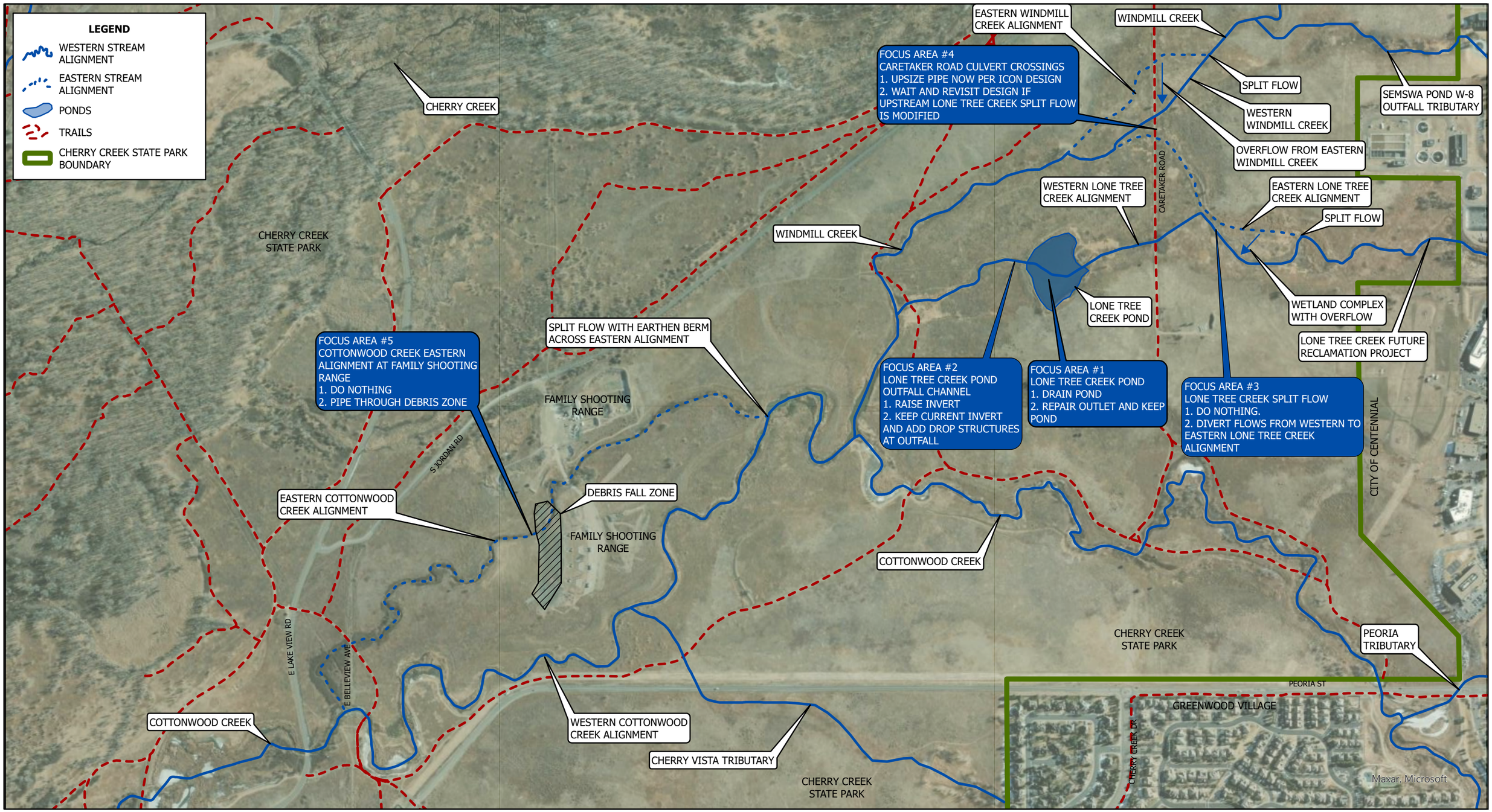

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WRIGHT WATER ENGINEERS, INC.

ARAPAHOE COUNTY, COLORADO

CHERRY CREEK STATE PARK
COTTONWOOD, LONE TREE, AND WINDMILL CREEKS
CHERRY CREEK BASIN WATER QUALITY AUTHORITY

1" = 600 Feet

0 300 600

PROJECT NO. 211-013.040

DRAFT

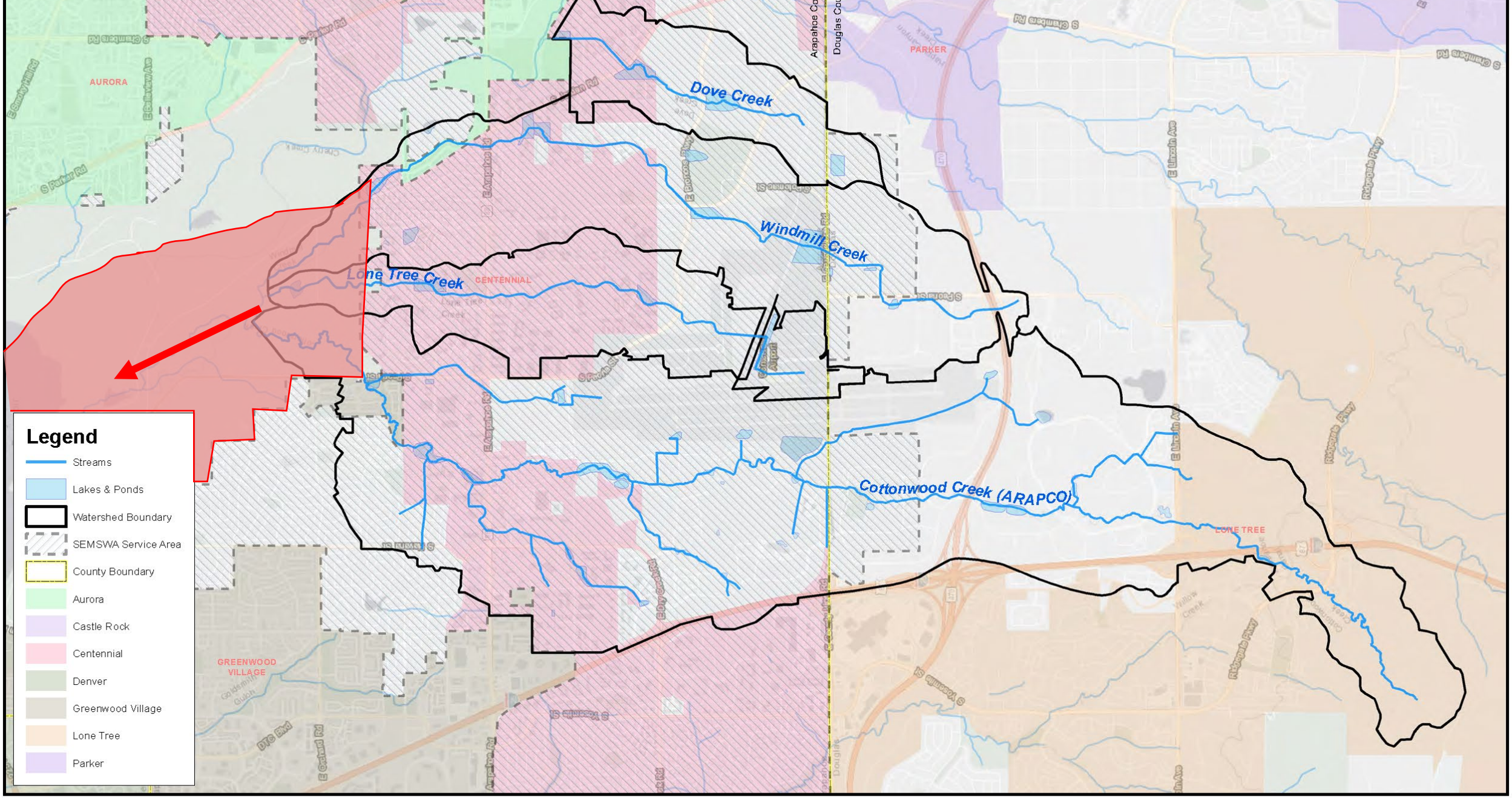
FACT SHEET

CCSP1

Lone Tree, Windmill, and Cottonwood Creek MDP in CCSP - Alternatives Selection

November 2023 TAC Working Group

Lone Tree, Windmill and Cottonwood Creek watershed in Cherry Creek State Park



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WWE

WWE PROJECT NO.
171-074.000
171-074.010

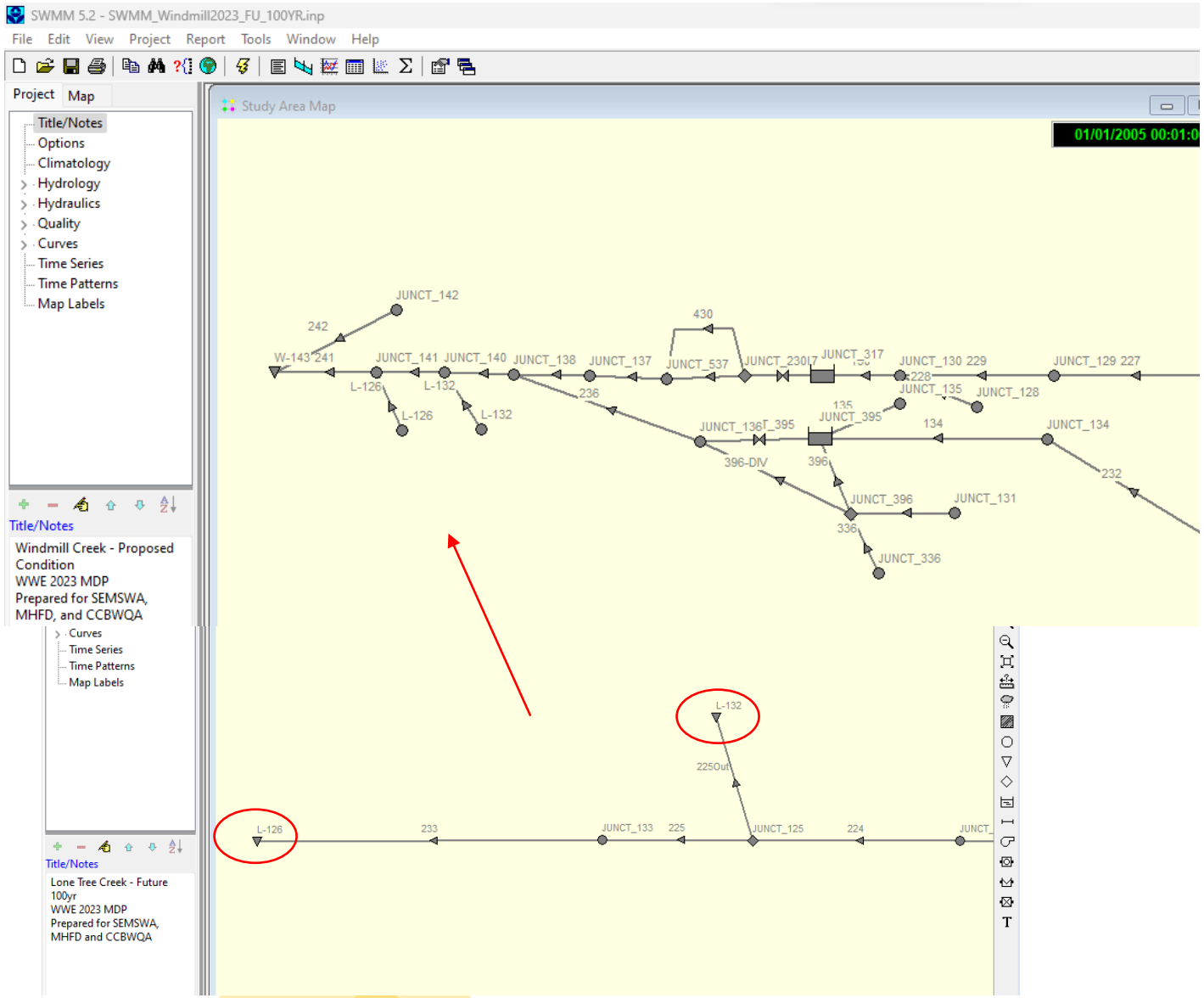
PROJECT STUDY AREA

COTTONWOOD, LONE TREE, WINDMILL AND DOVE CREEKS

0 0.5 1 Miles

Southeast Metro Stormwater Authority

FIGURE



Hydrology Extension

- First time model was extended to the reservoir
- Delineated and modeled 32 additional subbasins and over 1.5 square miles in the park
- Integrated three SWMM models via Python script so future users can adjust storm duration and other parameters needed for projects

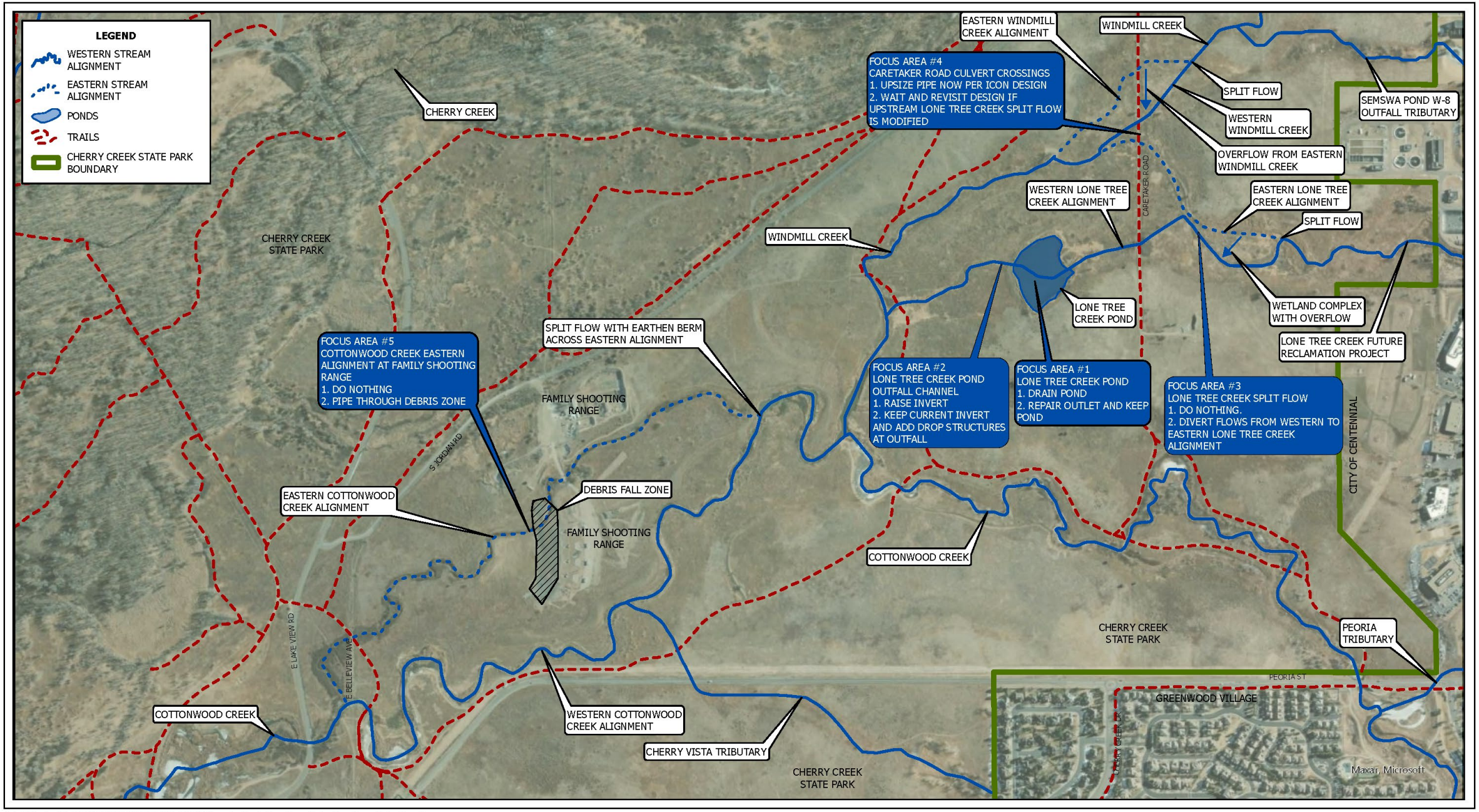
Peak Flow Rate Results (cfs)				
Location	Storm Event	2020 Hydrology Update (Upstream Node)	Current MDP Node	Current MDP Outfall
Lone Tree Creek Downstream Limit	2-year	420	130	130
	10-year	520	520	340
	100-year	1330	1530	1040
Windmill Creek Downstream Limit	2-year	250	250	420
	10-year	500	500	940
	100-year	1260	1240	2640
Cottonwood Creek Downstream Limit	2-year	1030	640	630
	10-year	1620	2010	2020
	100-year	4460	5930	6020

Results

The goal of this meeting is to select from alternatives!

Public and Stakeholder Feedback:

- **Same process as upstream MDP portion**
- **Website and GIS Story Map were created**
- **Solicited feedback at Cherry Creek Basin conference, social media, and Next Door**
- **Total of four responses, all pertaining to areas outside of the park**



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ARAPAHOE COUNTY, COLORADO

CHERRY CREEK STATE PARK

1" = 600 Feet

PROJECT NO.

28

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FACT SHEET

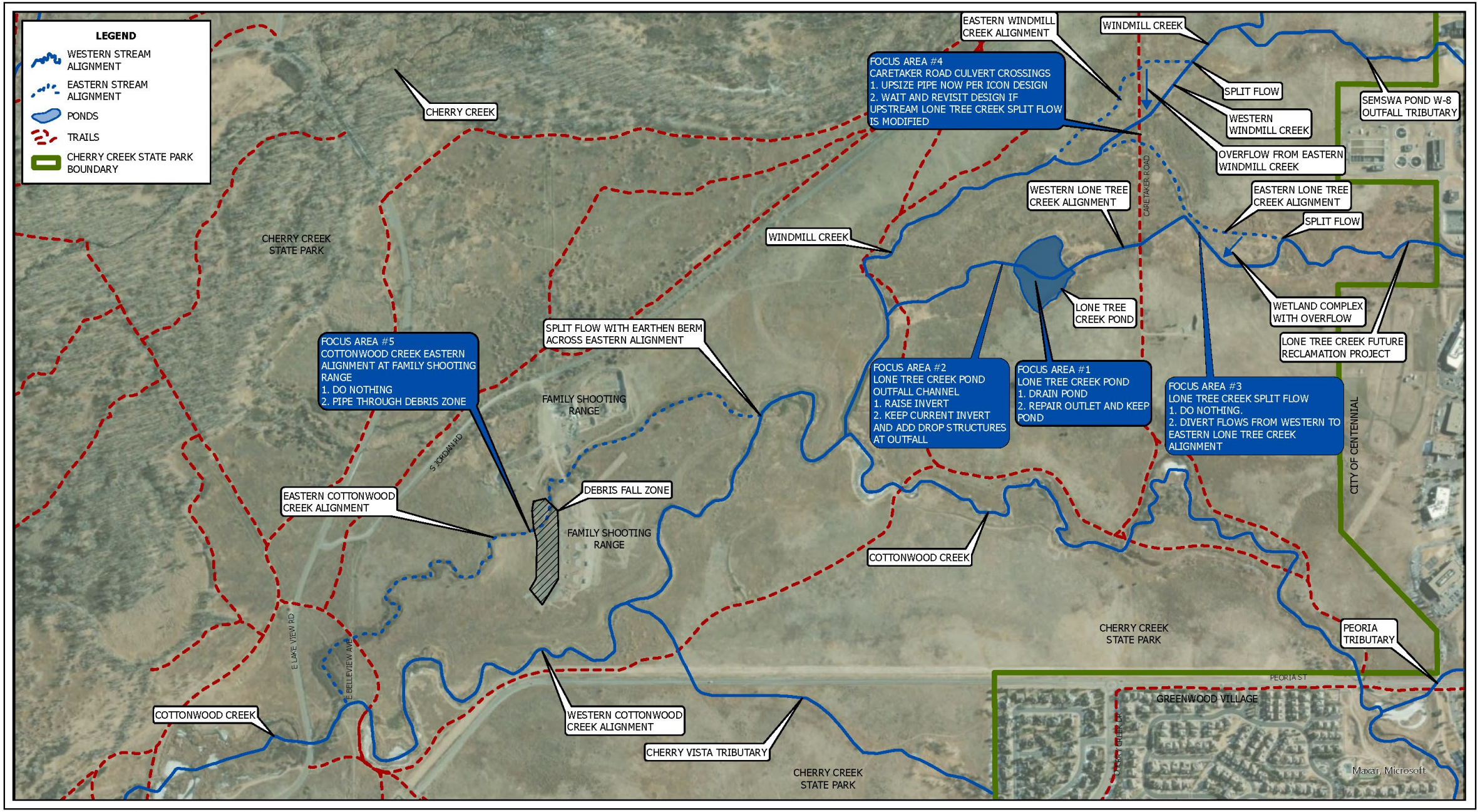
Focus Area 1. Lone Tree Creek Pond

Focus Area 2. Pond Outfall Channel

Focus Area 3. Lone Tree Creek Split Flow

Focus Area 4. Caretaker Road Culvert

Focus Area 5. Family Shooting Center



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ARAPAHOE COUNTY, COLORADO

CHERRY CREEK STATE PARK

1" = 600 Feet

PROJECT NO.

DRAFT
FACT SHEET

Optional Tools

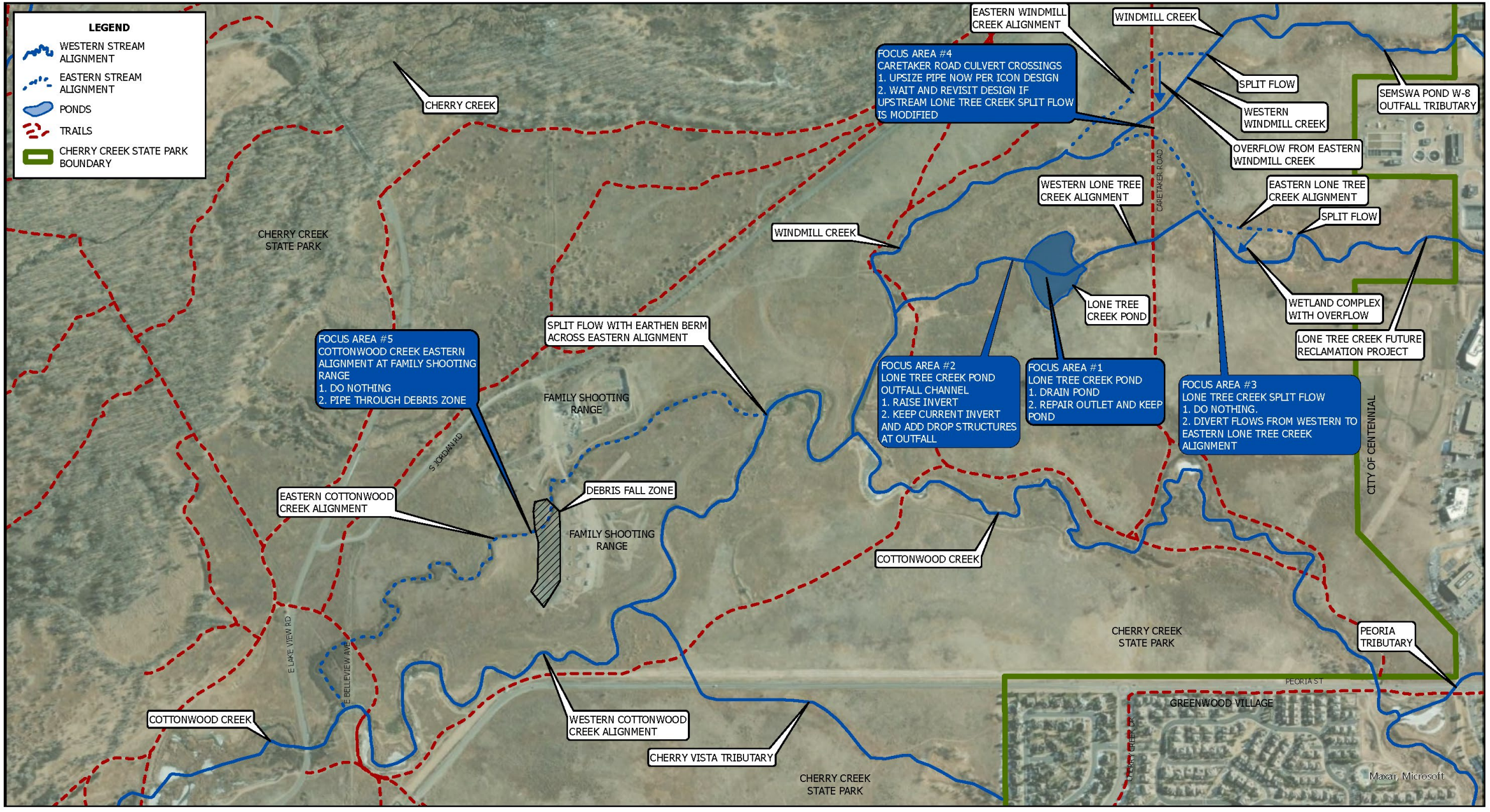
	Scoring Scale					
Scoring Parameters	**1**	**2**	**3**	**4**	**5**	Parameter Weight (%)
Project Cost	Over $1M	$500,000-$1M	$100,000-$500,000	$30,000-$100,000	<$30,000	35
Public Safety	Problem is severe or not addressed. Do nothing alternatives that do not address a public safety problem should score here.	Problem addressed minimally impacts drainageway health or public safety.	Problem addressed moderately impacts drainageway health or public safety.	Problem addressed significantly impacts multiple factors of public safety.	Project results in immediate and large improvement to public health, safety, and infrastructure.	15
Water Quality	Do nothing alternatives that will result in ongoing water quality degradation should go here.	Project does not consider aspects of water quality. Do nothing projects that wont have a significant effect for water quality should go here.	Minimally meets obligations of CCBWQA and Regulation 72	Addresses a water quality concern downstream	Improves aspects of multiple components of water quality	15
Stream Health	Alternative will not prevent current degradation or will exacerbate it.	Current degradation might continue but might lessen due to the project.	Project likely will prevent further degradation to channel and long-term monitoring will indicate if future improvements are necessary.	Project goal is to completely stabilize channel section for long-term function.	Planning for high functioning and low maintenance stream that will function for the future developed watershed.	10
Environmental	Completely removes and does not replace wetland or riparian area, adds concrete to drainageway, and/or includes a large land disturbance in waterway.	Major construction impacts to jurisdictional wetlands, major drainageways, and/or mature riparian area.	Minor construction impacts to mature riparian areas and non-jurisdictional wetlands. "Do nothing" alternatives that will result in ongoing moderate degradation to these environmental features should score here.	No impacts to wetlands or mature riparian areas or projects with moderate construction impacts but the final condition significantly improves upon the current environmental features.	Improves riparian buffer area or wetlands with minimal impacts to existing ecology.	15
Community Value	Proposed project reduces recreation or aesthetic value.	Recreation or aethetics are lacking and not improved.	Public is able to view or access the improved areas, which might add recreational or aesthetic value.	Public is able to access the improvements which add aesthetic or recreational value and project can be considered an amenity.	Accessible walkways are possible with recreational features proposed and improved aesthetics. Project is in line with future community access planning.	10
					Total	100

DRAFT Alternatives Matrix

Focus Areas	Description	Project Cost	Public Safety	Water Quality	Stream Health	Environmental	Community Value	Total Score	Total Possible Points	Percent Score
#1 Lone Tree Creek Pond	Drain Pond	3	4	3	3	2	1	280	500	56%
	Repair outfall and keep pond	2	3	3	3	4	4	290	500	58%
#2 Channel Erosion downstream of Lone Tree Creek Pond	Raise Invert	2	3	3	3	2	3	250	500	50%
	Keep current invert and add drop structures at the outfall	2	3	3	4	3	3	275	500	55%
#3 Lone Tree Creek Split Flow	Do nothing.	5	3	2	3	3	3	355	500	71%
	Divert flows from western to eastern Lone Tree Creek Alignment	1	3	2	4	2	3	210	500	42%
#4 Caretaker road culvert crossing	Upsize pipe now per Icon design	3	4	2	3	3	3	300	500	60%
	Wait and revisit design if upstream Lone Tree Creek split flow is modified (selection of this alternative is contingent on upstream diversion)	1	3	2	4	2	3	210	500	42%
#5 Family Shooting Range	Do Nothing. Implement Muller alternative when appropriate.	3	3	2	2	3	3	275	500	55%
	Pipe through debris zone.	4	4	5	3	3	3	380	500	76%

Discussion

- Focus Areas #1 and #2 related to the pond have extremely close scores.
- I'd like to go around and see if anyone has strong feelings about a particular alternative.
- Do we want to use selection matrix?
- If so, what adjustments do you have for the parameter weight or scores?



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ARAPAHOE COUNTY, COLORADO

CHERRY CREEK STATE PARK

1" = 600 Feet

PROJECT NO.

38

DRAFT

FACT SHEET

Next Steps

- Present recommendations to the TAC – Next Week?
- Incorporate into upstream MDP - draft due end of year
- Report comments due January 2024
- Final report due March 2024

CONNECTING WATER TO LIFE

TECHNICAL MEMORANDUM

Date: October 22, 2023

To: Cherry Creek Basin Water Quality Authority TAC
Jane Clary, CCBWQA Technical Manager

From: Erin Stewart, LRE Water

Subject: WY 2023 Monitoring Report Considerations and Schedule

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Background

Due to factors beyond our control, some of the flow and biological monitoring information that is used for water balance calculations and the evaluation of plankton dynamics analyses will not be available for a few months. This information will not be available until late 2023 or early 2024, which will restrict the completion of certain portions of the draft of the WY 2023 Monitoring Report by the typical deadline.

The 2023 floods caused damage and incorrect readings to the CCBWQA monitoring sites that collect inflow information. As an alternative, the water balance will be completed using a relative inflow approach which requires storage information from the USACE that is not available due to an equipment calibration problem on their end. The USACE is completing a survey in mid-late November which should allow storage calculations to be provided; their goal is the end of January.

In addition, due to an unexpected loss of the main analyst at the laboratory that analyzes our plankton samples, the results from the last two months of WY 2023 have been delayed as an alternative laboratory is evaluated and the analyses can be completed.

Recommendation

LRE Water recommends completing the report based on the available information by the December deadline as scheduled. The presentation of findings and review process can also be completed as scheduled. In early-mid 2024, the rest of the report will be completed and submitted in a final format once the additional information and data have been provided and analyzed.

The delay will not affect regulatory requirements or Regulation 72 reporting which includes the assessment of the seasonal chl-*a* concentration and attainment of the Reg 38 Class I Warm Water Aquatic Life classification standards. This information will be included and linked in the CCBWQA Annual Report and the other supplementary sections can be added when they become available. The timeline should allow for the additional sections before the presentation to the WQCC which normally occurs in August or September of the following year.

Budget Impact

There may be some minor budget implications due to 2023-2024 timing. The remaining funds from LRE's 2023 Contract for Task 4/Monitoring Report may need to be moved to 2024 to account for the schedule change.

Sustainable Rivers Program

Cherry Creek, South Platte River Tributary (Cherry Creek Dam)
Low-Level Release Strategy for Improving Reservoir Water Quality

Omaha District (NWO)

Scope of Work - FY24 Funding

Project Scope Statement

Cherry Creek Dam is located in Denver, Colorado on Cherry Creek, a tributary to the South Platte River. The dam was completed in June of 1950 for the authorized purpose of flood control, and later was authorized for general recreation and fish and wildlife recreation.

Cherry Creek Reservoir is currently on the State of Colorado's 303(d) list of impaired waters due to high chlorophyll-a levels and low dissolved oxygen conditions not supporting aquatic life. During the summer the reservoir can become thermally stratified and the volume of water below the thermocline (the hypolimnion) fails to mix with the surface water (the epilimnion). While thermal stratification at the reservoir has historically been limited, there is enough inhibition of mixing to allow hypoxic to anoxic conditions to regularly develop near the reservoir bottom. These low oxygen conditions at the sediment water interface result in sediment release of phosphate and ammonia, which build up in the hypolimnion until the reservoir mixes and become available for algal growth (increase in reservoir chlorophyll-a). Come winter, the resulting algal growth dies off and sinks to the bottom of the reservoir, adding to the oxygen demand of the sediment and fueling the development of anoxic conditions in future years. Concentrations of phosphate and ammonia in the hypolimnion of Cherry Creek Reservoir tend to peak in July.

The Omaha District will implement the storage of a small amount of water in the flood control zone, if available to store, in January through March. The maximum storage that would be allowed is located in the first foot of the flood control zone (5550 to 5551 feet, Project Datum) also known as the transition zone. This zone amounts to 925 AF or about 1% of the flood control zone. This storage would then be released via the reservoir's low-level gate in July. This release would flush some of the nutrients in the hypolimnion out of the reservoir before they can fuel algal growth. In addition, the July release has the potential to increase downstream flows during a time of the year when historically the release would be reduced or non-existent due to typically low reservoir inflows. The water control manual currently allows this first foot of flood storage to be used for "maintenance of the multipurpose zone", which includes water quality. If the transition zone is full, the target discharge for July would be 10 cfs to 25 cfs depending on the inflow.

To verify the release of nutrients through the low-level gate and evaluate downstream impacts or benefits, in-pool and downstream outflow nutrient grab samples and physical data will be collected through the entire summer field season. Funding provided by the Sustainable Rivers Program would assist in funding travel, labor, outreach, and laboratory testing of the proposed release.

Project Management

Katie Seefus (Hydraulic Engineer, NWO, EDH-A) – District POC and Project Manager
Brent Dinkel (Limnologist, NWO, EDH-A) – Outreach, implementation, and summary report writer
John Hargrave (Water Quality Specialist, NWO, EDH-A) – Implementation support
Bonnie Straka (Limnologist, NWO, EDH-A) – Implementation support

Description of Activities and Products

Task 1. Stakeholder Outreach and Coordination

Internal coordination, initiated in August and September 2023, was met with support for the proposal. External coordination was also initiated in August and September 2023. The agencies that were contacted ahead of the proposal include: the CO-Department of Water Resources, CO Parks and Wildlife, and Cherry Creek Basin Water Quality Authority. The team will be looking to expand the external agencies as appropriate.

The project will require at a minimum the following coordination:

- Spring kick-off meeting to discuss the project, potential benefits, and potential impacts.
- Fall results meeting to discuss the findings following the July low-level release.

Deliverable: Comments will be recorded and addressed as they are received. The internal and external teams will work collaboratively to determine the effectiveness of the July low-level release. Consideration will be given to all involved agencies on whether the release should be continued in the future.

Task 2. Water Quality Sampling

In-pool and downstream outflow nutrient grab samples and physical data will be collected through the entire summer field season of May into September. Funding provided by the Sustainable Rivers Program would assist in funding travel, labor, and laboratory testing of the monitoring and sampling.

Deliverable: Water quality data analyzing the effectiveness of the July low-level releases on reservoir nutrient removal and potential downstream impacts or benefits for inclusion in a brief summary report.

Task 3. Summary Report

Completion of a brief summary report that summarizes the effectiveness of the July low-level releases in terms of nutrient removal from the reservoir and potential upstream and downstream impacts or benefits.

Project Milestones

Fall 2023/Winter 2024 Stakeholder coordination/feedback

Spring 2024 Stakeholder kick-off meeting.

1 May 2024	Begin monthly water quality sampling at Cherry Creek Reservoir and outflow.
Fall 2024	Stakeholder results meeting.
13 Sept 2024	End monthly water quality sampling at Cherry Creek Reservoir and Outflow.
30 Sept 2024	Complete 80% of brief summary report on the effectiveness of the July low-level releases.

Project Budget

Water Quality Labor	$20,240.00
Water Quality Travel	$2,200.00
Water Quality Testing	$1,650.00
Water Control Labor	$11,220.00
Water Control Travel	$2,200.00
Documentation	$3,300.00
Ops/Vertical Team	$1,980.00
Total	**$42,790.00**

Cherry Creek Basin Water Quality Authority
cherrycreekbasin.org
303.968.9098
manager@ccbwqa.org

October 25, 2023

Via Email: cdphe.wqcc@state.co.us

Ms. Jojo La
Colorado Water Quality Control Commission
4300 Cherry Creek Drive S.
Denver, CO 80246-1530

Re: Issues Scoping Hearing for the Classifications and Numeric Standards for South Platte River Basin, Laramie River Basin, Republican River Basin, Smoky Hill River Basin, Regulation #38 (5 CCR 1002-38)

Dear Ms. La:

The Cherry Creek Basin Water Quality Authority (CCBWQA) is providing this letter to notify the Water Quality Control Commission (Commission) that it may propose site-specific total phosphorus and total nitrogen standards for Cherry Creek Reservoir (COSPCH02) at the June 2025 Regulation 38 Rulemaking Hearing with a delayed effective date after 12/31/2027.

Background

In Regulation 38, Cherry Creek Reservoir (COSPCH02) has an assigned chlorophyll *a* standard of 18 ug/L. The seasonal mean concentration is measured in the upper three meters of the water column for the months of July through September with an allowed exceedance frequency of once in five years. Additionally, Cherry Creek Reservoir is regulated under Regulation 72, which includes stringent phosphorus control requirements in the basin such as a 0.05 mg/L total phosphorus limit for wastewater treatment plant discharges.

CCBWQA was a party to the April 10, 2023 Rulemaking regarding adoption of Lakes Nutrient Criteria and expressed significant concerns about the applicability of proposed statewide standards to Cherry Creek Reservoir. In this rulemaking, the Commission decided to delay adoption of total phosphorus and total nitrogen standards adopted in Regulation 31.17 (Table V) into basin standards for many lakes, including Cherry Creek Reservoir, until after 12/31/2027. In Section 33.106 (B)(3)(a) Statement of Basis and Purpose of Regulation 38 (5 CCR 1002-38), the Commission stated its intent to consider site-specific nutrient standards for Cherry Creek Reservoir as follows:

> *The commission may also consider site-specific nutrients standards for the following lake and reservoir segments that have existing nutrient control regulations in future rulemaking hearings if information to support appropriate and protective revisions is developed:*

Upper South Platte River: 6b (COSPUS06b; Chatfield Reservoir)

Cherry Creek: 2 (COSPCH02; Cherry Creek Reservoir)

The commission did not adopt total nitrogen or total phosphorus table value standards for either waterbody in this rulemaking hearing.

Summary of Progress Since April 10, 2023 Lakes Nutrients Rulemaking Hearing

Since the April 2023 Lakes Nutrients Criteria Rulemaking Hearing, CCBWQA contracted with Hydros Consulting to help CCBWQA develop a site-specific standards methodology and standards proposal, utilizing CCBWQA's extensive site-specific data set, supplemented by its reservoir model. Hydros' approach utilizes the methodology developed by the Division and produces site-specific total phosphorus and total nitrogen standards falling between the Commission's 2012 "interim values" and the April 2023 values adopted in Regulation 31. On October 11, 2023, CCBWQA representatives met with representatives of the Water Quality Control Division's Standards Unit (Division), U.S. Environmental Protection Agency and Colorado Parks and Wildlife to review the site-specific standards approach and draft site-specific total phosphorus and total nitrogen standards. CCBWQA's approach was generally favorably received with some suggestions for minor revisions to the methodology. Due to the significant early progress on development of the site-specific standards and positive feedback obtained from the Division to date, CCBWQA anticipates moving forward with proposing site-specific standards in June 2025.

Recommendation

CCBWQA recommends that the Commission consider adoption of site-specific total phosphorus and total nitrogen standards for Cherry Creek Reservoir in the June 2025 Regulation 38 Rulemaking Hearing if proposed by the CCBWQA. CCBWQA anticipates submitting a proposal for site-specific standards that will follow the Division's Lake Nutrients Criteria methodology utilizing site-specific data for the Cherry Creek Reservoir. As currently envisioned, CCBWQA's proposal will likely also continue to propose a delayed effective date of these site-specific standards after 12/31/2027 to allow time for the Division and the broader regulated community to continue to work through implementation issues related to Lake Nutrients Criteria on the same schedule.

Submitted on Behalf of the Cherry Creek Basin Water Quality Authority,

Jane Clary, Technical Manager
Cherry Creek Basin Water Quality Authority

DRAFT TECHNICAL MEMORANDUM

TO: Jane Clary, Cherry Creek Basin Water Quality Authority (CCBWQA) Technical Manager

FROM: Christine Hawley and Kevin Bierlein, Hydros Consulting Inc.

SUBJECT: Rev. 1 DRAFT Development of Site-Specific Standard Values for TP and TN in Cherry Creek Reservoir

DATE: October 23, 2023

The Cherry Creek Basin Water Quality Authority (CCBWQA) asked Hydros Consulting (Hydros) to provide technical support in development of site-specific standards for total phosphorus (TP) and total nitrogen (TN) for Cherry Creek Reservoir. That analysis produced proposed site-specific TP and TN standards of 66 ug/L TP and 860 ug/L TN for Cherry Creek Reservoir. This memorandum explains the need for site-specific TP and TN standards in Cherry Creek Reservoir, the analysis conducted to generate the standard values, and associated longevity plan recommendations. This memorandum is organized in seven sections, followed by a listing of references cited:

Section 1: Background

Section 2: Need for Site-Specific TP and TN Standards

Section 3: Consideration of the Secchi-Based Site-Specific Equation

Section 4: Site-Specific TP and TN Standard Development

Section 5: Discussion of Site-Specific TP and TN Standard Values

Section 6: Longevity Plan Recommendations

Section 7: Summary

1 Background

The Water Quality Control Commission (WQCC) adopted new table value standards (TVSs) for TP and TN in Regulation 31 during the recent April 2023 rulemaking hearing. The standards now apply to lakes and reservoirs that have aquatic life and recreational (AL/Rec) use designations and are located above permitted dischargers. At this time it is anticipated that the TVSs for TP and TN will be adopted for all

remaining lakes and reservoirs with AL/Rec uses by 2027. Because Cherry Creek Reservoir is below permitted discharges, TP and TN standards have not yet been adopted but are anticipated by 2027[1].

The TP and TN standards for lakes and reservoirs are designed to correspond to the chlorophyll *a* (Chl*a*) standard for AL/Rec uses, recognizing the critical role that nutrient concentrations play in algal growth. Therefore, TP and TN standards provide a secondary level of protection to support meeting the Chl*a* standard. It is important to recognize that there are no toxicity concerns stemming directly from TP and TN for aquatic life or recreational contact at the concentrations typically observed in Colorado lakes and reservoirs; therefore, the standards are based on TP and TN relationships to Chl*a*.

In the absence of a successful site-specific standard proposal, it is expected that the WQCC will adopt TP and TN standards of 42 ug/L and 620 ug/L, respectively, for Cherry Creek Reservoir. Throughout this document, these values are referred to as the "default" TP and TN standard for Cherry Creek Reservoir. The default values reflect the use of the Water Quality Control Division's (WQCD) State-wide warm lakes Chl*a*:nutrients relationships, with input of Cherry Creek Reservoir's 18 ug/L site-specific Chl*a* standard (Table 1). Note that these values are more stringent than the warm lakes TVSs because they are based on 18 ug/L Chl*a* instead of the warm lakes Chl*a* TVS of 20 ug/L (Table 1). Note also that TP and TN TVSs are notably more stringent that the 2012 Interim Criteria (Table 1), which were the anticipated values until 2022 (WQCD, 2022a).

Table 1. Relevant State Nutrient Standards and Interim Criteria, Including the Default WQCD Standard for Cherry Creek Reservoir

Constituent	Warm Lakes Nutrient Regulatory Values		Default** Cherry Creek Reservoir Standards
	2012 Interim Criteria	TVSs* (TN and TP Adopted in April 2023)	
Chl*a* (ug/L)	20	20	**18**
TN (ug/L)	910	670	620
TP (ug/L)	83	47	42

Note: All are/would be assessed as July through September averages with a one-in-five-year allowable exceedance frequency.

*Currently only applicable to warm lakes above permitted discharges.

**Default TP and TN standards are those likely to be adopted for Cherry Creek Reservoir in the absence of a successful site-specific standard proposal. The TN and TP values were developed from the WQCD State-wide relationships used in the April 2023 RMH, applying the Cherry Creek Reservoir Chl*a* standard of 18 ug/L, in lieu of the warm lakes Chl*a* TVS of 20 ug/L.

[1] The WQCC is planning to consider site-specific nutrient standard proposals for lakes and reservoirs at the next corresponding basin hearing. For Cherry Creek Reservoir, that is the South Platte Basin hearing in June 2025. Currently, CCBWQA is considering proposing site-specific TP and TN standards at the June 2025, with a delayed effective date of 2027, matching the current schedule for planned TP and TN standard adoption for the reservoir.

2 Need for Site-Specific TP and TN Standards for Cherry Creek Reservoir

The default TP and TN standard values for Cherry Creek Reservoir (Table 1; 42 ug/L TP and 620 ug/L TN) are based on State-wide, TP:Chl*a* and TN:Chl*a* relationships for warm lakes developed by the WQCD and used to define the TVSs. For these values to be appropriate for Cherry Creek Reservoir, the underlying relationships must reasonably approximate TP:Chl*a* and TN:Chl*a* relationships in Cherry Creek Reservoir. Cherry Creek Reservoir is fortunate to have an extensive dataset (1992-2022; 31 years) to support a detailed evaluation of this premise, as discussed in the following subsections.

2.1 Observed Concentrations Compared to Default Nutrient Standards

As a first step in evaluating the appropriateness of the default TP and TN standards for Cherry Creek Reservoir, observed data[2] were plotted against the default TP and TN standard values (Figure 1). The observed data indicate that the average summer Chl*a* concentrations were below the Chl*a* standard value in 13 of 31 years of record. In contrast, Cherry Creek Reservoir TP and TN concentrations would have been below the default TP and TN standard values in zero of 31 years of record. This comparison indicates a fundamental disconnect between the underlying Chl*a*:TP and Chl*a*:TN relationships used to develop the default TP and TN standards and the actual algal response to TP and TN concentrations in Cherry Creek Reservoir.

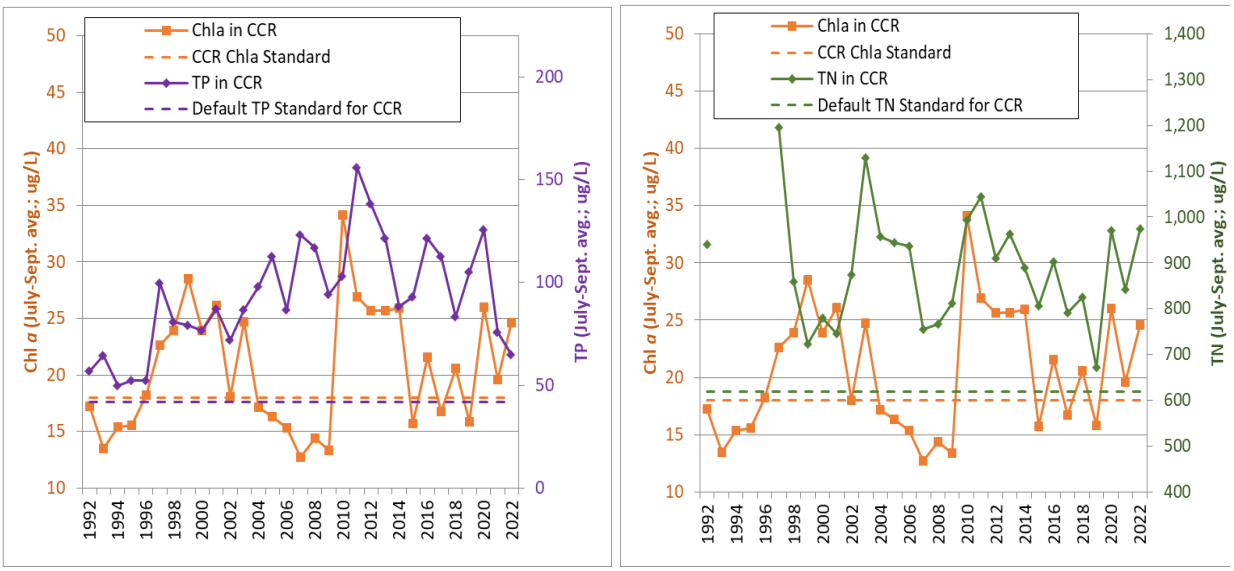


Figure 1. Comparison of Observed Chl*a* and Nutrient Data from Cherry Creek Reservoir to Existing Chl*a* Standard and Default TP and TN Standards for Cherry Creek Reservoir

[2] Note that the observed dataset was compiled from the CCBWQA database. Data reflect sampling photic zone results from the deepest location (CCR2). In a few early year of record (1994, 1995, and 2001 for Chl*a*; and 2001 for TP and TN), the database only includes CCR-Composite sample results (an average result of CCR1, CCR2, and CCR3). Analysis of the full dataset indicates that CCR-Composite results (July through September averages) exhibit excellent predictive capability for CCR2 July through September averages (R^2 = 0.94 for both Chl*a* and TN, and R^2 = 0.93 for TP). Therefore, CCR-Composite results were used to fill in CCR2 values for Chl*a* in 1994, 1995, and 2001, as well as TP and TN in 2001. There were no TN results at any locations in the database for 1993-1996.

2.2 Evaluation of Observed Chl*a* Response to Nutrients Using Cherry Creek Reservoir's Full Dataset

As a first step in direct comparison of site-specific Chl*a*:TN and Chl*a*:TP relationships in Cherry Creek Reservoir to the WQCD State-wide relationships, Cherry Creek Reservoir observed correlations were evaluated (Figure 2 and Figure 3). The first key finding from these graphics showing the full Cherry Creek dataset is the striking lack of a significant relationship between Chl*a* and TP (R^2 = 0.06) and between Chl*a* and TN (R^2 = 0.12). The lack of relationships is indicative of the underlying complexity and numerous factors driving Chl*a* response in Cherry Creek Reservoir. Nutrient concentrations are, of course, important drivers of Chl*a* response, but the data show that they are far from exclusive and independent controls of Chl*a* response in Cherry Creek Reservoir.

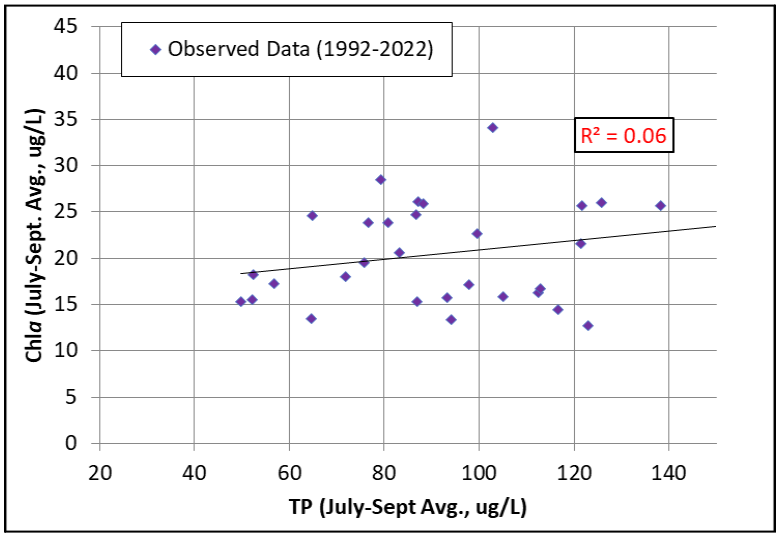


Figure 2. Observed Cherry Creek Dataset; Summer Chl*a* Response Compared to TP Concentrations; 1992-2022

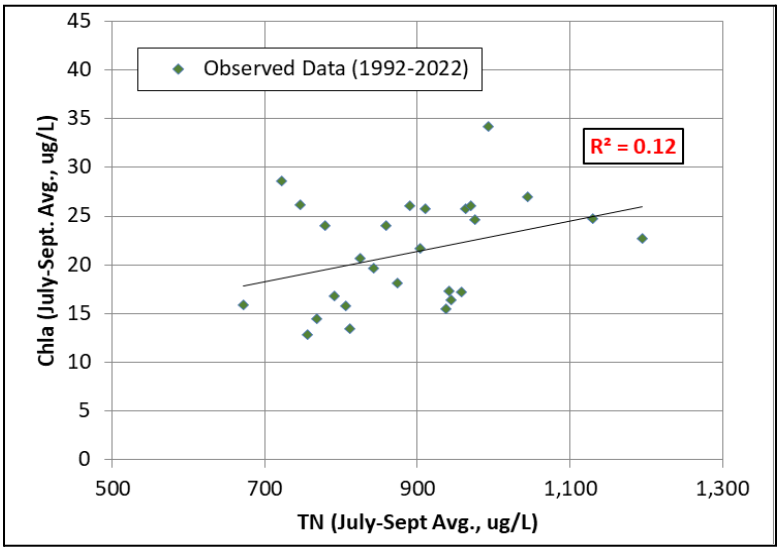


Figure 3. Observed Cherry Creek Dataset; Summer Chl*a* Response Compared to TN Concentrations; 1992-2022

2.3 Comparison of Cherry Creek Reservoir Data to State-Wide Warm Lakes Relationships

Direct comparison shows that the Cherry Creek Reservoir dataset is not well described by the WQCD warm lakes State-wide relationships used to develop the default TP and TN standards (Figure 4 and Figure 5). Specifically, the majority of Cherry Creek Reservoir lake-years (i.e., July through September averages) exhibit notably lower production of Chl*a* for a given nutrient concentration than what is predicted by the State-wide relationship.

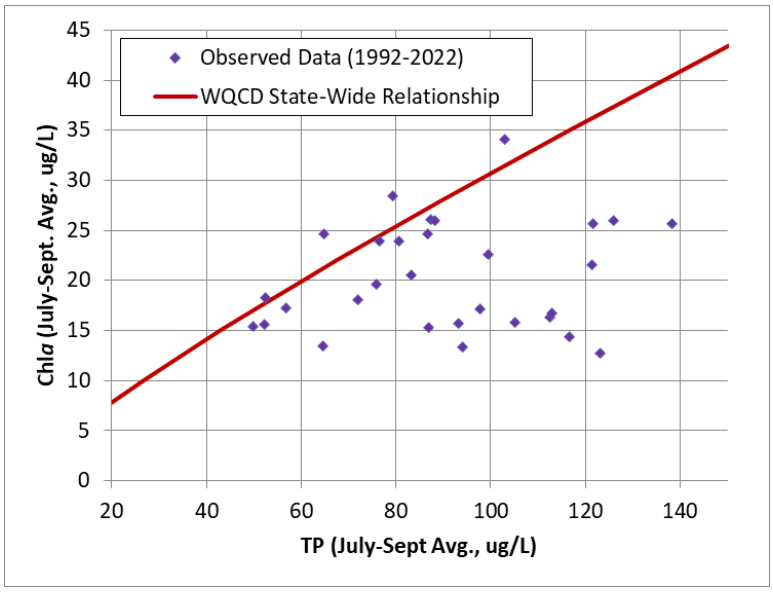


Figure 4. Observed Cherry Creek Dataset Compared to WQCD State-Wide Warm Lakes Relationship for Chl*a* and TP

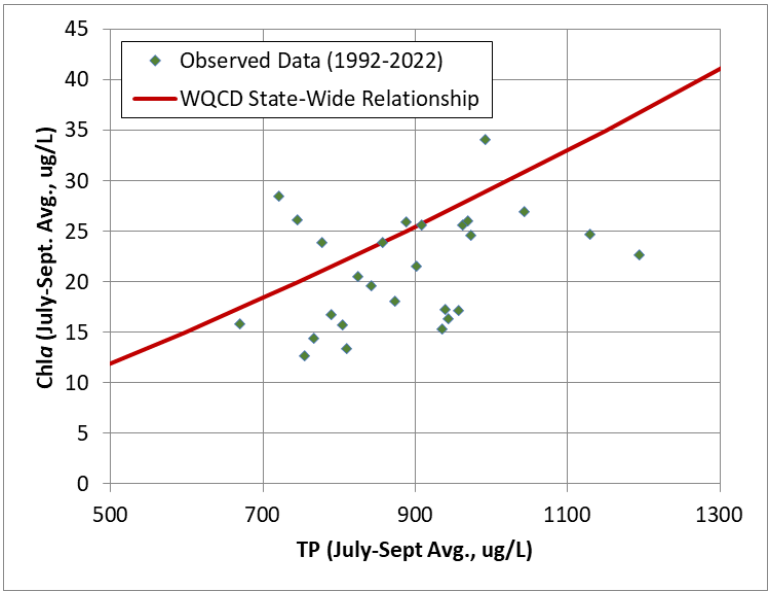


Figure 5. Observed Cherry Creek Dataset Compared to WQCD State-Wide Warm Lakes Relationship for Chl*a* and TN

2.4 Quadrant Plot Review of Default WQCD Nutrient Standards for Cherry Creek Reservoir

The mismatch between the observed response and the default TP and TN standards is also apparent when the Chl*a* standard and the default TP and TN standards are included in the Chl*a*:TP and Chl*a*:TN observed data graphics (Figure 6 and Figure 7). The standards lines on these graphics create quadrant plots similar to those presented by WQCD (WQCD, 2022a), which are helpful to evaluate how each year of data align with the related standards. Specifically, the quadrants on the plots effectively categorize the observed data into groups. These groups indicate how well the underlying relationships used to develop the TN and TP standards reflect the patterns in the observed data, as follows:

- **Aligned**: As shown in Figure 6, the upper right and lower left quandrants correspond to conditions where the observations generally align with the expected response inherent in the related standards. These two "aligned" quandrants indicate cases where both Chl*a* and nutrient standards are exceeded (upper right quadrant) or neither Chl*a* nor nutrient standards are exceeded (lower left quadrant). These conditions match the overall intent of the nutrient standards (i.e., agreement with/support for the Chl*a* standard).
- **Not Aligned**: Lake-year data in the lower right quadrant, where the Chl*a* standard value is met but the nutrient standard value is not met, indicate cases when the nutrient standards may be overly-stringent. Lake-year data in the upper left quadrant correspond to cases when the Chl*a* standard value is not met, but the nutrient standard value is met, indicating years when the nutrient standard may be under-protective for Chl*a* concentration.

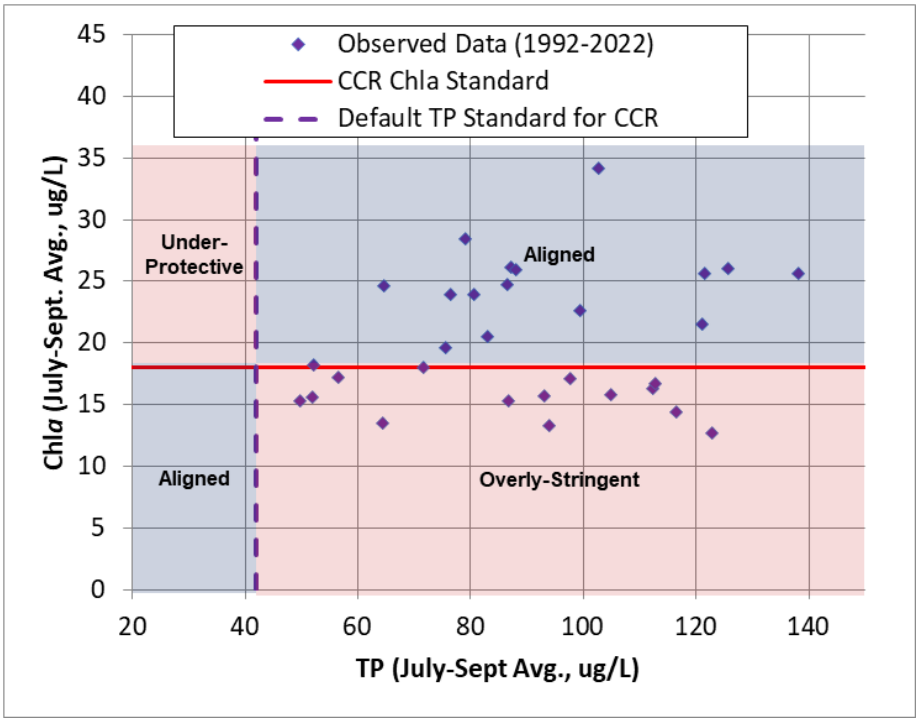


Figure 6. Cherry Creek Reservoir (CCR) Chl*a*: TP Quadrant Plot with the Default TP Standard

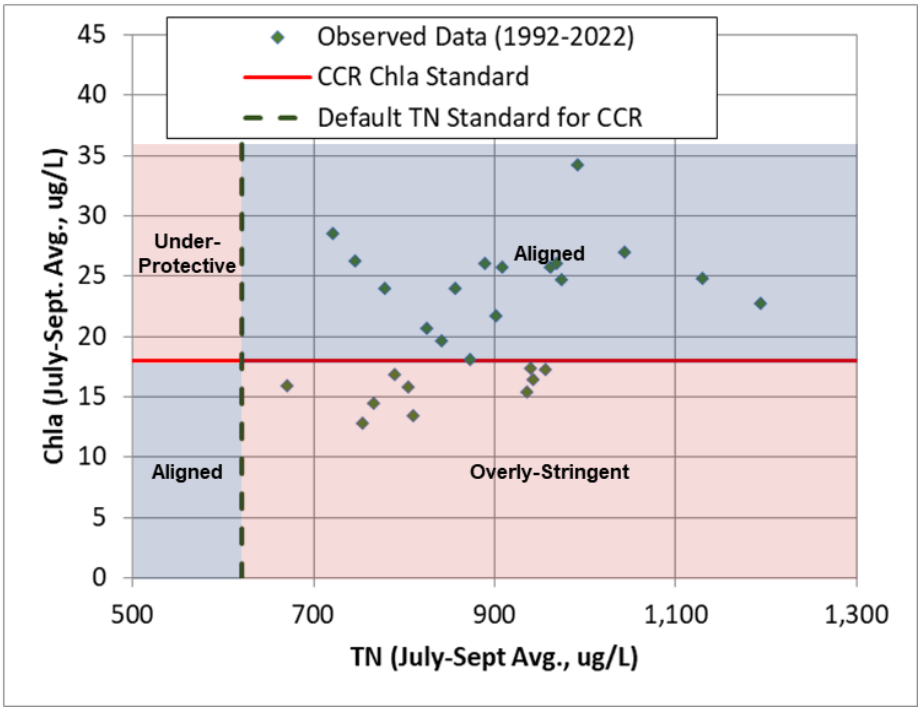


Figure 7. Cherry Creek Reservoir Chl*a*: TN Quadrant Plot with the Default TN Standard

While all lake-year data are not necessarily expected to exhibit perfect alignment on such quadrant plots, given the complexity of Chl*a* response to nutrients, the Cherry Creek Reservoir data show notably poor alignment for both TP (Figure 6) and TN (Figure 7). The quadrant plots indicate that the presumed WQCD TP and TN standards would be overly-stringent in more than 1/3 of the years of record. This further illustrates that the State-wide Chl*a*:TP and Chl*a*:TN relationships are not a good fit for Cherry Creek Reservoir.

Many site-specific factors may explain why Cherry Creek Reservoir does not fit well with the State-wide relationships used by WQCD in standards development. For example, Cherry Creek Reservoir receives high concentrations of TP in inflows, the majority of which is in the form of soluble reactive phosphorus (SRP). The high SRP concentrations have led to frequent nitrogen limitation, affecting the algal response and types of algal species present (Hydros, 2015 and 2019). Further, Cherry Creek Reservoir has a notably shallow bathymetric profile and is in a very windy location, creating a polymictic system that exhibits significant internal loading of nutrients (Hydros, 2015 and 2019). All of these factors affect the Chl*a* response in the Cherry Creek Reservoir and may help to explain why the reservoir does not fit well into the State-wide Chl*a*:TP and Chl*a*:TN relationships used to develop the lake nutrient TVSs.

2.5 Summary of Need for Site-Specific TP and TN Standards for Cherry Creek Reservoir

In summary, the comparisons presented in the preceding sections indicate that the default[3] TP and TN standards are not a good reflection of Chl*a* response to nutrient concentrations in Cherry Creek Reservoir. Further, the default TP and TN standards tend to be overly stringent, which is a significant

[3] Note that, as with the default TP and TN standards, the TVSs would also be overly stringent for Cherry Creek Reservoir and would fail to reflect the observed Chla response to nutrients in this system.

concern for CCBWQA. It is recognized that Cherry Creek Reservoir routinely exceeds the Chl*a* standard, and therefore, TMDLs for nutrients will eventually be established. If these TMDLs were to be based on in-lake nutrient standards that were notably more stringent than needed to meet the target Chl*a* concentrations, this would translate to significant additional costs and feasibility challenges for TMDL implementation. CCBWQA seeks to set appropriate site-specific nutrient standards that are neither under-protective nor overly-stringent, based on the extensive available dataset.

3 Consideration of the Secchi-Based Site-Specific Equations

During development of the TP and TN TVSs adopted in April of 2023, the WQCD also developed additional relationships that could be used on a site-specific basis to develop site-specific standard

proposals. These additional relationships were developed to include Secchi-depth data as a covariate, recognizing the important role that water clarity (including non-algal turbidity) can play in Chl*a* response to nutrient concentrations in some lakes. As such, the equations, termed Secchi-based site-specific equations, were provided by WQCD (WQCD, 2022a) as an optional tool to readily develop site-specific TP and/or TN proposals. Therefore, as a first step in site-specific TP and TN standard development for Cherry Creek Reservoir, the potential utility of the Secchi-based site-specific equations was evaluated.

Fortunately, Cherry Creek Reservoir has an extensive Secchi-depth dataset, meeting the frequency and timing requirements specified in WQCD (2022b) in 29 years of record between 1992 and 2022. Based on that dataset, the critical Secchi O/E[4] value (80th percentile) for Cherry Creek Reservoir was found to be 1.08. Applying the WQCD Secchi-based site-specific equations (WQCD, 2022b) for a Chl*a* standard of 18 ug/L, this corresponds to a TP standard of 28 ug/L and a TN standard of 490 ug/L for Cherry Creek Reservoir. These values are even more stringent than the default TP and TN standards (Figure 8 and Figure 9), which were deemed to be overly-stringent in the analysis in Section 2. Therefore, the Secchi-based site-specific equations do not serve to improve the agreement between the Chl*a* standard and the nutrient standards in Cherry Creek Reservoir and only exacerbate concerns delineated in Section 2 regarding the overly-stringent nature of the default nutrient standards. Based on this, the Secchi-based site-specific equations developed by WQCD are not considered further in site-specific standard development for Cherry Creek Reservoir.

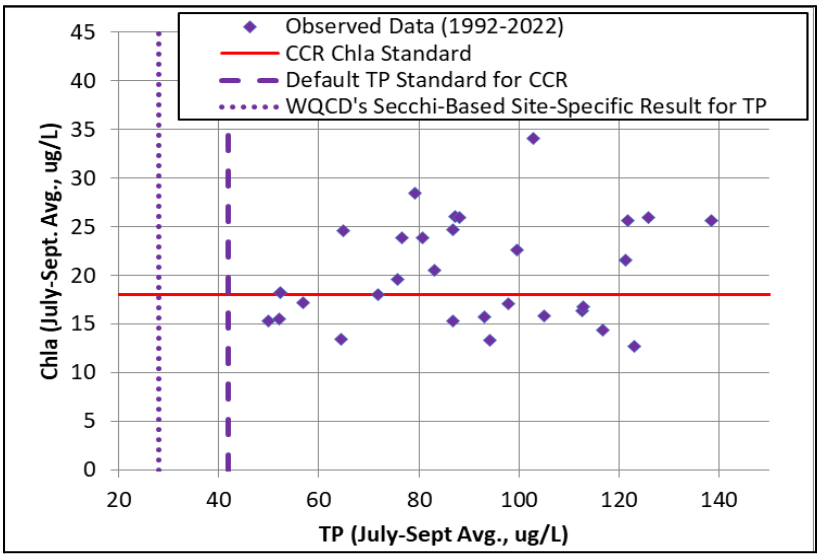


Figure 8. Observed Summertime Chl*a* and TP compared to the Default TP Standard and WQCD's Secchi-Based Site-Specific TP Standard for Cherry Creek Reservoir

[4] O/E refers to the ratio of "observed" to "expected" Secchi depth, where the "expected" value is based on an empirical relationship between Chl*a* and Secchi depth developed by Carlson (1977). Note also that use of this term as a predictor of Chl*a* raises technical concerns given that Secchi O/E is calculated with Chl*a* and is therefore not an independent variable for prediction of Chl*a*. Despite these concerns, testing of the WQCD Secchi-based site-specific equations for Cherry Creek Reservoir was conducted to meet presumed expectations for this analysis.

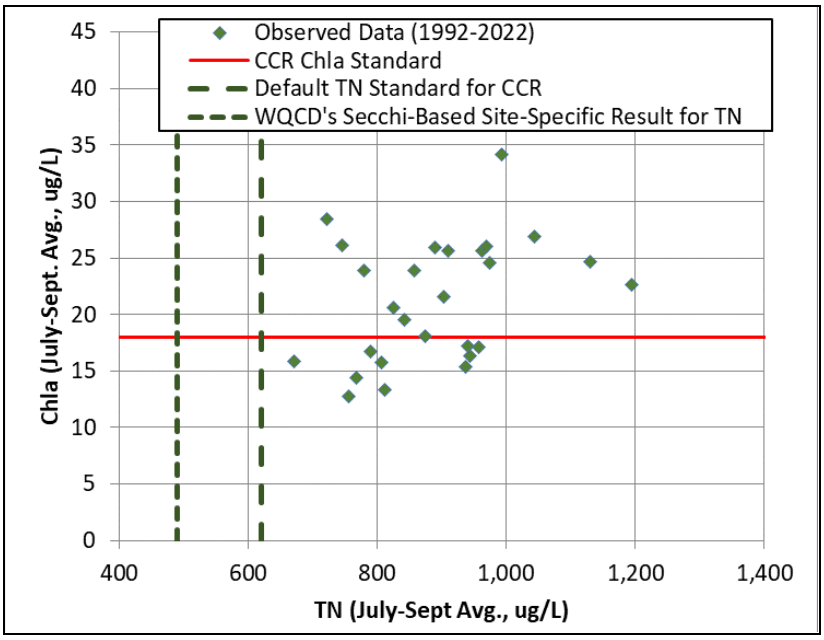


Figure 9. Observed Summertime Chl*a* and TN compared to the Default TN Standard and WQCD's Secchi-Based Site-Specific TN Standard for Cherry Creek Reservoir

4 Site-Specific TP and TN Standard Development

For the reasons explained in Section 2, Cherry Creek Reservoir needs site-specific standards for TP and TN. Further, WQCD's secchi-based site-specific equations do not work for this system (see Section 3); therefore, the site-specific TP and TN standards must be developed from site-specific relationships. This section describes the approach taken to develop the proposed site-specific standard values. Overall the approach follows the WQCD's 4-step method, which was used to develop the TP and TN TVSs adopted in the 2023 Rulemaking Hearing. The discussion begins with an overview of the WQCD's 4-steps (Section 4.1), followed by a detailed presentation of each step as applied to Cherry Creek Reservoir for the site-specific standard development (Section 4.2). Finally, additional analysis to further evaluate the proposed site-specific TP standard is presented in Section 4.3. Note that the approach and findings presented here are specific to Cherry Creek Reservoir, which has an extensive dataset and benefits from a detailed site-specific numerical model. Therefore, this approach to site-specific nutrient standard development may not necessarily be appropriate for other Colorado lakes/reservoirs.

4.1 Overview of the WQCD 4-Step Approach for TP and TN Standard Development

The approach taken to develop the proposed site-specific TP and TN standards for Cherry Creek Reservoir follows the 4-step method applied by the WQCD in development of the TP and TN lakes and reservoirs TVSs (WQCD, 2022a) which were adopted in the 2023 Rulemaking Hearing. The four steps apply relationships based on observed data to translate the Chl*a* standard into corresponding TP and TN standards. The translation approach further underscores that the fundamental purpose of the TP and TN standards is to protect lakes and reservoirs from algal growth in excess of the applicable Chl*a* standard. The four steps can be summarized as follows:

Step 1: Define the Chl*a* standard value.

The Chl*a* standards for lakes and reservoir are already established; therefore, this step simply involves identifying the applicable Chl*a* standard value.

Step 2: Translate the Chl*a* standard to a 50th percentile.

Chl*a* standards are evaluated as a July through September average, with a one-in-five-year allowable exceedance frequency. Because of the one-in-five-year allowable exceedance frequency, the WQCD considers the Chl*a* standard to be reflective of an 80th percentile. To support graphical comparison of observed Chl*a* and nutrient data, the Chl*a* standard value must first be translated from an 80th percentile to a 50th percentile. WQCD developed a State-wide relationship between the 80th percentile and the 50th percentile for summertime Chl*a* concentrations using data from well-sampled lakes and reservoirs. This relationship is used to translate the applicable Chl*a* standard value from Step 1 (reflective of an 80th percentile) to a corresponding Chl*a* concentration reflective of a 50th percentile (Figure 10).

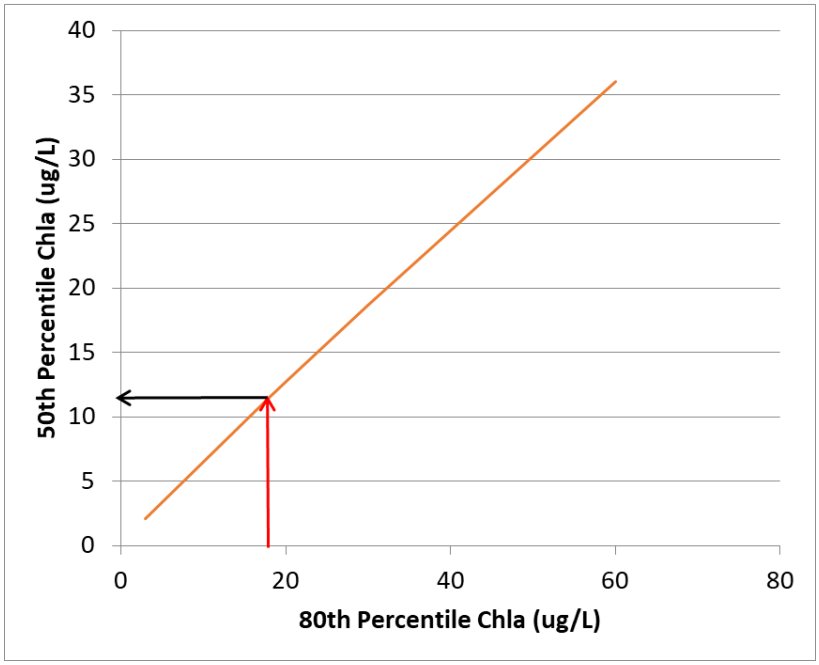


Figure 10. WQCD State-Wide Relationship for Translating Chl*a* Standard Value (80th Percentile) to a 50th Percentile (Step 2); Arrows Show Translation for Chl*a* Standard of 18 ug/L to 50th Percentile of 11.5 ug/L

<u>Step 3</u>: Translate Chl*a* as a 50th Percentile to TP and TN.

The next step is to translate the Chl*a* value (50th percentile) identified in Step 2 to TP and TN concentrations. To do this, the WQCD created State-wide relationships between observed July through September Chl*a* concentrations and TP and TN concentrations. Warm and Cold lakes were distinguished in this step. A fit to the data was found using quantile regression, resulting in an equation relating Chl*a* and TP and an equation relating Chl*a* and TN. Use of quantile regression, which is generally less sensitive to the influence of outliers (as compared to a least squares regression fit), is considered a good choice in this case given the high variability in the observed datasets. The resulting relationships were then used to translate the 50th percentile Chl*a* value to TP and TN concentrations (Figure 11 and Figure 12).

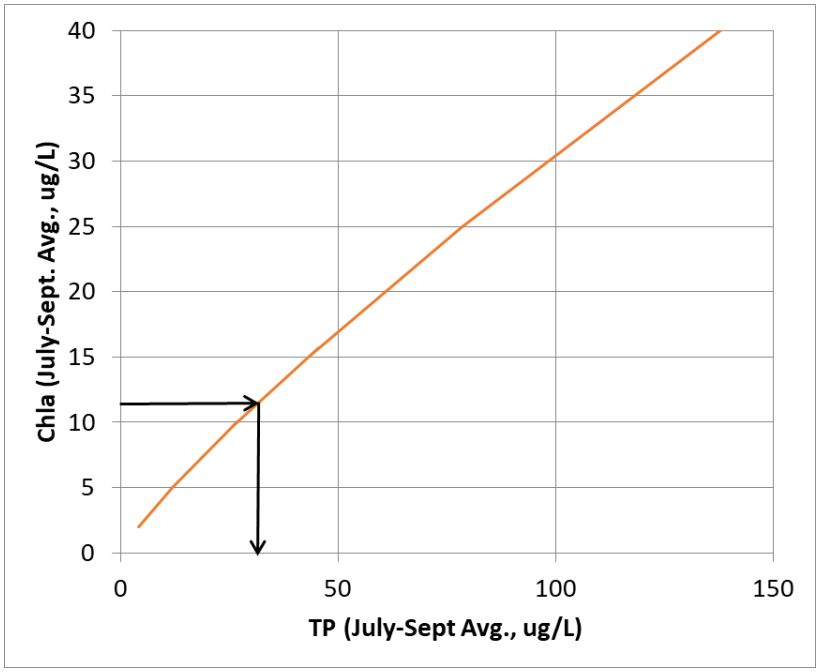


Figure 11. WQCD State-Wide Warm Water Relationship for Translating Chl*a* Standard (as a 50th Percentile) to Average Summertime TP Concentrations; Arrows Show Translation for Chl*a* 50th Percentile of 11.5 ug/L to a TP Concentration of 31.6 ug/L

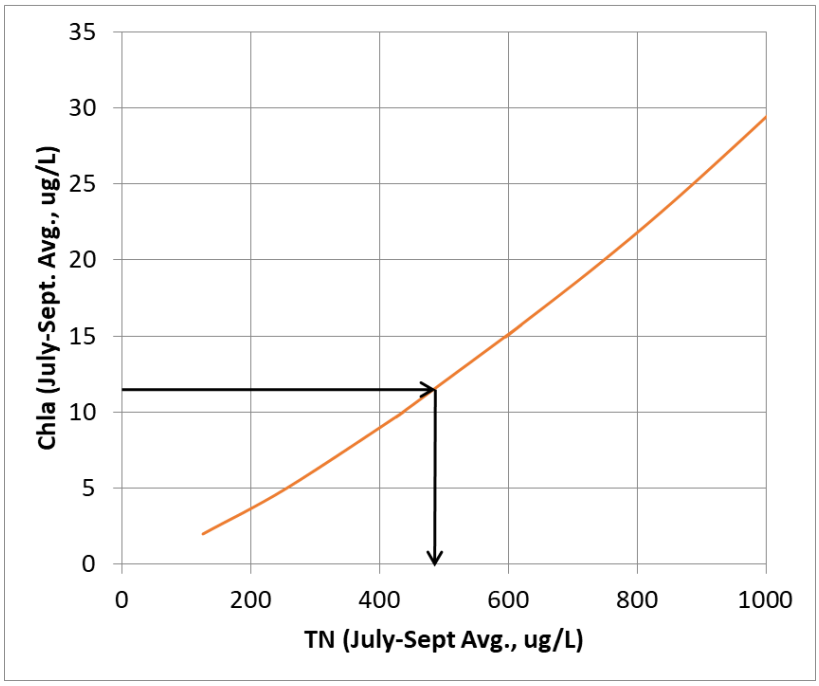


Figure 12. WQCD State-Wide Warm Water Relationship for Translating Chl*a* Standard (as a 50th Percentile) to Average Summertime TN Concentrations; Arrows Show Translation for Chl*a* 50th Percentile of 11.5 ug/L to a TN Concentration of 487 ug/L

<u>Step 4</u>: Translate TP and TN concentrations to 80th percentiles.

The final step of the 4-step process is to convert the summertime average TP and TN concentrations identified in Step 3 to 80th percentiles. The WQCD included this step to create TP and TN standard values that are applicable with a one-in-five-year allowable exceedance frequency. Following the same logic used in Step 2, the WQCD developed State-wide relationships between the 50th percentile and the 80th percentile summertime TP (or TN) concentrations, based on observed data from well-sampled lakes and reservoirs. These relationships were then used to translate the 50th percentile TP and TN values determined in Step 3 into 80th percentile TP and TN concentration values (Figure 13 and Figure 14). The resulting 80th percentile concentration values are the resulting TP and TN standard values, assessed as July through September averages with a one-in-five-year allowable exceedance frequency. Note that WQCD rounds the resulting TP and TN standard values to two significant figures.

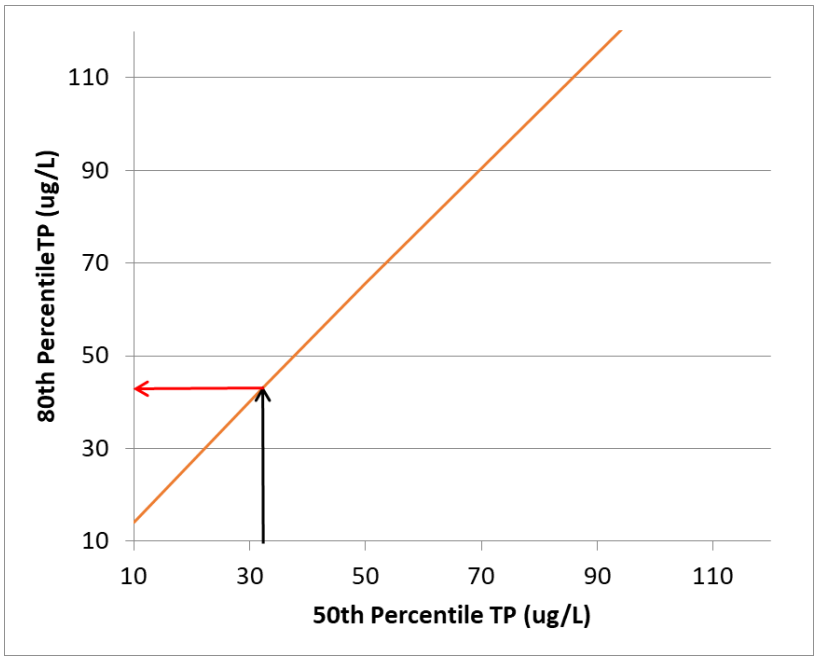


Figure 13. WQCD State-Wide Relationship for Translating Average Summertime TP (as a 50th Percentile) to Average Summertime TP as an 80th Percentile; Arrows Show Translation for 50th Percentile TP of 31.6 ug/L to the 80th Percentile TP Concentration of 42 ug/L

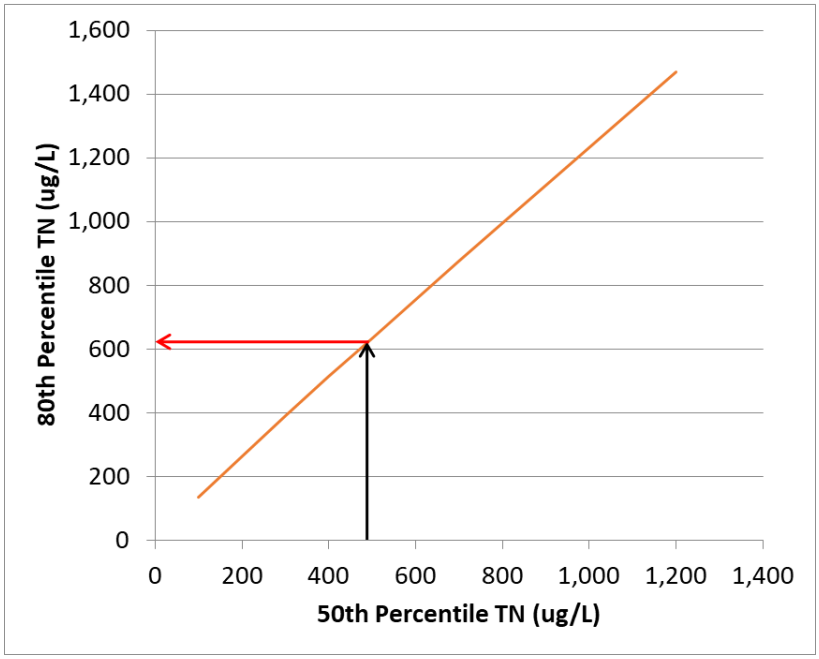


Figure 14. WQCD State-Wide Relationship for Translating Average Summertime TN (as a 50th Percentile) to Average Summertime TN as an 80th Percentile; Arrows Show Translation for 50th Percentile TN of 487 ug/L to the 80th Percentile TN Concentration of 620 ug/L

4.2 WQCD 4-Step Method Applied to Cherry Creek Reservoir

To develop the site-specific TP and TN standards, the WQCD's 4-step method described in Section 4.1 was applied using Cherry Creek Reservoir data instead of the State-wide dataset used to develop the TVSs. The discussion is organized by the four steps:

- **Step 1**: Define the Chl*a* standard value.
- **Step 2**: Translate the Chl*a* standard to a 50th percentile.
- **Step 3**: Translate Chl*a* as a 50th Percentile to TP and TN.
- **Step 4**: Translate TP and TN concentrations to 80th percentiles.

4.2.1 Cherry Creek Reservoir – Step 1: Define the Chl*a* standard Value

The first step is to define the Chl*a* standard value. For Cherry Creek Reservoir, there is an existing, site-specific Chl*a* standard value of 18 ug/L.

4.2.2 Cherry Creek Reservoir – Step 2: Translate the Chl*a* Standard to a 50th Percentile

Continuing to follow the WQCD's 4-step method, the second step is to translate the Chl*a* standard to a 50th percentile. While the WQCD has a strong State-wide relationship based on well-sampled lakes,

CCQWQA has an extensive[5] site-specific dataset to support consideration of whether the State-wide relationship appropriately reflects the distribution of summertime average Chl*a* concentrations in Cherry Creek Reservoir, or if a site-specific relationship should be used instead. The Cherry Creek Reservoir dataset was broken into five-year blocks of time[6] (2018-2022, 2013-2017, etc.) to generate a site-specific 80th percentile to 50th percentile relationship for the summertime average Chl*a*. Five-year blocks were used to produce multiple points to generate a regression line[7], and the resulting relationship is strong (R^2 = 0.86; Figure 16). The WQCD relationship, however, does not do a good job of reflecting the Cherry Creek Reservoir dataset (Figure 16). Specifically, the State-wide relationship is consistently biased low relative to the Cherry Creek Reservoir dataset.

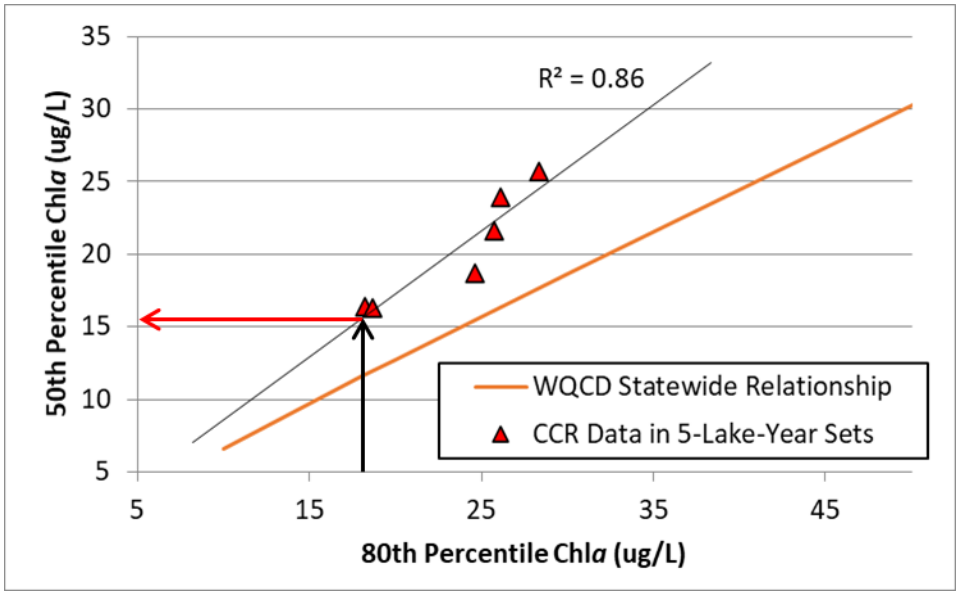


Figure 16. Cherry Creek Reservoir Site-Specific Relationship between Summertime Chl*a* 80th Percentile and 50th Percentile Concentrations (Data Presented in Five-Year Sets) Compared to the WQCD State-Wide Relationship; Arrows Show Translation for Chl*a* Standard of 18 ug/L to 50th Percentile of 15.55 ug/L

It is reasonable to expect that a given water body may exhibit a distribution of summertime Chl*a* concentrations that differs from that defined based on a State-wide dataset. Therefore, given the

[5] Note that Cherry Creek Reservoir dataset includes 31 years of record with 6 to 14 Chl*a* observations each year in the months of July through September (1992-2022).

[6] The five-year block approach is considered reasonable, given the WQCD designation that a lake must include at least five years of record for inclusion in the State-wide 80-50 relationship for Chl*a*. In other words, the WQCD considers five years of data adequate to characterize the 80-50 relationship for Chl*a* for a given lake; therefore, five-year blocks of time should be appropriate for use in the development of a site-specific 80-50 relationship.

[7] Note that use of all the Cherry Creek Reservoir data in a single data group would produce a single 80-50 data point. More than one point is needed to generate a regression line to translate the Chl*a* standard value (representative of an 80th percentile) to a 50th percentile. Further, it would not be appropriate to work from a single point and simply assume that the line should pass through the origin, recognizing that the State-wide relationship also does not pass through the origin.

extensive dataset available for Cherry Creek Reservoir and the apparent differences from the State-wide relationship, the following site-specific relationship was applied for Step 2:

$$\text{Chl}a_{50\text{th \%ile}} = 0.8683*\text{Chl}a_{80\text{th \%ile}} - 0.0772$$

The equation translates the 80th percentile Chl*a* standard value of 18 ug/L to a 50th percentile Chl*a* value of 15.55 ug/L (Figure 16).

4.2.3 Cherry Creek Reservoir – Step 3: Translate Chl*a* as a 50th Percentile to TP and TN

Step 3 is the critical step translating summertime Chl*a* concentrations to summertime TP and TN concentrations based on the observed relationships. As established in Section 2, the WQCD's State-wide warm lakes relationships for Chl*a*:TP and Chl*a*:TN do not perform well in describing the observed algal response in Cherry Creek Reservoir to TP and TN concentrations (Figure 4 and Figure 5). However, it is also noted that the full Cherry Creek dataset lacks clear relationships between Chl*a* and TP (Figure 2) and Chl*a* and TN (Figure 3). Therefore, additional analysis was needed to identify a site-specific relationship to support completion of Step 3.

In review of the 31-year dataset for Chl*a* and nutrients in Cherry Creek Reservoir, an apparent pattern was noted. Specifically, a general pattern match was identified between the response of summertime Chl*a* to TN concentrations from ~2004 through 2022 (Figure 17). In other words, the data show that over that time period there is general agreement between Chl*a* and TN in terms of the direction of change (i.e., when TN increases, Chl*a* generally increases and vice versa). Interestingly, over the same set of years, the pattern is completely absent for TP (Figure 18). This may indicate the dominance of TN (vs. TP) as a primary control on algal growth (nitrogen limitation) in these years (~2004-2022).

Correspondingly, there appears to be a general pattern match between TP and Chl*a* in the preceding set of years in the record (1992-~2003; Figure 18). For 1992-~2003, there is a general pattern match for TP and Chl*a* (1992-~2003), while there is no similar match between TN and Chl*a* in the same years (Figure 17). This may indicate the dominance of TP (vs. TN) as a primary control on algal growth (phosphorus limitation) in this portion of the record (1992-~2003). These earlier years also correspond to a period when TP concentrations were generally lower than the average observed in the more recent years, further supporting the possibility that the patterns indicate TP limitation followed by TN limitation. Note that there is no alternative explanation[8] for this pattern at this time.

[8] There is no change in reservoir operations that corresponds to the 2003/2004 timeframe identified here as a change point in the dataset. While the destratification system operations all occurred in the second timeframe, the destratification system was operated in fewer than half of the summers in the second timeframe (2008-2013, 2021, and 2022). Therefore, destratification system operations are align with or explain this pattern. There are also no clear step changes corresponding to the 2003/2004 timeframe for in-reservoir conditions such as temperature, clarity, non-volatile suspended solids (NVSS), etc. Therefore, the change in phosphorus concentrations is currently thought to be the primary explanation for the change in pattern.

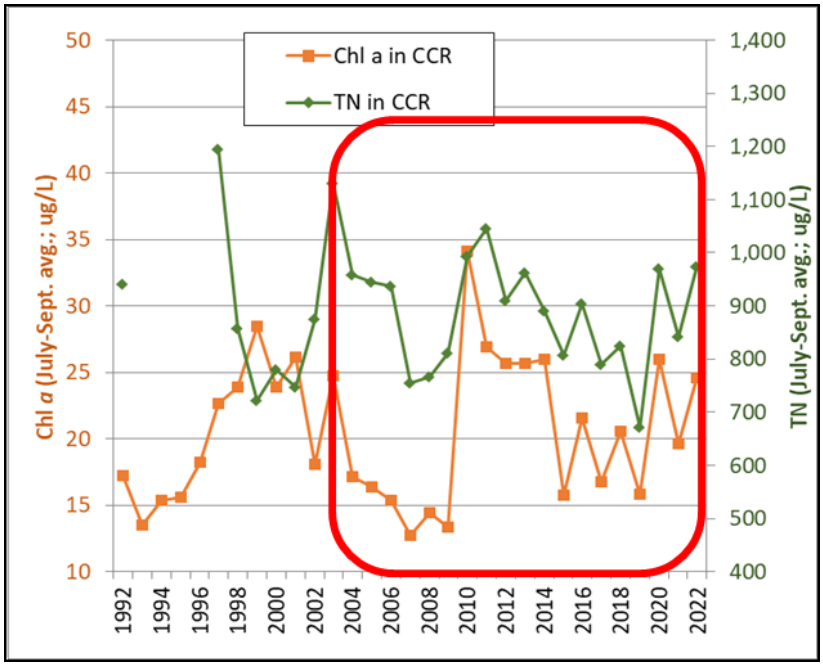


Figure 17. Summertime TN and Chl*a* Concentrations in Cherry Creek Reservoir; Red Outline Indicates Period of Apparent Pattern Match and Possible Dominance of N-Limitation

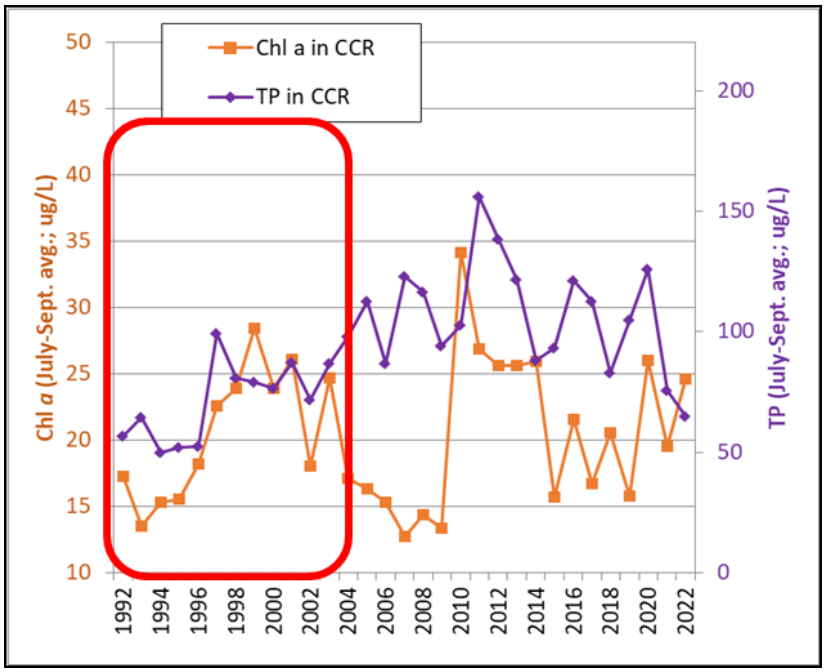
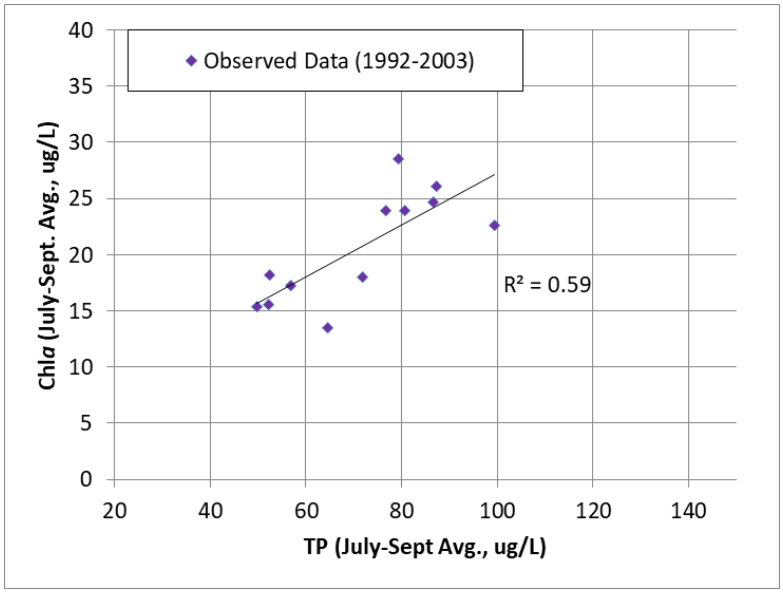


Figure 18. Summertime TP and Chl*a* Concentrations in Cherry Creek Reservoir; Red Outline Indicates Period of Apparent Pattern Match and Possible Dominance of P-Limitation

This pattern change in the observed dataset appears to offer a glimpse into the underlying relationships between TP and Chl*a* and TN and Chl*a* that are not readily apparent in the full dataset. When TP and Chl*a* data from 1992-2003 are plotted, the data exhibit a reasonable correlation (R^2 = 0.59; Figure 19),

which is a dramatic improvement over the lack correlation in the full dataset (R^2 = 0.06; Figure 2). Similarly, when TN and Chl*a* data from 2004-2022 are plotted, the data exhibit a reasonable correlation (R^2 = 0.48; Figure 20), which is a dramatic improvement[9] over the lack of correlation in the full dataset (R^2 = 0.12; Figure 3).

Based on this finding, site-specific relationships for Step 3 were developed by dividing the data into two parts (1992-2003 to identify the Chl*a*:TP relationship, and 2004-2022 to identify the Chl*a*:TN relationship). Fortunately, due to the long (31-year) period of record available for Cherry Creek Reservoir, even the subdivided datasets are still reasonably long (12 years of record used to define the Chl*a* response to TP, and 19 years of record used to define the Chl*a* response to TN).



[9] While these correlations are notable improvements to those based on the full dataset, and these are comparable, in terms of goodness of fit, to the State-wide relationships used to develop TVSs for warm lakes, the relationships are still far from perfect. This is to be expected when attempting to predict Chl*a* from TN or TP alone. First, TN and TP are imperfect measures of biologically available nutrient concentrations. TN and TP include nitrogen and phosphorus associated with recalcitrant organic matter, which is slow to decay rendering the nutrients largely inaccessible for algal uptake. The fraction of TN and TP in recalcitrant organic matter can vary over time, limiting the predictive capability of TN and TP for Chl*a*. Second, Chl*a* is an imperfect measure of algal biomass. The amount of Chl*a* produced by a gram of algal cells can vary widely depending on the algal species and light conditions in the reservoir. Third, algal growth in response to TN and TP can be interdependent, particularly in a system like Cherry Creek Reservoir, which exhibits nitrogen limitation (excess bioavailable phosphorus relative to bioavailable nitrogen) at times and nitrogen-fixing cyanobacteria. Fourth, many factors beyond TN and TP concentrations affect the Chl*a* response in lakes, including vertical mixing dynamics, water temperature, light, etc. In short, there are many reasons to expect an imperfect fit when plotting lake Chl*a* response to TN or TP concentrations.

At the request of EPA (Moon, 2023), non-volatile suspended solids ([NVSS], data available from 2011-2022) was considered as a secondary predictor variable with TN and TP. However, the analysis did not prove fruitful as NVSS was found to be an insignificant predictor of Chl*a,* exhibiting high p-values (>0.25). While there are currently no successful approaches identified for Cherry Creek Reservoir to support consideration of secondary controls on Chl*a* response to nutrients in Cherry Creek Reservoir for the purpose of site-specific standards development, CCBWQA is open to future discoveries.

Figure 19. Observed Cherry Creek Dataset; Summer Chl*a* Response to TP Concentrations; 1992-2003

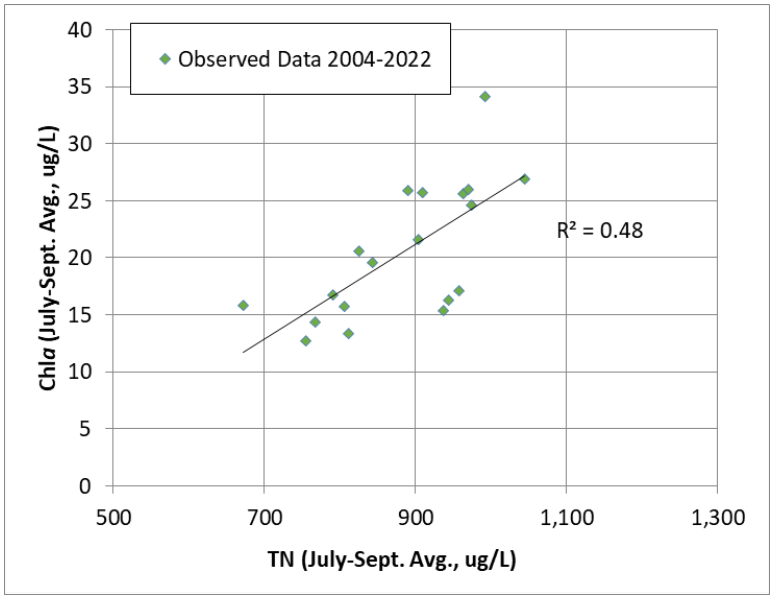


Figure 20. Observed Cherry Creek Dataset; Summer Chl*a* Response to TN Concentrations; 2004-2022

50th quantile regressions[10] were fit to the subsets of data to support completion of Step 3 (Figure 21 and Figure 22). The site-specific 50th quantile relationships for Cherry Creek Reservoir are:

$$TP(ug/L) = 10^{((log_{10}[Chla]+4.09425)/1.83521)}$$

$$TN(ug/L) = 10^{((log_{10}[Chla]+0.31154)/0.88261)}$$

Using these relationships, the Chl*a* value from Step 2 (15.55 ug/L) translates to 50.5 ug/L TP and 759 ug/L TN (Figure 21 and Figure 22).

[10] While the WQCD applied a 75th quantile regression fit to the State-wide warm lakes dataset in an effort to identify the response of highly-productive lakes, it is appropriate to use a 50th quantile fit in a site-specific analysis for a single lake/reservoir.

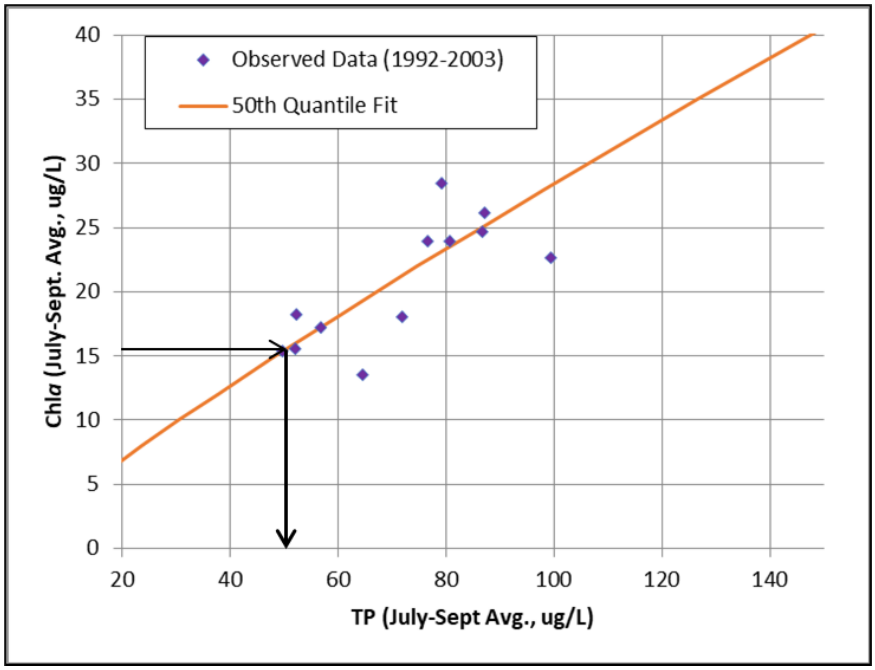


Figure 21. 50th Quantile Fit to Cherry Creek Reservoir Summer Chl*a* Response to Summer TP Concentrations; 1992-2003; Arrows Show Translation for Chl*a* 50th Percentile of 15.55 ug/L to a TP Concentration of 50.5 ug/L

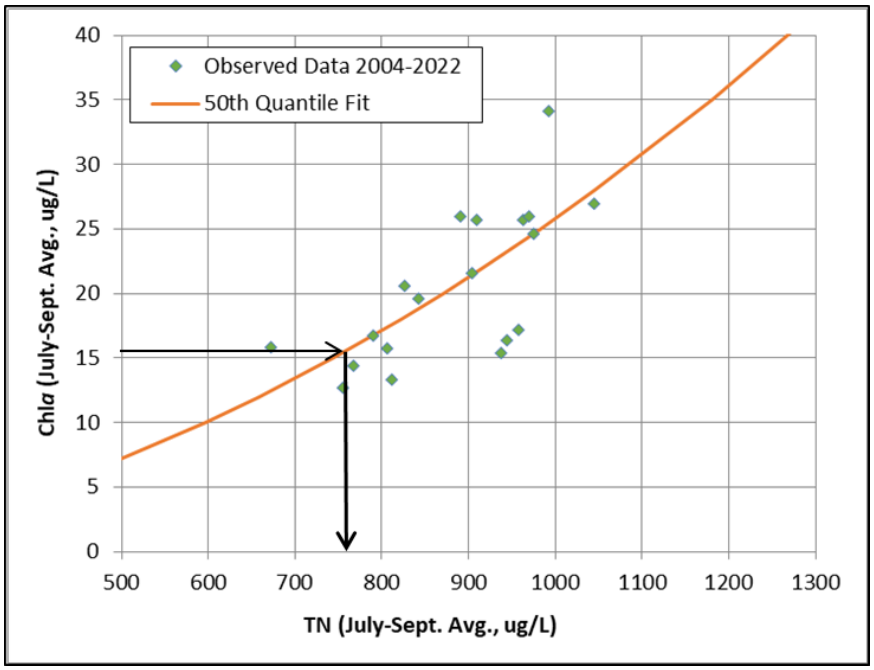


Figure 22. 50th Quantile Fit to Cherry Creek Reservoir Summer Chl*a* Response to Summer TN Concentrations; 2004-2022; Arrows Show Translation for Chl*a* 50th Percentile of 15.55 ug/L to a TN Concentration of 759 ug/L

4.2.4 Cherry Creek Reservoir – Step 4: Translate TP and TN Concentrations to 80th Percentiles

In the final step, the summertime average TP and TN concentrations identified in Step 3 were converted to final standard values reflective of 80th percentiles. While the WQCD has a strong State-wide relationship to translate TP and TN summertime averages (reflective of 50th percentiles) to values reflective of summertime 80th percentiles, Cherry Creek Reservoir has an extensive dataset that exhibits strong site-specific relationships[11] for TP and TN (Figure 25 and Figure 26). Further, the site-specific relationships do not agree well with the WQCD relationships, exhibiting a consistent high bias in 80th percentile response.

As noted for Chl*a* in Section 4.2.2, it is reasonable to expect that a given water body may exhibit summertime TP and TN concentration distributions that differ from relationships based on the State-wide dataset. Therefore, given the extensive dataset available for Cherry Creek Reservoir, the strong relationships, and the apparent difference from the State-wide relationships, the site-specific 50-80 translations for TP and TN were applied (Figure 25 and Figure 26):

$$\mathrm{TP}_{80\text{th }\%\text{ile}} = 1.0127 * \mathrm{TP}_{50\text{th }\%\text{ile}} + 15.255$$

$$\mathrm{TN}_{80\text{th }\%\text{ile}}\,(\mathrm{ug/L}) = 0.7346 * \mathrm{TN}_{50\text{th }\%\text{ile}} + 307.13$$

The resulting proposed site-specific nutrient standard values are:

- Proposed Site-Specific Standard for TP: **66 ug/L TP**, and
- Proposed Site-Specific Standard for TN: **860[12] ug/L TN.**

As with the TVSs, these site-specific standards would be assessed based on July through September averages, with a one-in-five-year allowable exceedance frequency.

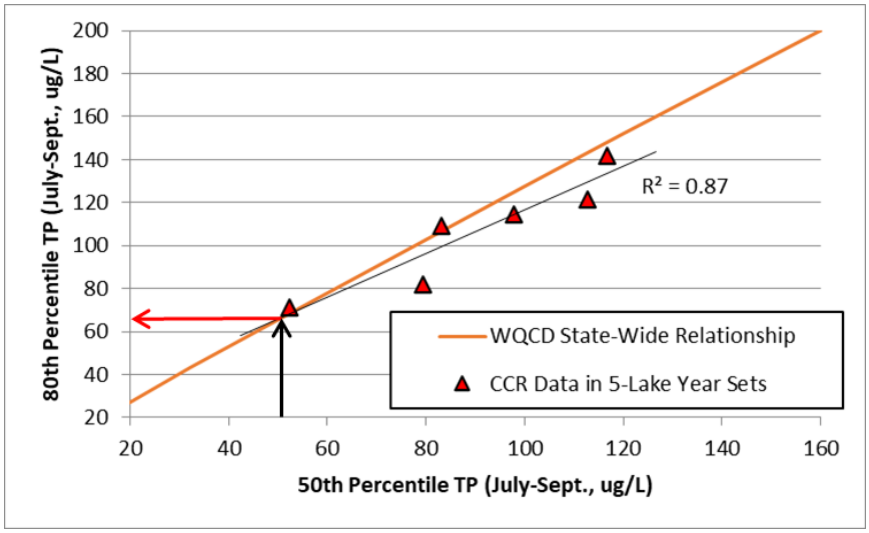


Figure 25. Cherry Creek Reservoir Site-Specific Relationship between Summertime TP 50th Percentile and 80th Percentile Concentrations; Arrows Show Translation for 50.5 ug/L TP (50th Percentile) to 80th Percentile TP Standard Value of 66 ug/L

[11] Following the same reasoning described in Section 4.2.2 for Step 2, the site-specific relationships for Step 4 were developed from five-year blocks of data.

[12] Note that these values follow the WQCD precedent of rounding the TP and TN standard values to two significant figures.

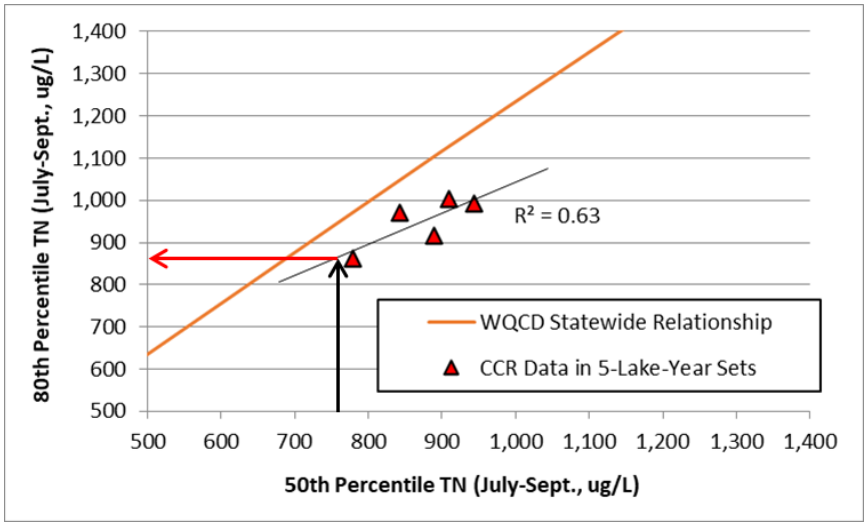


Figure 26. Cherry Creek Reservoir Site-Specific Relationship between Summertime TN 50th Percentile and 80th Percentile Concentrations; Arrows Show Translation for 759 ug/L TN (50th Percentile) to 80th Percentile TN Standard Value of 860 ug/L

4.3 Additional Analysis for TP

The following subsections present additional analysis conducted to further evaluate the proposed site-specific TP standard. Additional analysis was considered useful for TP for two reasons. First, the Chl*a*:TP relationship applied to develop the proposed TP standard is based on the older portion of the observed dataset (1992-2003). Next, the translations for TP in the 4-step process tend to fall at or even slightly below the lower end of the observed range of TP concentrations (e.g., Figure 21). In contrast, the TN proposal is based on the recent 19 years of observed record and does not use extrapolations below the observed ranges.

4.3.1 Clean Lakes Study TP Data Comparison

To further evaluate the site-specific Chl*a*:TP relationship used in Step 3 (Section 4.2.3), historical data from the Cherry Creek Reservoir Clean Lakes Study (DRCOG, 1984) were considered. Samples for TP and Chl*a* were collected through the summer of 1982, providing an additional data point[13] at the lower range of TP concentrations. This data point falls reasonably close to the 50th quantile relationship developed from the 1992-2003 dataset (Figure 27), providing additional confidence in the relationship and in its extrapolation to a TP concentration that is slightly lower than the 1992-2003 observed range (Figure 21). Unfortunately, TN data were not available from the Clean Lakes Study for a similar analysis; however, the TN relationship is based on the 19 years of recent record and the translation is taken from within the observed range of TN concentrations (though it is on the lower end of the range).

[13] The average summertime TP concentration for Cherry Creek Reservoir in 1982 (29.3 ug/L) was based on the average of the July, August, and September values reported on page 72 of the Clean Lakes Study document for Cherry Creek Reservoir (DRCOG, 1984), and the summer average Chl*a* in 1982 (10.7 ug/L) was based on the value reported on page 73 of the document.

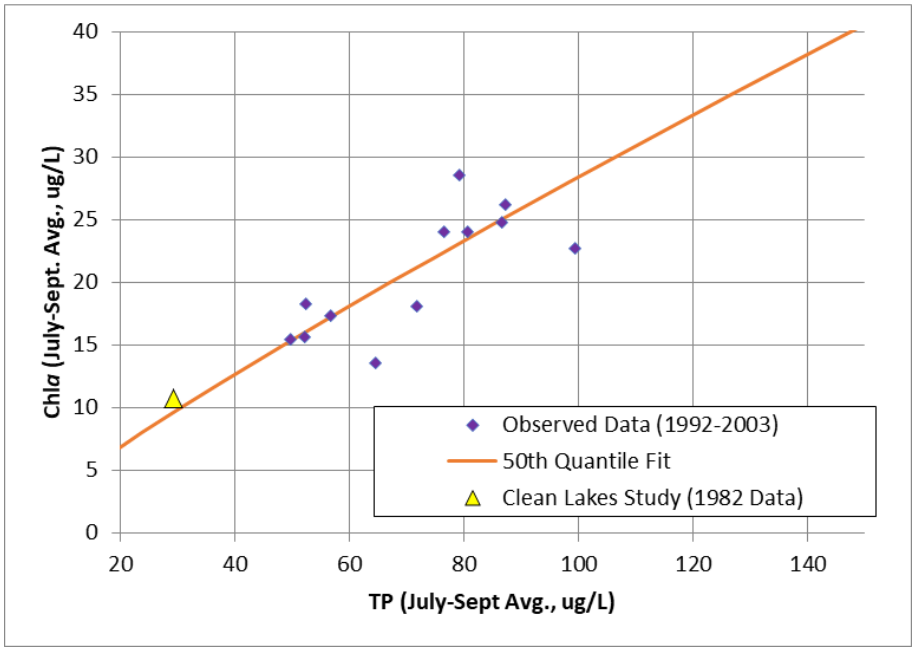


Figure 27. 50th Quantile Fit to Cherry Creek Reservoir Summer Chl*a* Response to Summer TP Concentrations; 1992-2003; Clean Lakes Study 1982 Data Also Shown

4.3.2 Modeling Analysis for TP

To provide further review of the proposed site-specific TP standard for Cherry Creek Reservoir, the existing hydrodynamic and water-quality model of the reservoir (Hydros, 2017 and 2019) was applied. The Cherry Creek Reservoir model is a two-dimensional hydrodynamic and water-quality model developed using CE-QUAL-W2 (Cole and Wells, 2017). The model simulates hydrodynamics, temperature, dissolved oxygen, nutrients, and Chl*a* in Cherry Creek Reservoir from 2003 through 2017, including representation of the effects of the destratification system. The original model development and its extension are documented in detail in Hydros (2017) and Hydros (2019), respectively. The model is considered a useful tool for this purpose because it incorporates much of the complexity absent in the empirical Chl*a*:TP relationships, such as year-to-year differences in residence time, light, water temperature, wind, etc.

The goal in application of the Cherry Creek Reservoir model was to see what the model suggests as an appropriate TP standard corresponding to the Chl*a* standard and consider that relative to the site-specific TP standard developed from the observed data (as described in Sections 4.2 through 4.2.4). This was done by conducting a series of runs that simulated Chl*a* response to reductions in reservoir TP concentrations extending below the current observed range. Run results for summertime TP and Chl*a* concentrations were then used in place of observed data in Step 3 of the WQCD's 4-Step method.

4.3.2.1 Model Runs

Reductions in TP concentrations in the reservoir were simulated in a series of model runs reflecting the two general nutrient control strategies concepts of watershed controls and in-reservoir nutrient management. In addition to the calibration run simulating observed conditions from 2003-2017, the following ten modeling runs were conducted:

- 20% Less TP Inflow (uniform 20% reduction in inflow TP concentrations);
- 50% Less TP Inflow (uniform 50% reduction in inflow TP concentrations);
- 80% Less TP Inflow (uniform 80% reduction in inflow TP concentrations);
- 20% Less TP Int. Load (20% reduction in internal loading rates for TP);
- 50% Less TP Int. Load (50% reduction in internal loading rates for TP);
- 80% Less TP Int. Load (80% reduction in internal loading rates for TP);
- 20% Less TP Inflow; 80% Less TP Int. Load (uniform 20% reduction in inflow TP concentrations and 80% reduction in internal loading rates for TP);
- 50% Less TP Inflow; 50% Less TP Int. Load (uniform 50% reduction in inflow TP concentrations and 50% reduction in internal loading rates for TP);
- 50% Less TP Inflow; 80% Less TP Int. Load (uniform 50% reduction in inflow TP concentrations and 80% reduction in internal loading rates for TP); and
- 80% Less TP Inflow; 80% Less TP Int. Load (uniform 80% reduction in inflow TP concentrations and 80% reduction in internal loading rates for TP)

Note that simulation designs were not constrained to fractional reductions that are currently considered achievable, particularly in terms of watershed controls. Inclusion of such runs is considered reasonable recognizing that the objective of this effort is not to assess attainability but instead to evaluate the modeled relationship between Chl*a* and TP, ideally including conditions below the Chl*a* standard.

4.3.2.2 Modeling Results

Modeling results for the runs listed above were compiled in terms of July through September average concentrations for TP and Chl*a*. A 50th quantile regression was then fit to the full set of run results (Figure 28). The R^2 analog for the 50th quantile regression fit is 0.70 indicating a relatively good correlation. Interestingly, modeling results show that the Chl*a* response to summertime TP predictions becomes more consistent (a better fit) at lower TP concentrations (<~70 ug/L), which may reflect a general turning point to (or toward) phosphorus limitation in the reservoir. Another interesting finding in the results is that TP concentration reductions on the order of 20% (as inflow loading reductions or as internal loading rate reductions) do not change the Chl*a* response enough to bring most years below the Chl*a* standard. To get most years below the Chl*a* standard, the modeling indicates that major reductions are needed (50% to 80% reductions), and a combination of inflow and in-reservoir strategies produce the best results.

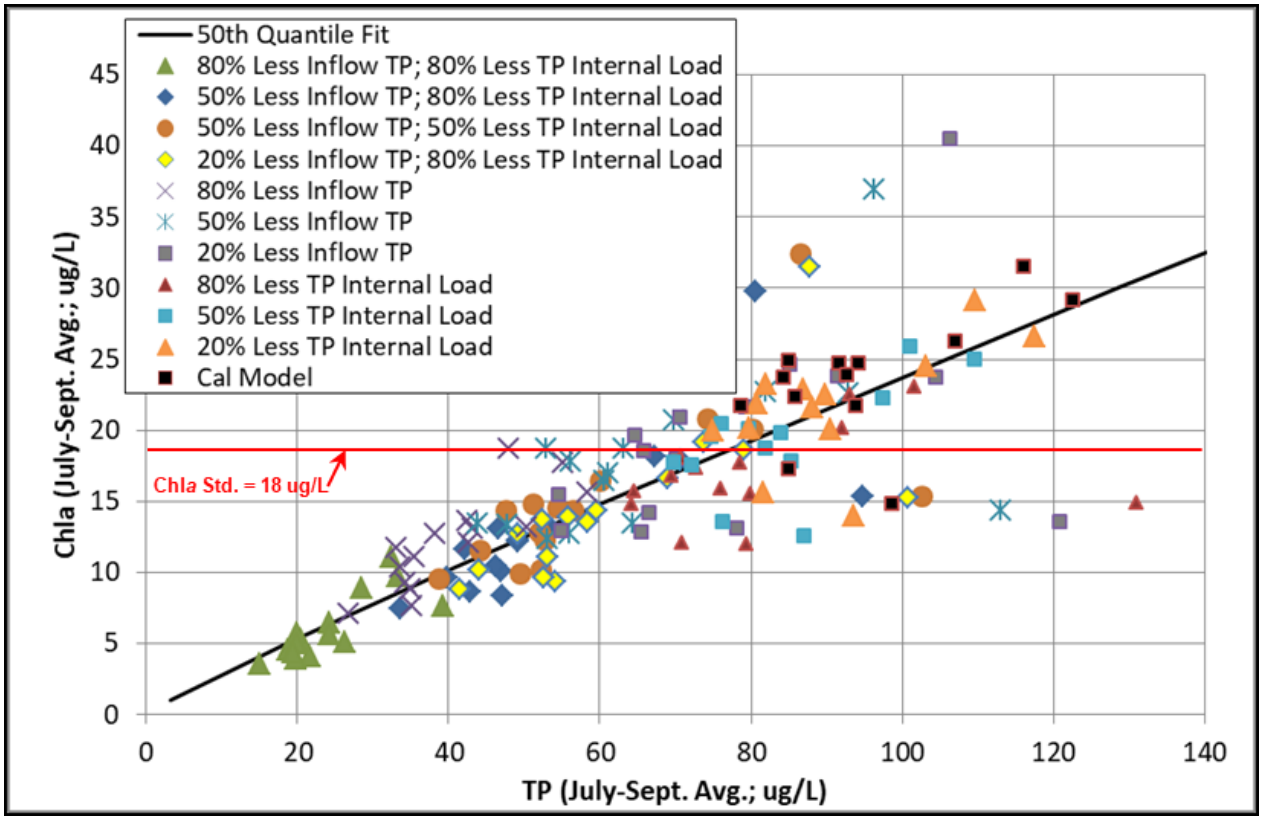


Figure 28. Results of Cherry Creek Reservoir Model Runs Showing Chl*a* Response to Progressive Reductions of Inflow Phosphorus Concentrations and Internal Phosphorus Loading Rates

Using the 50th quantile regression fit from the modeling results[14] in Step 3 of the WQCD's 4-step process (note: all other steps use relationships presented in Sections 4.2, 4.2.2, and 4.2.4), the modeling results produce a site-specific TP standard value of 79 ug/L. This value is higher (less stringent) than the 66 ug/L site-specific TP standard developed from the observed data. The CCBWQA is not planning to propose the modeling-based TP standard (79 ug/L) at this time, but is instead planning to propose the more stringent observation-based site-specific standard value of 66 ug/L TP. The modeling results are considered to provide supporting evidence that a standard value less stringent than the default TP standard for Cherry Creek Reservoir (42 ug/L TP) is justifiable. Further, the modeling results are considered to be an indication that future refinements to the site-specific TP standard for Cherry Creek Reservoir may be warranted, particularly as in-reservoir TP concentrations decrease and the observed data record better reflects the underlying Chl*a*:TP relationship at lower concentrations.

4.4 Summary of Site-Specific TP and TN Standard Development

Site-specific TP and TN standards for Cherry Creek Reservoir were developed following the same 4-step process applied by WQCD to develop the TVSs. In each step, the extensive Cherry Creek Reservoir dataset was used in lieu of the WQCD's State-wide database. The resulting proposed site-specific nutrient standard values are:

[14] $\mathrm{TPug/L} = 10((\log10[\mathrm{Chla}]+0.47309)/0.92469)$

- Proposed Site-Specific Standard for TP: **66 ug/L TP**, and
- Proposed Site-Specific Standard for TN: **860[15] ug/L TN.**

As with the TVSs, these site-specific standards would be assessed based on July through September averages, with a one-in-five-year allowable exceedance frequency.

[15] Note that these values follow the WQCD precedent of rounding the standard values to two significant figures.

5 Discussion of Site-Specific TN and TP Standard Values Developed for Cherry Creek Reservoir

Based on the analysis described in Section 4, site-specific TP and TN standards of 66 ug/L TP and 860 ug/L TN were developed for Cherry Creek Reservoir. In this section, these values are discussed in the context of State-wide TP and TN standards for warm lakes as well the observed data record for Cherry Creek Reservoir. The intent of this discussion is to offer perspective on the site-specific standard values relative to the broader regulatory framework and relative to the range of observed conditions in the reservoir.

While the site-specific TP and TN standard values developed for Cherry Creek are less stringent than the default values that the WQCC would assign to the reservoir, they are more stringent than the 2012 Interim Criteria values for lakes and reservoirs that were approved by the Environmental Protection Agency (EPA, 2016; site-specific TP and TN standard values). As such, the site-specific TP and TN standard values are considered to fall within a reasonable range from a regulatory context (i.e., between two sets of EPA-approved nutrients standards for warm lakes in Colorado)[16].

Table 2. Cherry Creek Reservoir Site-Specific TP and TN Standards Compared to Relevant State Nutrient Standards and Interim Criteria

Constituent	Warm Lakes Nutrient Standards		Default** Cherry Creek Reservoir Standards	Site-Specific Standards Developed for Cherry Creek Reservoir
	2012 Interim Criteria	TVSs* (TN and TP Adopted in April 2023)		
Chl*a* (ug/L)	20	20	**18**	**18**
TN (ug/L)	910	670	620	**860**
TP (ug/L)	83	47	42	**66**

Note: All are/would be assessed as July through September averages with a one in five-year allowable exceedance frequency.

*Currently only applicable to warm lakes above permitted discharges.

** Default TP and TN standards are those expected to be adopted for Cherry Creek Reservoir in the absence of a successful site-specific standard proposal. The TN and TP values were developed from the WQCD State-wide relationships used in the April 2023 RMH, applying the Cherry Creek Reservoir Chl*a* standard of 18 ug/L, in lieu of the general warm lakes Chl*a* standard of 20 ug/L.

When compared to the Cherry Creek Reservoir water-quality records, the proposed site-specific TP and TN standards fall on the low end of the observed dataset (Table 3 and Figure 29). While the Chl*a*

[16] While this is considered to be a reasonable range based of EPA-approved standard values, it should be noted that site-specific standard values outside of this range may be appropriate for some warm lakes, depending on the observed system response.

standard value is not routinely met, it is met[17] in 13 of the 31 years of record (Figure 29). Similarly, the proposed site-specific standard for TN would have been met in a similar number of years of record (12 of 27). In contrast, the proposed site-specific standard for TP would have only been met in 6 years of record (Figure 29). This pattern agrees with the overall conceptual understanding of the system, which is generally considered to be further from the optimal TP concentration than the optimal TN concentration. The relevant point is that meeting the proposed site-specific standards for both TP and TN would require in-reservoir summer concentrations well below typically-observed concentrations. As such, the proposed site-specific standards comprise challenging targets for CCBWQA as they continue their mission to protect and improve water quality in the reservoir. The challenge of meeting these targets is further underscored by the modeling results presented in Section 4.3, which indicate that major reductions in inflow nutrient concentrations and/or in-reservoir nutrient internal loading rates (on the order of 50 to 80%) are needed to meet the Chl*a* standard (and, correspondingly, the nutrient standards).

Table 3. Comparison of Site-Specific TP and TN Standards Developed for Cherry Creek Reservoir to Range of Summertime Average Observations

Constituent	Site-Specific Standards* Developed for Cherry Creek Reservoir	Cherry Creek Reservoir Observed Data (1992-2022) Jul.-Sept. Averages (Avg., Range)
Chl*a* (ug/L)	**18**	21 (13-34)
TN (ug/L)	**860**	889 (672-1,195)
TP (ug/L)	**66**	93 (50-156)

*All would be assessed as July through September averages with a one in five year allowable exceedance frequency.

[17] Note the terminology used here is purposeful, referring to a direct comparison of the standard value to the observed data, as opposed to an assessment of compliance with the standard. This analysis is not intended to evaluate compliance. Compliance analysis would require consideration of the one-in-five-year allowable exceedance frequency and does not match the purpose of this comparison conducted here.

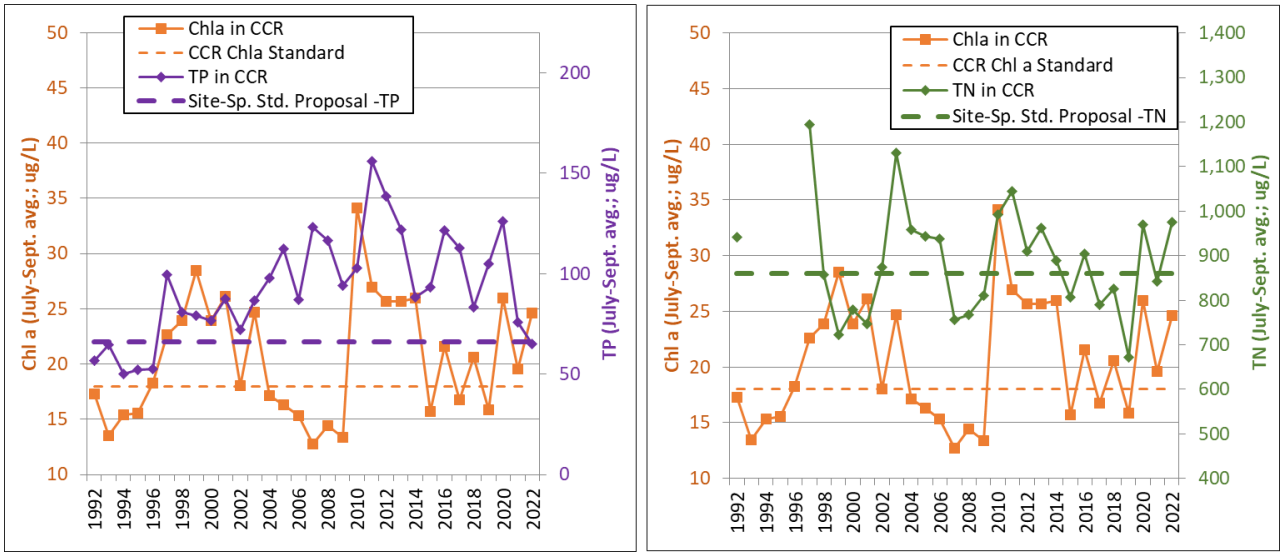


Figure 29. Comparison of Observed Chl*a* and Nutrient Data from Cherry Creek Reservoir to Existing Chl*a* Standard and Site-Specific TP and TN Standards Developed for Cherry Creek Reservoir, 1992-2022

The site-specific TP and TN standards developed for Cherry Creek Reservoir were also reviewed against the observed dataset using the quadrant plot approach (described in Section 2.4). Even with the site-specific proposal values, there are still numerous years of record that fail to show alignment between the Chl*a* standard and the TP and TN standards (Figure 30). In fact, there is no ideal value for the TP and TN standards to lead to good alignment with the full observed dataset. This underscores the underlying complexity of the Chl*a* response to nutrient concentrations in Cherry Creek Reservoir. In other words, TP and TN are clearly not independent controls on Chl*a* in Cherry Creek Reservoir as effectively assumed in the standard development process. That said, following the WQCD's 4-step process using site-specific data is expected to have produced TP and TN standard values that better reflect the underlying relationships between nutrients and Chl*a* in Cherry Creek Reservoir.

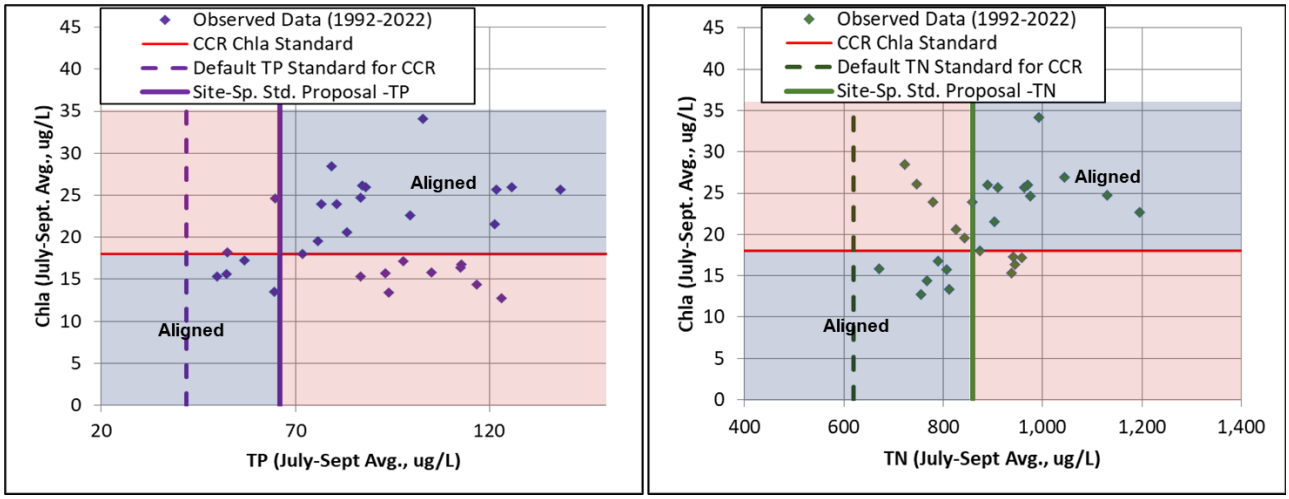


Figure 30. Cherry Creek Reservoir Chl*a*: TP and Chl*a*: TN Quadrant Plots with Site-Specific TP and TN Standards Developed for Cherry Creek Reservoir, 1992-2022

The underlying relationships become more apparent when the quandrant plots are reviewed focusing on the subsets of years used in standard development (Figure 31). As a reminder, the subsets of years used in the site-specific standard development (1992-2003 for TP and 2004-2022 for TN) are expected to generally differentiate between years with a greater tendency toward phosphorus limitation and years with a greater tendency toward nitrogen limitation. Using those data subsets, the proposed site-specific TP and TN standards align reasonably well with the Chl*a* standard in Cherry Creek Reservoir (Figure 31). Further, the site-specific TP and TN standards show much better alignment with the observed dataset as compared to the default TP and TN standards for Chery Creek Reservoir (Figure 31). As noted previously, future refinement of the site-specific standards, particularly for TP, may be needed as concentrations in the reservoir decrease and the observed dataset further illuminates the underlying relationship between TP and Chl*a* at lower concentrations.

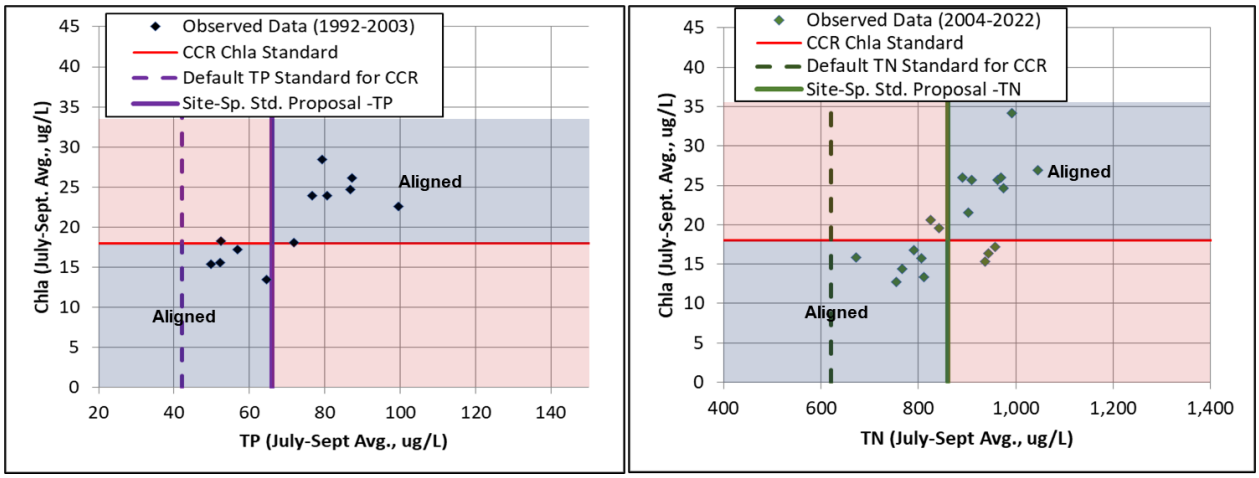


Figure 31. Cherry Creek Reservoir Chl*a*: TP and Chl*a*: TN Quadrant Plots with Site-Specific TP and TN Standards Developed for Cherry Creek Reservoir, Observed Data Limited to Year Sets Used in Standard Development

6 Longevity Plan Recommendations

It is recommended that a Longevity Plan be developed and included in the proposal for site-specific TP and TN standards for Cherry Creek Reservoir. As noted in Regulation 31 (WQCC, 2023) in the Statement of Basis and Purpose for the June 2021 Rulemaking Hearing, the purpose of a Longevity Plan for a site-specific standard is "to guarantee the collection and analysis of information that will be necessary to ensure that a site-specific standard is maintained over time, continues to be scientifically sound, protects the beneficial uses, and can be updated or revised as needed."

Key elements of the Longevity Plan for the site-specific TP and TN standard for Cherry Creek Reservoir should include:

- **Sampling –** The plan should include a commitment by CCBWQA to continue July through September monthly (at a minimum) sampling in the mixed layer at CCR2 for ammonia, nitrate+nitrite, total Kjeldahl nitrogen, SRP, TP, and Chl*a*, with current sampling and analysis methods.

- **Data Analysis** – The plan should include a commitment for analysis of the sampling results to evaluate Chl*a*:TP and Chl*a*:TN response relative to the historical dataset and review of apparent agreement in reservoir response relative to the TP and TN standards as compared to response relative to the Chl*a* standard.
- **Reporting** – The plan should include a commitment to generate a report every three years for the WQCC, corresponding to the triennial review cycle for the basin. Each report should provide the dataset corresponding to data collection commitment, a summary of the data analysis conducted, and a statement of the finding as to whether or not the site-specific TP and TN standards are still considered appropriate for Chery Creek Reservoir and adequately protective of the AL/Rec beneficial uses.

These data collection, analysis, and reporting commitments in a Longevity Plan should support ongoing review of the appropriateness and protectiveness of the site-specific TP and TN standards. It is anticipated that the data analysis may also support subsequent proposals to adjust the site-specific standards in the future, as needed. Note that the sampling and data analysis commitments in the Longevity Plan are intended to provide the minimum adequate information needed to support the WQCC in determining whether there have been any major changes in reservoir response which could indicate that the basis and assumptions used to support adoption of the original site-specific standards have become invalid. As such, the Longevity Plan is not intended to limit, in any way, the information that may be considered or the approach that may be taken to develop revised site-specific TP and TN standard for Cherry Creek Reservoir in the future, as needed.

7 Summary

The State-wide Chl*a*:TP and Chl*a*:TN relationships for warm lakes that were used to develop the AL/Rec TP and TN TVSs do not reflect the observed Chl*a* response to nutrient concentrations in Cherry Creek Reservoir. This mismatch may be due to the polymictic nature of the reservoir, high inflow concentrations of SRP, and/or the existence of strong nitrogen limitation in much of the observed record. Ultimately, the observed data indicate that the default standards are not appropriate for Cherry Creek Reservoir. Further, WQCD's Secchi-based Site-specific equations do not provide improved approximations of observed conditions in Cherry Creek Reservoir. Therefore, site-specific TP and TN standards are needed for Cherry Creek Reservoir.

An analysis of the observed dataset was conducted to identify site-specific nutrient standards for Cherry Creek Reservoir that are neither under-protective nor overly stringent. The resulting proposed site-specific standards for Cherry Creek Reservoir are:

- Proposed Site-Specific Standard for TP: **66 ug/L TP**, and
- Proposed Site-Specific Standard for TN: **860[18] ug/L TN.**

The site-specific TP and TN standards would be assessed with annual July through September averages and a one-in-five-year allowable exceedance frequency. These standards are considered to be defensible and appropriately protective for Cherry Creek Reservoir for the following reasons:

- The site-specific standards presented here were developed using the Cherry Creek Reservoir's extensive dataset (31-year record).
- The site-specific standards presented here were developed using the same 4-step method developed and applied by WQCD to define the TP and TN TVSs for lakes and reservoirs.
- The proposed values better reflect the apparent underlying Chl*a*:TP and Chl*a*:TN relationships present in the Cherry Creek Reservoir datasets, as compared to the default standards for Cherry Creek Reservoir.
- Historical TP data from 1982 (Clean Lakes Study) further support the proposal.
- Reservoir water-quality modeling of Chl*a* response to TP further supports the proposal.
- The proposed site-specific standard values fall into the range between the EPA-approved warm lakes TVSs (adopted in April of 2023) and the EPA-approved 2012 Interim Criteria, suggesting the magnitude of the values is reasonable.
- The proposed site-specific TP and TN standards comprise challenging targets that will not in any way deter CCBWQA from continuing its long-term efforts to drastically reduce nutrient concentrations in the reservoir.

A longevity plan is recommended for inclusion with the site-specific proposal. The longevity plan would include data collection, analysis, and reporting commitments to support ongoing review of the appropriateness and protectiveness of the site-specific TP and TN standards.

[18] Note that these values follow the WQCD precedent of rounding the standard values to two significant figures.

In summary, this analysis provides a strong technical basis for proposal of site-specific TP and TN standards of 66 ug/L TP and 860 ug/L TN for Cherry Creek Reservoir to the WQCC. These values are considered to be protective of the AL/Rec beneficial uses and more appropriate for Cherry Creek Reservoir than the default TP and TN standards.

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CHERRY CREEK BASIN WATER QUALITY AUTHORITY
2023 Capital Project Status Report
December 1, 2023

RESERVOIR PROJECTS

1. East Shade Shelters Phase III and Tower Loop Phase II Shoreline Stabilization (CCB-17.5 and CCB-17.7)
    a. Description: These projects were identified in 2014 through the annual inspection. The Tower Loop Phase II connects to the Phase I project and extends shoreline protection 570 feet to the southeast towards Dixon Grove. The East Shade Shelters Phase III starts on the north end of the Shade Structure and goes 400-feet to the south.
    b. Status: Consultant selection is scheduled for the 1st quarter. A consultant selection committee will be set in February (1/29/21). At the February TAC meeting Jason Trujillo, Jon Erickson, Lanae Raymond, Bill Ruzzo were interested in serving on the consultant selection committee (2/11/21). This selection committee was discussed at the 3/18/21 Board Meeting, and no further members were added. The Request for Proposals (RFP) has been posted on BidNet and Proposals are due 04/21/21 (3/25/21). The pre-proposal meeting was held on 4/7/21. 5 proposals were received on 4/28/21; the selection committee is reviewing them. Interviews were held and a selection is being brought to the May Board meeting (5/14/21). Board authorized negotiations with RESPEC (5/27/21). Agreement has been executed with RESPEC (10/15/21). Field Survey of project areas and topographic mapping is underway (12/30/21). A design kickoff meeting was held on 4/22/22. A design sprint workshop was held on 7/12/22 which included a site visit and evaluation of alternatives. RESPEC is developing a recommended alternative (9/8/22). RESPEC provided updated project costs for budgeting (10/13/22). The 30% submittal was received on 11/16/22 and is under review. CCBWQA provided comments on 30% review on 1/17/23; a value engineering effort is recommended as the project costs exceed the budget. The value engineering meeting was held on 2/24/23. RESPEC's request for additional services was approved by TAC and Board in May (5/25/23). The reservoir water level has come down since the May and June storms and additional erosion was observed on 7/14/23; a site visit was made with RESPEC on 8/1/23 and the erosion areas at East Shade Shelters were measured. *It has been estimated that roughly 14 cubic yards of soil was eroded from the 2023 storms (9/15/23).* A progress meeting was held on 9/15/23, RESPEC will refine the breakout of components between recreational (CPW responsibility), water quality (CCBWQA responsibility), and shared (both CPW and CCBWQA responsibilities) costs and work on 408 review submittal to US Army Corps of Engineers. *RESPEC was provided the US Army Corps of Engineers' guidance on cut and fill and asked to prioritize the 408 application and review; they are coordinating with Gene Seagle in preparation for this submittal (12/1/23).*

STREAM RECLAMATION PROJECTS

1. Cherry Creek Stream Reclamation at Arapahoe Road aka Reaches 3 and 4 (CCB-5.14C)
    a. Description: This project continues the work on Cherry Creek by CCBWQA, MHFD, and local partners. It ties into the previous stream reclamation projects of Cherry Creek Eco Park to Soccer Fields (CCB-5.14A) and Cherry Creek at Valley Country Club (CCB-5.14B). The 5,167 Linear Feet of stream reclamation reduces bed and bank erosion immobilizing approximately 88 pounds of phosphorus annually. The project is anticipated to be funded over several years and likely be broken into phases.
    b. Status: In 2021, and IGA was executed between CCBWQA, MHFD, City of Aurora, and SEMSWA to begin this work. IGA Amendment that brings in 2022 funding is under review (5/13/22). Board authorized IGA Amendment for 2022 funding on 7/21/22 (8/12/22). IGA Amendment has been revised to show Aurora's lower participation; CCBWQA's participation was lowered accordingly to meet 25% partner project level; revised IGA Amendment received TAC recommendation and is being taken to Board for their consideration in October

(10/13/22). Board authorized the IGA Amendment for 2022 funding at their 10/22/22 meeting. It appears that CCBWQA's 2023 participation will be reduced as a result of less partner funding available for this project (2/24/23). The IGA Amendment that brings in 2023 funding was recommended by the TAC and authorized by the Board at their June meetings (6/29/23). MHFD is starting consultant selection process (10/13/23). Jacobs, Olsson, and Muller were shortlisted for interviews which are scheduled for mid-December (11/10/23).

2. Cherry Creek Stream Reclamation – Upstream of Scott Road (CCB-5.17)
    a. Description: Design and construction of stream reclamation is in partnership with Douglas County and MHFD. It improves 4,100 feet of Cherry Creek and is located upstream of Scott Road.
    b. Status: IGA was approved by the Board at their April 2020 meeting. Muller had been selected as consultant, and design scope of work is being prepared. Kickoff meeting was held on 12/11/20; a follow-up field visit will be scheduled for early 2021. Site visit was held on 1/29/21. Conceptual design is complete, negotiations are underway to contract for 60% design (4/8/21). Muller is working on alternatives (4/30/21). Muller is working on preliminary design and an IGA Amendment to bring in additional 2021 funding from Douglas County is being brought to the Board in October (10/15/21); IGA Amendment has been executed (11/11/21). Muller is preparing 60% Design Submittal (1/28/22). Muller submitted 60% Design on 2/2/22; comments have been provided on 60% Design Submittal (3/10/22). IGA Amendment bringing in 2022 funding is scheduled for TAC and Board consideration in June (5/27/22). IGA Amendment was authorized at the June 16th Board Meeting (6/30/22). Muller is working on Final Design and held a progress meeting on 4/14/23, a site visit is being scheduled to support the 90% design submittal. The 90% site visit was held on 5/22/23. Muller submitted their 90% design submission on 9/14/23; the engineer's estimate confirms that additional funding is needed for construction. IGA Amendment for additional funding is scheduled for TAC and Board consideration at October meetings and 90% review meeting was held on 10/13/23. Comments were provided for 90% submittal and discussed at the review meeting (11/10/23).

3. Cherry Creek Stream Reclamation at Dransfeldt (CCB-5.17.1B)
    a. Description: Design and construction of stream reclamation is in partnership with Town of Parker and MHFD. It improves 2,400 feet of Cherry Creek near the future location of Dransfeldt bridge which is just downstream of the Cherry Creek at KOA project.
    b. Status: Initial scoping has begun, and a partners meeting was held on 1/30/21. IGA is scheduled for CCBWQA's May TAC and Board meetings (4/30/21). IGA was approved by all parties and has been executed (6/25/21). Muller Engineering has submitted their Draft Scope of Work for Design Services, and the project sponsors have reviewed it (7/8/21). Design kickoff meeting was held on 10/14/21. Alternatives are being evaluated (12/9/21). Pre-submittal meeting for the 404 permit is being scheduled (12/30/21). CLOMR is being prepared for project (3/10/22) and was submitted to FEMA on 3/31/22. CEI was selected for as project partner to provide contractor input during the design (5/27/22). CLOMR is under review by FEMA (8/12/22). Muller has received comments on CLOMR and is preparing responses; 90% Submittal is scheduled for early February (1/27/23). Comments on 90% Submittal were provided on 2/22/23; project is experiencing substantive cost increases due to current market conditions (2/24/23). TAC at their 3/2/23 meeting recommended that the Board authorized the IGA Amendment to bring in 2023 funding along with an increase in CCBWQA's 2023 funding from $170,000 to $570,000. The Board authorized the IGA Amendment with the increased 2023 funding of $570,000 at their 3/16/23 meeting. The Conditional Letter of Map Revision (CLOMR) was issued by the Federal Emergency Management Agency (FEMA) on April 28, 2023 (5/12/23). The sanitary sewer relocation will be contracted to start with, in order to avoid a pipe material cost increase, and to get it out of the way for the forthcoming stream reclamation (7/13/23). The sanitary sewer relocation has been contracted for with Concrete Express Inc. or CEI (8/11/23). Construction of stream reclamation will start once 404 permit has been received (11/10/23).

4. McMurdo Gulch Priority 3 Stream Reclamation (CCB-7.2)
    a. Description: The design and construction of stream reclamation is in partnership with Castle Rock. Castle Rock is the lead agency. This phase continues the work from the previous phase. Muller Engineering is the design consultant.
    b. Status: Board authorized IGA for Priority 3 at their May 19,2022 meeting. Muller submitted their 30% deliverable on 10/31/22, review comments were returned on 11/8/22. Easements needed for projects have been identified (1/23/22). The 60% Submittal was received on 1/30/23 and comments have been provided on 2/7/23. Muller is working on updating their construction cost estimate (2/8/23). On 2/23/23, Castle Rock requested that CCBWQA's 2023 funding be deferred to 2024 to match their schedule.

5. Lone Tree Creek in Cherry Creek State Park (CCB-21.1)
    a. Description: This project includes a trail connection to Cherry Creek State Park and includes 570 linear feet of stream reclamation on Lone Tree Creek from the State Park Boundary to the Windmill Creek Loop Trail. The City of Centennial is the project lead. CCBWQA participation is for stream reclamation only.
    b. Status: 95% submittal is under review (5/13/22); review comments have been returned (5/27/22). Project funding was brought to TAC at their 7/7/22 meeting, during drafting of IGA it was discovered that future maintenance of stream reclamation should be considered, project will be brought back to TAC at an upcoming meeting for maintenance discussion and recommendation (8/12/22). A stakeholder meeting was held on 9/29/22 to discuss maintenance. A stakeholder meeting was held on 11/2/22 to discuss findings from CCBWQA's site visit and findings included in Wright Water Engineers report. The Board supports CCBWQA's partnering with Centennial at their 11/17/22 meeting. A Memo of Understanding is under review by Colorado Parks and Wildlife (CPW) affirming maintenance responsibilities for the stream reclamation fit under the current agreement between CCBWQA and CPW (3/30/23). CCBWQA sent the Draft IGA to Centennial for review on 5/23/23. The project is included in CCBWQA's 2024 Budget and 10-year CIP (11/10/23).

6. Happy Canyon Creek – County Line to Confluence with Cherry Creek (aka Jordan Road, CCB-22.1)
    a. Description: The design and construction are in partnership with Southeast Metro Stormwater Authority and MHFD and includes 2,500 feet of stream reclamation. The Authority's water quality component share for design and construction is estimated to be $325,000. The total project cost is estimated at $1,300,000.
    b. Status: IGA is scheduled for June TAC and Board meetings (5/27/21). IGA has been approved and executed by all parties (7/29/21). Jacobs has been selected as design consultant and project scoping is underway; limits have been extended upstream to the County Line and sediment capture area and transport will be included with the project (10/15/21). Jacobs has submitted their scope of work and fee for design which is under review by project sponsors (11/11/21). Project sponsors have completed a review of Jacobs' fee and scope of work and the agreement is being routed for signatures (1/28/22). IGA Amendment to bring in 2022 funding is in process (3/10/22). A project kickoff meeting was held on 3/28/2022. A site visit was performed on 4/12/22 to document existing conditions and identify sediment source/transport/deposition areas. Project Team is preparing a sampling plan for bank and bed materials to determine phosphorus content (5/13/22). The project team met on 5/24/22 to discuss project goals and Jacobs is progressing through the study. Jacobs and ERC are working on sediment transport analysis and model (6/30/22). The results from the sediment transport model were presented at the 8/23/22 progress meeting and an upstream sediment capture area just south of the JWPP was included in the alternatives analysis (8/26/22). The alternative analysis report is expected to be completed before the end of 2022 (10/13/22). Lab results from stream soil samples were sent to Jacobs so that they include phosphorus reduction in the alternatives analysis report; a groundwater investigation is needed to inform sediment capture facility and stream reclamation alternatives, scoping and negotiations are in progress (11/11/22). Groundwater scope of work has been reviewed and approved by project sponsors (1/13/23). The IGA Amendment bringing in the 2023 funding was recommended by TAC and authorized by the Board in April (5/12/23). Progress

meeting was held on 10/30/23 where the groundwater information was reviewed and the impacts from the 2023 storms were discussed; MHFD is planning additional sediment removals accordingly.

7. Happy Canyon Creek - Upstream of I-25 (CCB-22.2)
    a. Description: The design and construction are in partnership with Douglas County, City of Lone Tree, and MHFD and includes 2,500 feet of stream reclamation. The Authority's water quality component share for design and construction is estimated to be $500,000. The total project cost is estimated at $2,000,000.
    b. Status: Douglas County, City of Lone Tree, and MHFD have initially funded and selected Muller Engineering as the design engineer. Design has started and a progress meeting was held on 1/27/21. Design is progressing (2/11/21). Muller has submitted 60% Design Deliverables (5/27/21). IGA for 2021 Funding is being brought to Board in September (9/9/21). 2021 IGA Amendment has been executed (11/11/21). Coordination with CDOT and easement acquisitions are on-going (1/13/22). Board authorized 2022 funding and IGA Amendment at their June 16th meeting (6/30/22). The project received environmental clearance from CDOT (8/12/22). The 90% design submittal is scheduled for delivery by end of September (8/26/22). The 90% design submittal is being reviewed (10/13/22). Comments were provided on 90% submittal (11/11/22). Muller completed the 100% design submittal on 11/22/22. CDOT permit was issued, and pre-construction meeting was held on 1/10/23; construction start is scheduled for 1/30/23 pending execution of easement documents from Surrey Ridge which has agreed to terms and easement language. Notice to Proceed on construction is pending execution of easement documents (1/27/23). Easements have been signed by property owners and Notice to Proceed has been issued to Naranjo Civil Constructors (2/8/23). Construction is underway with initial construction BMPs/stormwater controls in place; water diversion and control is being set up for the downstream section of the project (3/10/23). Water control is in place and construction of stream reclamation is underway for downstream sections of the project (3/30/23). Riffle and Boulder Cascade drop structures on downstream third of project are nearing completion (4/13/23). Construction is underway in the middle third of the project; efforts consist of stream grading and installation of Riffle and Boulder Cascade drop structures (5/12/23). The storm damage from May 11 to 13, 2023 event is being identified and repaired (5/25/23). Construction on the middle third is substantially complete and work has begun on the upstream third (7/27/23). The construction is nearly complete with the punch list walk on 9/13/23; contractor is working on completing plantings and resolving punch list items. Asphalt repairs on the frontage road are being scheduled and some of the plantings will need to be done during the 2024 spring planting window to improve their chance for success (11/10/23). *Asphalt repairs have been made and the project summary has been prepared (12/1/23).*

8. Dove Creek - Otero to Chambers Rd. (CCB-23.1)
    a. Description: The design and construction are in partnership with Southeast Metro Stormwater Authority (SEMSWA) and with Mile High Flood District (MHFD) being a key stakeholder; it includes 1,300 feet of stream reclamation. The Authority's water quality component share for design and construction is estimated to be $175,000. The total project cost is estimated at $700,000.
    b. Status: SEMSWA is drafting the Intergovernmental Agreement to bring in the 2021 funding for the project (3/12/21). RESPEC is the design consultant; two conceptual design alternatives have been prepared and reviewed during meeting on 3/15/21. IGA is scheduled for CCBWQA's May TAC and Board meetings (4/30/21). IGA has been approved and executed by all parties (7/29/21). 30% Design Review Meeting was held on 8/23/21. A Progress meeting is scheduled for 2/26/22 with 60% Plan submittal expected to follow (1/28/22). The 60% Design was submitted on 2/16/2022, comments were provided, and a design review meeting was held on 2/23/2022. IGA Amendment to bring in 2022 funding is in process (3/10/22). Construction costs were prepared by CEI based on 60% submittal (5/13/22). A design progress meeting was held 6/14/22 and 90% design submittal is being prepared (6/30/22). 90% design submittal is expected by the end of July (7/15/22). The 90%

design submittal was reviewed, and comments were submitted on 8/22/22. Construction is anticipated in 2023 (10/13/22). A progress meeting was held on 11/8/22, project will likely be done in 2 phases, IGA Amendment will be needed early in 2023 so that construction can start ahead of storm season. Dove Creek IGA for construction of Phase 1 is scheduled for TAC and Board in January 2023, construction is expected to start shortly afterwards (12/30/22). Construction is scheduled to start mid-February; construction agreement and engineering construction services amendment are currently being reviewed (1/27/23). Construction and engineering construction services have been finalized and a preconstruction meeting was held on 2/2/23. Notice to Proceed has been issued to Concrete Express; construction is underway with initial construction BMPs/stormwater controls in place (3/10/23). Water control is in place and construction of stream reclamation is on-going (3/30/23). Step pool drop structures have been constructed and work on soil wraps is underway (4/13/23). Low-flow or bank full channel work (soil wraps and erosion control blanket) and step-pool structures are complete, water diversion has been removed, and is active to storm flows; work continues in upland areas and higher elevations of stream reclamation (5/12/23). Storm damage from May 11 to 13, 2023 event is being repaired (5/25/23). Construction punch list is being completed (6/29/23). Construction of Phase 1 is complete (7/27/23). *Project summary has been prepared (12/1/23).*

9. Dove Creek - Chambers Rd. to Pond D-1 (CCB-23.1)
    a. Description: The design and construction are in partnership with Southeast Metro Stormwater Authority (SEMSWA) and with Mile High Flood District (MHFD) being a key stakeholder; it includes 1,300 feet of stream reclamation. Construction was broken into 2 phases with Phase 2 scheduled for 2024.
    b. Status: CCBWQA acted at their October meeting to advance their funding for Phase 2 Construction to 2023 with SEMSWA's funding scheduled for 2024, IGA has been prepared and scheduled for signatures after SEMSWA's November Board meeting, phosphorus estimates for sediment capture areas for the project were provided to Technical Manager (11/10/23).

10. Piney Creek from Fraser Street to Confluence with Cherry Creek aka Reaches 1 and 2 (CCB-21.1)
    a. Description: This project includes 2900 liner feet of stream reclamation on Piney Creek. The project partners are SEMSWA and CCBWQA.
    b. Status: Project coordination meeting was held with SEMSWA on 6/29/22. IGA drafted and is being reviewed by SEMSWA (8/12/22). IGA was approved by CCBWQA at the 9/15/22 Board meeting. IGA Amendment to bring in 2023 funding was recommended by the TAC and authorized by the Board in May (5/25/23). CCBWQA sent the Draft IGA Amendment to SEMSWA for review on 6/29/23. SEMSWA has no comments on the IGA Amendment and plans to take it to their Board in October (8/11/23). The project site was walked with SEMSWA and Olsson and Associates on 8/30/23, Olsson is preparing their scope of work and fee for design. Comments on Olsson's scope of work and fee were provided to and coordinated with SEMSWA (11/10/23). *Olsson's scope of work and fee have been finalized and SEMSWA is planning on contracting for the initial design phase in early 2024 (12/1/23).*

11. Mountain and Lake Loop Shoreline Stabilization Phase II (OM 4.6)
    a. Description: This project was identified through the 2020 annual inspection and design and permitting started in 2021. It adds about 40 feet of shoreline protection where it has eroded leaving a 1-2 foot tall vertical bank.
    b. Status: Construction Plans have been prepared and the GESC was submitted to Arapahoe County for review (1/13/22). Plans are being reviewed by US Army Corps of Engineers for 408 clearance (5/13/22). *Comments were received from the US Army Corps of Engineers on 8/29/23.* A meeting has been scheduled for 11/16/23 with USACOE's local staff and CPW staff to discuss the cut and fill balance requirements on this project and other planned projects in Cherry Creek State Park (11/10/23). *A site meeting with CPW is being scheduled to determine the feasibility of the project after the 2023 storm damage (12/1/23).*

12. Cherry Creek from Reservoir to Lake View Drive (OM 4.6)
    a. Description: This project is in follow up to CCBWQA's study of Cherry and Piney Creeks in Cherry Creek State Park (CCSP). Muller completed two reports on Cherry Creek from Reservoir to State Park Boundary, Stream and Water Quality Assessment and Baseline Channel Monitoring Report, in 2022. These reports highlight the need for this project.
    b. Status: A workshop is scheduled for the 3/16/23, to seek CCBWQA Board and TAC input on this project and Cherry and Piney Creeks in CCSP (3/10/23). *The follow up from workshop is underway – project overview and funding flyer has been created,* Muller is scoping the next step of design for Reach 1 and providing a fee, and multi-pronged approach is in development for workshop priority reaches that prioritizes Reach 1 and reduces risk from upstream reaches; these items will be brought to TAC and Board for discussion, direction, and/or action at upcoming meetings (3/30/23). A site visit for partner outreach and funding was held on 5/25/23 at 1-4 pm (6/8/23). A coordination meeting was held with Aurora on 6/23/23 and they showed interest in partnering on the project to protect their water lines. The Mile High Flood District has provided their budget/CIP schedule and Arapahoe County Open Space has been contacted to investigate potential partnering opportunities (7/13/23). The TAC created a subcommittee for this project on 8/3/23; which will attend progress meetings, provide timely feedback to Muller, and to coordinate with TAC as needed. The alternatives analysis kickoff meeting was held on 8/29/23. A site visit was held on 9/22/23 to look at multiple flow paths and potential risks for consideration in alternatives analysis. *It was verbally reported at the 11/16/23 Board meeting that Colorado Parks and Wildlife's repair of Lake View Drive is underway which includes the alternatives of concrete pipe and trash racks, cleaning out of culverts 1-9 and the beaver debris, and it is scheduled for completion by mid-December. Muller was provided US Army Corps of Engineers' guidance on cut and fill for consideration in their alternatives analysis (12/1/23).*