



Cherry Creek Basin Water Quality Authority  
8390 East Crescent Parkway, Suite 500  
Greenwood Village, Colorado 80111  
(P) 303.779.4525

**REGULAR BOARD MEETING AGENDA**

**Date:** March 15, 2018 (Thursday)  
**Time:** 9:00 a.m.  
**Place:** CliftonLarsonAllen LLP  
8390 East Crescent Parkway, Suite 500  
Greenwood Village, CO 80111

**I. Call to Order and Pledge of Allegiance**

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- II. Administrative Matters**
- A. Review and Approve Minutes of February 15, 2017 (enclosed)
  - B. Review and Accept Current Cash Position Statement as of 3/7/18 (enclosed)
  - C. Review and Accept Current Claims (enclosed)
  - D. Other
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**III. Public Comment / Visiting Guests**

- A. Other

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- IV. Discussion & Action Items**
- A. Discuss and Consider Approval of the CCBWQA’s 2017 Annual Report (enclosed, Fendel)
  - B. Discuss and Consider Approval CCBWQA’s Memo to the Water Quality Control Commission Regarding the Control Regulation #72 Triennial Informational Hearing (Flynn, enclosed)
  - C. Discuss Next Steps in Artificial Circulation Options and Modeling (Boyer)
  - D. Discuss and Consider 2018 Contract for Hydros Consulting (enclosed, Reid)
  - E. Discuss and Consider Recommendation from the Sampling & Analysis RFP Committee for Awarding the 2018 Contract (to be handed-out, Reid)
  - F. Other
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- V. Reports**
- A. TAC (Goncalves)
  - B. Capital Projects (Swanson)
    - 1. 2018 Capital Projects and Maintenance Status Report (enclosed)
    - 2. Land Use Referral Summary (enclosed)

**Reports, continued**

3. WERF Stream Restoration as a BMP Crediting Guidance Report (enclosed)
  4. Other
- C. Water Quality Update  
D. Regulatory & Watershed (Fendel)  
E. Administration & Finance (Reid)
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**VI. Legal**

- A. Update on the Bow Tie Water Rights & Wells
  - B. Other
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**VII. Board Member and Other Items**

- A. Discussion of Potential Orthophosphate Regulations (Poticha)
  - B. Other
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**VIII. Adjournment**

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**Enclosed Informational Items:**

- 3/1/18 TAC Agenda
- Hydros Response to CCBWQA Questions

Hearings Timeline – Regulations 38 (Water Quality Standards) & 72 (Control Regulation)

	<b>2018</b>	<b>2019</b>	<b>2020</b>	<b>2021</b>
<b>Reg 38</b>	Issues Scoping Hearing October 2018	Issues Formulation Hearing November 2019	Rulemaking Hearing June 2020	
<b>Reg 72</b>	Triennial Review Informational Hearing May 2018			Triennial Review Informational Hearing May 2021

**Next Board Meeting: Thursday, April 19, 2018 at 9:00 a.m.**  
**CliftonLarsonAllen LLP, 8390 E. Crescent Parkway, Suite 500**  
**Greenwood Village, CO 80111**  
“Before Hours” Office Number 303-265-7914

**MINUTES OF A REGULAR MEETING  
OF THE BOARD OF DIRECTORS OF THE  
CHERRY CREEK BASIN WATER QUALITY AUTHORITY  
February 15, 2018 9:00 a.m.**

**8390 E. Crescent Pkwy., Suite 500, Greenwood Village, CO 80111**

**Members Present**

Stephanie Piko, Chairman; City of Centennial  
John McCarty; Governor's Appointee  
Ron Weidmann; Governor's Appointee  
John Woodling; Governor's Appointee  
Myrna Poticha; Governor's Appointee  
Alan Vajda; Governor's Appointee  
Christopher Lewis; Governor's Appointee  
Nancy Sharpe; Arapahoe County  
Susan Squyer; City of Lone Tree  
Roger Kilgore; Governor's Appointee  
Francois Bergan; City of Aurora  
George Teal; Town of Castle Rock  
Judith Hilton; Greenwood Village

**Others Present**

Mike Sutherland; City of Centennial, Alternate  
Bahman Hatami; Colorado Parks & Wildlife, TAC  
Jim Dederick; Douglas County, TAC  
Jacob James; Town of Parker, TAC  
David Van Dellen; Town of Castle Rock, TAC  
Chris Rolison; Pinyon Environmental  
Joe Hogan; Solitude Lake Management  
Rick Goncalves; TAC Chairman  
Julie Vlier; Red Mountain Engineering  
Tim Flynn; Collins Cockrell & Cole  
Katie Fendel; Leonard Rice Engineers (LRE)  
Jim Swanson; JRS Engineering Consultants  
Chuck Reid and Pat Shannon; CliftonLarsonAllen LLP (CLA)

**Call to Order**

Chairman Piko called the meeting to order at 9:04 a.m. and led the Pledge of Allegiance.

**Oath of Office for New Directors**

Chairman Piko administered the Oath of Office to Judith Hilton of Greenwood Village, Michael Sutherland of the City of Centennial and Francois Bergan of the City of Aurora.

**Administrative Matters**

- A. Review & Approve Minutes from January 18, 2018

After discussion, Director Weidmann moved and Director McCarty seconded a motion approving the January 18, 2018 minutes as amended. The motion passed unanimously.

B. Review and Accept December 31, 2017 Draft Financial Statements

Mr. Reid presented and answered questions about the December 31, 2017 Draft Financial Statements. After discussion, Director Sharpe moved and Director Weidmann seconded a motion accepting the December 31, 2017 Draft Financial Statements with amendments made to certain line item names and categories. The motion passed unanimously.

C. Review and Approve Current Claims

Mr. Reid reviewed the current claims. After discussion, Director Weidmann moved and Director Sharpe seconded a motion approving the current claims. The motion passed unanimously.

D. Other - none

**Public Comment & Visiting Guests**

A. Water Year 2017 – Annual Monitoring Report

Ms. Vlier presented the Annual Monitoring Report for Water Year 2017. The Board requested some edits, which primarily related to keeping the Monitoring Report focused on facts and data (with no interpretation), as well as providing context for algal speciation and values. The Board's comments will be incorporated into the final report. The Report is available request.

B. Other – None.

**Discussion & Action Items**

A. Discuss and Consider Approval of Reservoir Model Runs and Destratification System Study

Mr. Goncalves reported that the TAC recommends that the Board:

1. Authorize Hydros to update the reservoir model through the 2017 water year;
2. Develop a Bubble Plume Model concurrently with a Destratification System Study; and
3. Single source the Destratification System Study to an engineer or engineering firm.

The Board discussed the recommendations of the TAC and after discussion, Director McCarty moved and Director Weidmann seconded a motion approving an update to the Reservoir Model for a total price not to exceed \$67,300 and providing Mr. Reid with authority to execute the agreement, subject to a clarification of the work product and an updated rate schedule. The motion passed.

The Board discussed whether the Bubble Plume model and its relationship to the Destratification System Study. After discussion, Director Weidmann moved and Director Teal seconded a motion approving the development of a Bubble Plume Model for a price not to exceed \$46,000. The motion failed, with four (4) aye votes and seven (7) nay votes.

Director Woodling moved and Director Teal seconded a motion to defer discussion of the Bubble Plum Model and Destratification System Study until the next Board Meeting. The motion passed.

B. Update on Control Regulation 72 Triennial Hearing

Mr. Reid reported that staff is developing a memorandum to state that the Authority does not recommend any changes to the control regulation. Mr. Reid noted that hearing will be held on May 7<sup>th</sup> at 10:00 a.m.

C. Other – None.

## **Reports**

**TAC** – No Update

### **Capital Projects**

1. 2017 Capital Projects and Maintenance Status Report

Mr. Swanson noted that the Cherry Creek Reach 2 stream restoration project and the Piney Creek Reach 6 project are moving forward and are on schedule.

2. Land Use Referral Summaries

Mr. Swanson reported that the Authority received 27 referral requests in January and had received 9 to date in February.

3. Other – None.

### **Water Quality Update**

Mr. Reid noted that the water quality update is included in the meeting packet.

### **Regulatory & Watershed** – No Update

### **Administrative and Finance**

Mr. Reid reported that the CCAMP data has still not been released to the Authority. RESPEC is moving forward with the watershed model and anticipating that they will not receive the CCAMP data.

Mr. Reid reported that Ms. Vlier has completed the work product in her contract with the Authority, and requested that the Board approve a contract extension not to exceed \$15,000 that will allow Ms. Vlier to assist in the selection of a new sampling contractor and help prepare for the Control Regulation #72 Triennial Hearing.

After discussion, Director Woodman moved and Director Kilgore seconded a motion approving the extension of Ms. Vlier's contract for a total price not to exceed \$15,000. The motion passed.

**Legal** – No Update

**Board Member and Other Items**

1. Other

Chairman Piko announced that she will not be at the March meeting, due to a National League of Cities Conference in Washington D.C.

**Adjournment**

There being no further business, Chairman Piko adjourned the meeting at 11:23 a.m.

Respectfully submitted,

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Secretary for the Meeting

## CHERRY CREEK BASIN WATER QUALITY AUTHORITY

Schedule of Cash Position

December 31, 2017

Updated as of March 7, 2018

	General Fund	Pollution Abatement Fund	Enterprise Fund	Total
<b><u>1st Bank - Checking Account</u></b>				
Balance as of 12/31/17	\$ 24,427.33	\$ -	\$ 2,594.41	\$ 27,021.74
Subsequent activities:				
01/17/18 - Transfer from ColoTrust to cover checks	115,951.33	55,123.72	375.00	171,450.05
01/18/17 - Vouchers payable	(115,951.33)	(55,123.72)	(375.00)	(171,450.05)
01/31/18 - Interest income	0.71	-	-	0.71
02/14/18 - Transfer from ColoTrust to cover checks	80,782.43	14,944.03	322.25	96,048.71
02/14/17 - Vouchers payable	(80,782.43)	(14,944.03)	(322.25)	(96,048.71)
02/28/18 - Interest income	0.46	-	-	0.46
Anticipated transfer from ColoTrust to cover checks	49,541.51	16,546.17	-	66,087.68
Anticipated vouchers payable	(49,541.51)	(16,546.17)	-	(66,087.68)
<i>Anticipated balance</i>	<u>24,428.50</u>	<u>-</u>	<u>2,594.41</u>	<u>27,022.91</u>
<b><u>ColoTrust General - (8001)</u></b>				
Balance as of 12/31/17	381,425.97	606,588.59	763,148.79	1,751,163.35
Subsequent activities:				
01/10/18 - Arapahoe/Douglas County Treasurer	12,304.29	-	-	12,304.29
01/17/18 - Transfer to Checking to cover checks	(115,951.33)	(55,123.72)	(375.00)	(171,450.05)
01/26/18 - Reimbursement from GEI Constlants	-	1,059.24	-	1,059.24
01/31/18 - Interest Income	2,204.44	-	-	2,204.44
January - Recreation fees, Building permits, WW surcharge	-	-	104,302.49	104,302.49
01/31/18 - Allocation of 60% of revenue to Pollution Abatement	(8,705.24)	71,286.73	(62,581.49)	-
02/10/18 - Arapahoe/Douglas County Treasurer	95,837.53	-	-	95,837.53
02/14/18 - Transfer to Checking to cover checks	(80,782.43)	(14,944.03)	(322.25)	(96,048.71)
02/28/18 - Interest Income	2,127.18	-	-	2,127.18
February - Recreation fees, Building permits, WW surcharge	-	-	9,276.76	9,276.76
02/28/18 - Allocation of 60% of revenue to Pollution Abatement	(58,778.83)	64,344.89	(5,566.06)	-
03/10/18 - Arapahoe/Douglas County Treasurer	636,312.42	-	-	636,312.42
Anticipated transfer to checking to cover checks	(49,541.51)	(16,546.17)	-	(66,087.68)
Anticipated allocation of 60% of revenue to Pollution Abatement	(381,787.45)	381,787.45	-	-
<i>Anticipated balance</i>	<u>434,665.04</u>	<u>1,038,452.98</u>	<u>807,883.24</u>	<u>2,281,001.26</u>
<b><u>ColoTrust Pollution Abatement - (8002)</u></b>				
Balance as of 12/31/17	-	50,761.03	-	50,761.03
Subsequent activities:				
01/31/18 - Interest income	-	65.04	-	65.04
02/28/18 - Interest income	-	62.86	-	62.86
<i>Anticipated balance</i>	<u>-</u>	<u>50,888.93</u>	<u>-</u>	<u>50,888.93</u>
<b><u>CSAFE - Savings Account</u></b>				
Balance as of 12/31/17	859,161.30	7,366.28	311,005.78	1,177,533.36
Subsequent activities:				
01/31/17 - Interest income	-	850.08	566.72	1,416.80
02/28/17 - Interest income	-	821.23	547.49	1,368.72
<i>Anticipated balance</i>	<u>859,161.30</u>	<u>9,037.59</u>	<u>312,119.99</u>	<u>1,180,318.88</u>
<b><i>Total funds available as of date above</i></b>	<u>\$ 1,318,254.84</u>	<u>\$ 1,098,379.50</u>	<u>\$ 1,122,597.64</u>	<u>\$ 3,539,231.98</u>

**Current yield (as of 02/28/2018)**

1st Bank - 0.010%

ColoTrust Plus - 1.62%

CSAFE - 1.51%



Cherry Creek Basin Water Quality Authority  
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## MEMORANDUM

To: CCBWQA Finance Committee  
From: Chuck Reid *Chuck*  
Date: March 8, 2018  
Subject: Current Accounts' Payable

Enclosed is the current AP, and a summary of YTD consultant expenses. I certify that all recommended payments correspond with the Authority's policies, Board decisions and applicable State Statutes, and I am recommending payment of all invoices as presented.



CCBWQA YTD Consultant Expenditures - 2018					
	Current Months Only (with old & future months "hidden")				
Contract	Budget/Contract	January	February	Total	%
Audit	\$14,000				
Wagner Burke Barnes	\$6,500			\$0	0%
CLA	\$7,500			\$0	0%
Cherry Creek Stewardship	\$25,000			\$0	0%
CLA Accounting	\$34,000	\$3,800		\$3,800	11%
CLA Management	\$123,000	\$10,300		\$10,300	8%
Special Services		\$705		\$705	
Direct Expenses		\$4		\$4	
Total		\$11,009		\$11,009	
Write-off, if any		\$858		\$858	
				\$0	
Collins, Cockrel, Cole	\$55,000	\$4,097		\$4,097	7%
Davis Graham & Stubbs		\$523		\$523	1%
Hydros				\$0	
Swanson	\$161,060	\$12,338	\$10,868	\$23,206	14%
LRE	\$231,500	\$23,840		\$23,840	10%
RESPEC	\$151,630			\$0	
Previous Year	\$63,383				
RG & Associates	\$10,000			\$0	0%
Ruzzo	\$10,000		\$1,275	\$1,275	13%
Red Mountain Engineering	\$30,000	\$8,979	\$8,772	\$17,751	
<b>Total: standard contracts</b>	<b>\$693,560</b>	<b>\$76,453</b>	<b>\$20,915</b>	<b>\$97,368</b>	<b>14%</b>

**Cherry Creek Basin Water Quality Authority  
Cash Requirement Report - Detailed**

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All Dates

GL Account	Description	Gross Open Amount	Discount Available	Net Open Amount	Cash Required
<b>CLA CliftonLarsonAllen LLP</b>					
Reference:	1713950	Date:	01/31/18	Discount exp date:	
GL AP account:	102500	Due date:	01/31/18	Payment term:	
107000	Accounting - CliftonLarsonAllen LLP	<u>3,799.68</u>			
	Totals	3,799.68	0.00	3,799.68	3,799.68
Reference:	1719253	Date:	01/31/18	Discount exp date:	
GL AP account:	102500	Due date:	01/31/18	Payment term:	
107440	Management/administration - CliftonLarsonAllen LLP	<u>6,605.51</u>			
	Totals	6,605.51	0.00	6,605.51	6,605.51
Reference:	1719253	Date:	01/31/18	Discount exp date:	
GL AP account:	112500	Due date:	01/31/18	Payment term:	
117440	Management/administration - CliftonLarsonAllen LLP	<u>4,403.67</u>			
	Totals	4,403.67	0.00	4,403.67	4,403.67
	<b>Totals for CliftonLarsonAllen LLP</b>	<u><u>14,808.86</u></u>	<u><u>0.00</u></u>	<u><u>14,808.86</u></u>	<u><u>14,808.86</u></u>
<b>COLL Collins, Cockrel &amp; Cole, PC</b>					
Reference:	167M/January2018	Date:	01/31/18	Discount exp date:	
GL AP account:	102500	Due date:	01/31/18	Payment term:	
107460	Legal services - Collins, Cockrel & Cole, PC	<u>4,097.00</u>			
	Totals	4,097.00	0.00	4,097.00	4,097.00
	<b>Totals for Collins, Cockrel &amp; Cole, PC</b>	<u><u>4,097.00</u></u>	<u><u>0.00</u></u>	<u><u>4,097.00</u></u>	<u><u>4,097.00</u></u>
<b>DAVISGRAHAM Davis Graham &amp; Stubbs LLP</b>					
Reference:	754042	Date:	02/28/18	Discount exp date:	
GL AP account:	102500	Due date:	02/28/18	Payment term:	
107050	Triennial review hearing - Davis Graham & Stubbs LLP	<u>522.50</u>			
	Totals	522.50	0.00	522.50	522.50
	<b>Totals for Davis Graham &amp; Stubbs LLP</b>	<u><u>522.50</u></u>	<u><u>0.00</u></u>	<u><u>522.50</u></u>	<u><u>522.50</u></u>
<b>JRS JRS Engineering Consultants</b>					
Reference:	2018-2	Date:	02/28/18	Discount exp date:	
GL AP account:	112500	Due date:	02/28/18	Payment term:	
117440	Management/administration - JRS Engineering Consultants	<u>10,867.50</u>			
	Totals	10,867.50	0.00	10,867.50	10,867.50
	<b>Totals for JRS Engineering Consultants</b>	<u><u>10,867.50</u></u>	<u><u>0.00</u></u>	<u><u>10,867.50</u></u>	<u><u>10,867.50</u></u>
<b>LEONARDRICE Leonard Rice Engineers, Inc.</b>					
Reference:	11743	Date:	01/31/18	Discount exp date:	
GL AP account:	102500	Due date:	01/31/18	Payment term:	
107450	General watershed management - Leonard Rice Engineers, Inc.	13,404.50			
107451	Annual report - Leonard Rice Engineers, Inc.	5,564.75			
107453	Data management - Leonard Rice Engineers, Inc.	<u>4,871.00</u>			
	Totals	23,840.25	0.00	23,840.25	23,840.25

**Cherry Creek Basin Water Quality Authority  
Cash Requirement Report - Detailed**

All Dates

GL Account	Description	Gross Open Amount	Discount Available	Net Open Amount	Cash Required
	<b>Totals for Leonard Rice Engineers, Inc.</b>	<u>23,840.25</u>	<u>0.00</u>	<u>23,840.25</u>	<u>23,840.25</u>
<b>REDMOUNTAIN</b>	<b>Red Mountain Engineering, LLC</b>				
Reference:	150	Date:	02/28/18	Discount exp date:	
GL AP account:	102500	Due date:	02/28/18	Payment term:	
107500	General technical support - Red Mountain Engineering, LLC	<u>8,772.40</u>			
	Totals	8,772.40	0.00	8,772.40	8,772.40
	<b>Totals for Red Mountain Engineering, LLC</b>	<u>8,772.40</u>	<u>0.00</u>	<u>8,772.40</u>	<u>8,772.40</u>
<b>RGASSOC</b>	<b>RG and Associates LLC</b>				
Reference:	1013579	Date:	02/28/18	Discount exp date:	
GL AP account:	102500	Due date:	02/28/18	Payment term:	
107445	TAC coordination - RG and Associates LLC	<u>666.67</u>			
	Totals	666.67	0.00	666.67	666.67
	<b>Totals for RG and Associates LLC</b>	<u>666.67</u>	<u>0.00</u>	<u>666.67</u>	<u>666.67</u>
<b>SDA</b>	<b>Special District Association</b>				
Reference:	2018022342762383	Date:	02/23/18	Discount exp date:	
GL AP account:	102500	Due date:	02/23/18	Payment term:	
107350	Dues and licenses - Special District Association	<u>1,237.50</u>			
	Totals	1,237.50	0.00	1,237.50	1,237.50
	<b>Totals for Special District Association</b>	<u>1,237.50</u>	<u>0.00</u>	<u>1,237.50</u>	<u>1,237.50</u>
<b>RUZZOWILLIA</b>	<b>William P. Ruzzo, P.E., LLC</b>				
Reference:	08-231-115	Date:	02/28/18	Discount exp date:	
GL AP account:	112500	Due date:	02/28/18	Payment term:	
117440	Management/administration - William P. Ruzzo, P.E., LLC	<u>1,275.00</u>			
	Totals	1,275.00	0.00	1,275.00	1,275.00
	<b>Totals for William P. Ruzzo, P.E., LLC</b>	<u>1,275.00</u>	<u>0.00</u>	<u>1,275.00</u>	<u>1,275.00</u>
	<b>Company Totals</b>	<u>66,087.68</u>	<u>0.00</u>	<u>66,087.68</u>	<u>66,087.68</u>

**CHERRY CREEK BASIN WATER QUALITY AUTHORITY**  
**Property Tax Schedule**  
**2018**

**SUMMARY - ARAPAHOE & DOUGLAS COUNTIES**

	Current Year						Prior Year				
	Property Taxes	Delinquent Tax, Rebates and Abatements	Specific Ownership Taxes	Interest	Treasurer's Fees	Total Amount Received	% of Levied Taxes Received		Total Amount Received	% of Levied Taxes Received	
							Monthly	Y-T-D		Monthly	Y-T-D
January	\$ 81,092.51	\$ 1,028.49	\$ 14,874.91	\$ 74.68	\$ (1,233.06)	\$ 95,837.53	4.25%	4.25%	\$ 44,714.07	1.67%	1.67%
February	634,897.10	(3,020.62)	13,918.82	(4.78)	(9,478.10)	636,312.42	32.68%	36.93%	599,985.51	33.44%	35.11%
March	-	-	-	-	-	-	0.00%	36.93%	161,500.59	8.28%	43.38%
April	-	-	-	-	-	-	0.00%	36.93%	300,384.11	16.81%	60.19%
May	-	-	-	-	-	-	0.00%	36.93%	220,173.06	11.74%	71.93%
June	-	-	-	-	-	-	0.00%	36.93%	455,117.56	25.12%	97.05%
July	-	-	-	-	-	-	0.00%	36.93%	37,734.57	1.33%	98.39%
August	-	-	-	-	-	-	0.00%	36.93%	25,177.39	0.45%	98.84%
September	-	-	-	-	-	-	0.00%	36.93%	17,478.45	0.15%	98.98%
October	-	-	-	-	-	-	0.00%	36.93%	20,859.54	0.20%	99.18%
November	-	-	-	-	-	-	0.00%	36.93%	25,666.28	0.50%	99.68%
December	-	-	-	-	-	-	0.00%	36.93%	12,304.29	-0.02%	99.66%
<b>TOTAL</b>	<b>\$ 715,989.61</b>	<b>\$ (1,992.13)</b>	<b>\$ 28,793.73</b>	<b>\$ 69.90</b>	<b>\$ (10,711.16)</b>	<b>\$ 732,149.95</b>	<b>36.93%</b>	<b>36.93%</b>	<b>\$1,921,095.42</b>	<b>99.66%</b>	<b>99.66%</b>

	Taxes Levied	% of Levied	Property Taxes Collected	% Collected to Amount Levied
<b>Property Tax</b>				
General Fund - Arapahoe	\$ 846,082	43.76%	\$ 282,733.16	33.42%
General Fund - Douglas	1,087,214	56.24%	431,264.32	39.67%
	<u>\$ 1,933,296</u>	<u>100.00%</u>	<u>\$ 713,997.48</u>	<u>36.93%</u>

	Taxes Levied	% of Levied	Property Taxes Collected	% Collected to Amount Levied
<b>Specific Ownership Tax</b>				
General Fund	\$ 193,330	100.00%	\$ 28,793.73	14.89%
	<u>\$ 193,330</u>	<u>100.00%</u>	<u>\$ 28,793.73</u>	<u>14.89%</u>

	Taxes Levied	% of Levied	Property Taxes Collected	% Collected to Amount Levied
<b>Treasurer's Fees</b>				
General Fund	\$ 28,999	100.00%	\$ 10,711.16	36.94%
	<u>\$ 28,999</u>	<u>100.00%</u>	<u>\$ 10,711.16</u>	<u>36.94%</u>

**CHERRY CREEK BASIN WATER QUALITY AUTHORITY**  
**Property Tax Schedule**  
**2018**

**Arapahoe County**

	Current Year						Prior Year				
	Property Taxes	Delinquent Tax, Rebates and Abatements	Specific Ownership Taxes	Interest	Treasurer's Fees	Total Amount Received	% of Levied Taxes Received		Total Amount Received	% of Levied Taxes Received	
							Monthly	Y-T-D		Monthly	Y-T-D
January	\$ 35,915.45	\$ 1,301.06	\$ 5,377.69	\$ 79.70	\$ (559.44)	\$ 42,114.46	4.40%	4.40%	\$ 14,609.41	1.18%	1.18%
February	245,519.31	(2.66)	5,215.47	(3.86)	(3,682.69)	247,045.57	29.02%	33.42%	226,593.19	29.26%	30.44%
March	-	-	-	-	-	-	0.00%	33.42%	100,118.03	12.45%	42.89%
April	-	-	-	-	-	-	0.00%	33.42%	123,257.25	15.68%	58.57%
May	-	-	-	-	-	-	0.00%	33.42%	104,652.47	13.06%	71.63%
June	-	-	-	-	-	-	0.00%	33.42%	202,280.07	25.89%	97.52%
July	-	-	-	-	-	-	0.00%	33.42%	11,522.01	0.81%	98.33%
August	-	-	-	-	-	-	0.00%	33.42%	9,640.93	0.42%	98.75%
September	-	-	-	-	-	-	0.00%	33.42%	6,702.88	0.21%	98.96%
October	-	-	-	-	-	-	0.00%	33.42%	8,458.32	0.25%	99.21%
November	-	-	-	-	-	-	0.00%	33.42%	8,643.93	0.30%	99.51%
December	-	-	-	-	-	-	0.00%	33.42%	5,434.10	0.03%	99.53%
	\$ 281,434.76	\$ 1,298.40	\$ 10,593.16	\$ 75.84	\$ (4,242.13)	\$ 289,160.03	33.42%	33.42%	\$ 821,912.59	99.53%	99.53%

**Douglas County**

	Current Year						Prior Year				
	Property Taxes	Delinquent Tax, Rebates and Abatements	Specific Ownership Taxes	Interest	Treasurer's Fees	Total Amount Received	% of Levied Taxes Received		Total Amount Received	% of Levied Taxes Received	
							Monthly	Y-T-D		Monthly	Y-T-D
January	\$ 45,177.06	\$ (272.57)	\$ 9,497.22	\$ (5.02)	\$ (673.62)	\$ 53,723.07	4.13%	4.13%	\$ 30,104.66	2.04%	2.04%
February	389,377.79	(3,017.96)	8,703.35	(0.92)	(5,795.41)	389,266.85	35.54%	39.67%	373,392.32	36.64%	38.68%
March	-	-	-	-	-	-	0.00%	39.67%	61,382.56	5.08%	43.76%
April	-	-	-	-	-	-	0.00%	39.67%	177,126.86	17.67%	61.43%
May	-	-	-	-	-	-	0.00%	39.67%	115,520.59	10.73%	72.16%
June	-	-	-	-	-	-	0.00%	39.67%	252,837.49	24.54%	96.70%
July	-	-	-	-	-	-	0.00%	39.67%	26,212.56	1.73%	98.43%
August	-	-	-	-	-	-	0.00%	39.67%	15,536.46	0.47%	98.91%
September	-	-	-	-	-	-	0.00%	39.67%	10,775.57	0.10%	99.00%
October	-	-	-	-	-	-	0.00%	39.67%	12,401.22	0.16%	99.16%
November	-	-	-	-	-	-	0.00%	39.67%	17,022.35	0.65%	99.81%
December	-	-	-	-	-	-	0.00%	39.67%	6,870.19	-0.05%	99.76%
	\$ 434,554.85	\$ (3,290.53)	\$ 18,200.57	\$ (5.94)	\$ (6,469.03)	\$ 442,989.92	39.67%	39.67%	\$1,099,182.83	99.76%	99.76%



# 2017 ANNUAL REPORT ON ACTIVITIES

MARCH 31, 2018



# 2017 Annual Report on Activities Cherry Creek Basin Water Quality Authority

## CCBWQA Board and TAC Leadership

### Board Members

Stephanie Piko  
Tom Bishop  
John McCarty  
Nancy Sharpe  
David Weaver  
Brad Pierce  
George Teal  
Susan Squyer  
Joshua Rivero  
Pieter Van Ry  
Roger Kligore  
Myrna Poticha  
Alan Vajda  
Christopher Lewis  
Ron Weidmann  
John Woodling  
Lora Thomas

### TAC Members

Rick Goncalves  
Jim Dederick  
Steve Miller  
Jill Platt-Kemper  
David Van Dellen  
Lanae Raymond  
Ann Woods  
John Cotten  
Jacob James  
Rich Borchardt  
Max Grimes  
Casey Davenhill  
Elaine Hassinger  
Jason Trujillo  
Tim Rose  
Bahman Hatami

## Cherry Creek Basin Water Quality Authority

[www.cherrycreekbasin.org](http://www.cherrycreekbasin.org)

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8390 E. Crescent Parkway, Suite 500  
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(303) 265-7914  
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“As the Denver Metropolitan Area expands up the Cherry Creek Watershed and surrounds Cherry Creek Reservoir, the CCBWQA continues its effort to maintain water quality and beneficial uses through good public policy decisions.”



Look for the Link symbol throughout this report for opportunities to explore water quality data on your own.

There are also many hyperlinks to existing documents, denoted in [blue underline](#).

# Contents

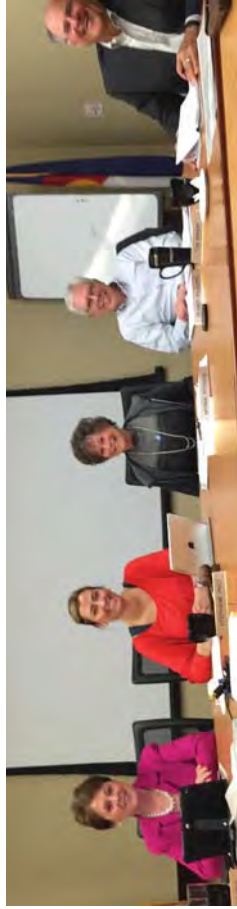
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The Annual Report provides an easy-to-read update about the CCBWQA's 2017 efforts, and reflects the leadership provided by the Board and TAC.”

- Chuck Reid, CCBWQA Manager

# Who We Are

We are the Cherry Creek Basin Water Quality Authority (Authority), tasked with improving, protecting, and preserving water quality for beneficial uses. The Authority was formed following the completion of a [Clean Lakes Study](#) in 1984, which led to the development of our first Master Plan in 1985. Subsequent to the adoption of the [Master Plan](#), the local governments in the Cherry Creek Basin formed an Authority by intergovernmental agreement and worked diligently to gain State approval of legislation to create the Cherry Creek Basin Water Quality Authority. That goal was accomplished during the 1988 General Assembly with the Governor signing the Cherry Creek Basin Water Quality Authority [Statute](#), House Bill 1029, on April 28, 1988 (C.R.S. 25-8.5-101 *et seq.*).



## Authority Board

The governing body of the Authority is its Board of Directors ("Board"). According to our Statute, the [Authority Board](#) is to include representatives from the following:

- Arapahoe and Douglas Counties;
- The Cities and/or Towns of Aurora, Castle Pines, Castle Rock, Centennial, Foxfield, Greenwood Village, Lone Tree, and Parker;
- One member representing the seven special districts providing wastewater services in the Authority's boundaries; and
- Seven citizens representing sports persons, recreational users, and concerned citizens appointed by the Governor.

## Technical Advisory Committee (TAC)

The [Authority's Bylaws](#) allow each entity member (municipality, county, and the one (1) wastewater district member) to appoint one representative to serve on the TAC. The Board may also appoint other individuals who represent educational or public interest groups having an interest in stormwater drainage and water quality in the Cherry Creek Basin, and any governmental or quasi-governmental agencies that are not members of the Authority, but have an interest in stormwater drainage or water quality in the Basin. The role of the TAC is to consider and report to the Board on matters of a scientific or technical nature.

The following entities and interests are represented on the Board and TAC:

Board		TAC
2 Counties	Arapahoe	Arapahoe
	Douglas	Douglas
8 Municipalities	Aurora	Aurora
	Castle Pines	Castle Pines
	Castle Rock	Castle Rock
	Centennial	Centennial
	Foxfield	Foxfield
	Greenwood Village	Greenwood Village
	Lone Tree	Lone Tree
	Parker	Parker
<b>1 Special District</b>		
Representative from Water & Sanitation Districts		Representative from Water & Sanitation Districts
<b>7 Governor Appointees</b>		<b>Public Interest/Local Government (appointed at the Board's discretion)</b>
Sports person or recreational organization with members that use Cherry Creek Reservoir (must be Colorado resident)		Southeast Metro Stormwater Authority (SEMSWA) (governmental entity)
Sports person or recreational organization with members that use Cherry Creek Reservoir (must be Colorado resident)		Cherry Creek Stewardship Partners (non-profit public interest)
Citizen or environmental organization interested in water quality with members that use Cherry Creek Reservoir or live in Cherry Creek Basin.		Colorado Parks and Wildlife (CPW) (governmental entity)
Citizen or environmental organization interested in water quality with members that use Cherry Creek Reservoir or live in Cherry Creek Basin.		Urban Drainage & Flood Control District (UDFCD) (governmental entity)
Person with background or professional training in water quality issues.		Tri-County Health Department (TCHD) (governmental entity)
Person with background or professional training in water quality issues.		Cherry Creek State Park (governmental entity)
Person with background or professional training in water quality issues.		TAC Chair (other individual with interest in Cherry Creek Basin)

*\*In 2017, there were Board and TAC vacancies for both Castle Pines and Foxfield.*



# Our Regulation 72 Responsibilities

Just as the State Legislature created the Cherry Creek Basin Water Quality Authority to improve, protect, and preserve the water quality of Cherry Creek and Cherry Creek Reservoir, the Legislature also created a Water Quality Control Commission (Commission) to develop and implement a program for the prevention, control, and abatement of water pollution and for water quality protection throughout the state.

The Commission has broad powers to promulgate water quality rules and regulations. The Commission establishes beneficial uses for waters of the state and assigns numeric and/or narrative water quality criteria to protect the beneficial uses, along with an antidegradation process to protect existing quality.

Once water quality standards are developed, there are several tools that can be used to ensure the standards are achieved. These include options such as issuing discharge permits, limiting the allowable load of a particular pollutant to a water body, issuing compliance schedules, and developing control regulations.

Cherry Creek Reservoir has a Control Regulation, which is designated "Regulation 72" by the Commission. A control regulation can contain limitations on pollutants that are discharged, management requirements, or precautionary measures to prevent or minimize pollutants entering the water. The Cherry Creek Reservoir Control Regulation 72 prescribes activities necessary to reduce the inflow of total phosphorus concentrations to Cherry Creek Reservoir to attain the chlorophyll a standard.

Regulation 72 requires:

- ✓ Construction of nonpoint source projects, called Pollutant Reduction Facilities (PRFs)
- ✓ Inclusion of phosphorus permit limits for point source dischargers
- ✓ Inclusion of Best Management Practices (BMPs) in stormwater permits
- ✓ Collaboration in pursuing incentives, grants, and cooperative programs for agricultural sources
- ✓ Implementation of a public information and education program
- ✓ Limitations on the construction of new Onsite Wastewater Treatment Systems (OWTS)
- ✓ Consideration of floodplain, riparian corridor, and wetlands projects
- ✓ Nutrient monitoring
- ✓ Submission of an Annual Report to the Commission on these activities

**WATER QUALITY STANDARDS =**

**BENEFICIAL USES**

**+ CRITERIA TO PROTECT USES**

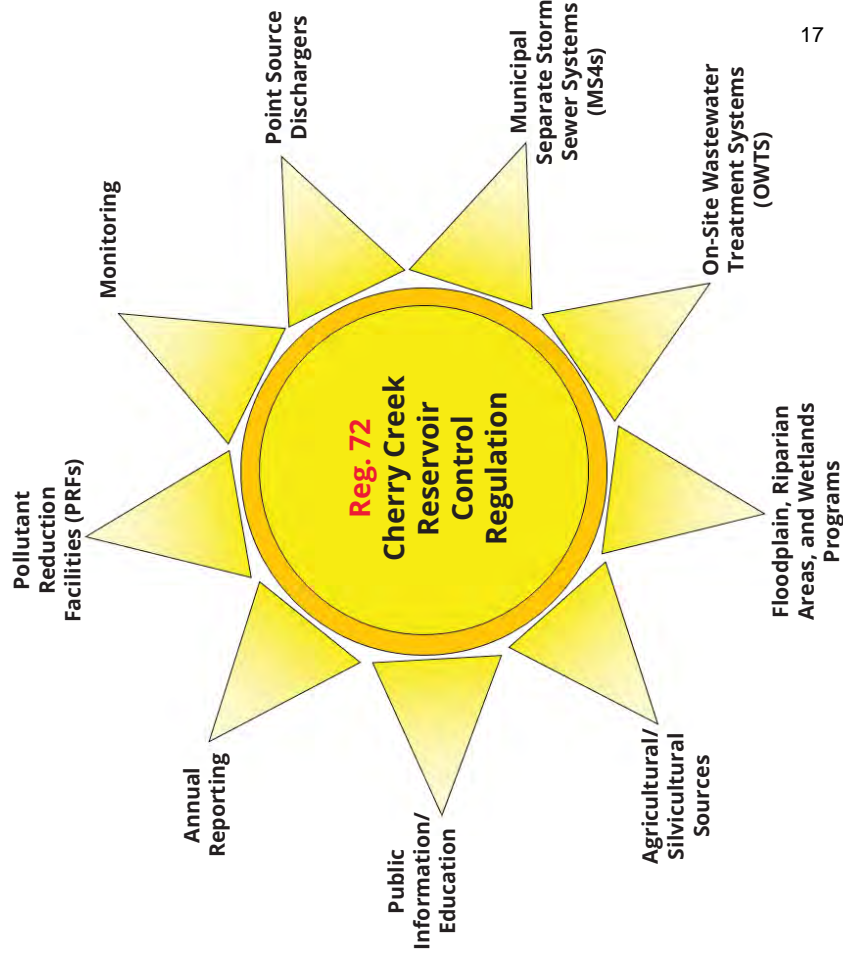
**+ ANTI-DEGRADATION REQUIREMENTS**

The activities required under Regulation 72 are assigned to different entities.

- The Authority is to construct [Pollutant Reduction Facilities](#), implement a [public information and education program](#), and conduct water quality monitoring. The Authority may collaborate on [floodplain, riparian corridor, conservation easements, and wetlands projects](#).
- The Colorado Water Quality Control Division (Division) is to include limits and water quality requirements in [point source](#) and [Municipal Separate](#)

[Storm Sewer System \(MS4\) permits](#). The Division is also directed to collaborate with [agricultural and silvicultural](#) owners/operators in pursuing incentives, grants, and cooperative programs to study and control nonpoint sources, as well as collaborate with local governments to encourage connection of existing OWTS and new development to central wastewater facilities.

- **Tri-County Health Department** cannot allow construction of new [Onsite Wastewater Treatment Systems](#) in the 100-year floodplain.



# What Makes Us Unique

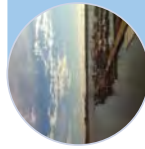
The Cherry Creek Basin Water Quality Authority was formed by Statute, and given powers and authorities unique to our basin, such as the ability to establish rates, tolls, fees, and charges for the Authority's facilities and program. No other watershed in the state has a statute specifically designed to protect its reservoir.

Although our reservoir is also subject to the Cherry Creek Reservoir Control Regulation 72 (as are many other Colorado reservoirs with similar control regulations), it is the additional powers in our Statute that sets us apart.

The [Statute's Purposes](#) include:



**Preserving water quality in Cherry Creek and Cherry Creek Reservoir**



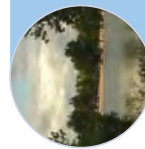
**Preserving waters for recreation, fisheries, water supplies, and other beneficial uses**



**Promoting the health, safety, and welfare of the people of Colorado**



**Providing for effective efforts by counties, municipalities, districts, and landowners to protect water quality**



**Providing that new developments & construction activities pay their equitable proportion of costs for water quality preservation and facilities**

# Additional Opportunities in Our Statute

Several [unique powers](#) are given to the Authority by the State Legislature. The Statute gives the Authority expansive opportunities to protect and improve water quality.

## Statutory Opportunities

- Incur debts/liabilities/obligations
- Enter into contracts/agreements
- Acquire/lease/hold/dispose of/encumber real property
- Establish rates, tolls, fees, charges, penalties, Cherry Creek State Park fees, taxes on property, bonds
- Develop and implement plans for water quality controls for the reservoir and watershed to achieve and maintain water quality standards
- Acquire, construct, lease, rent, improve, equip, relocate, maintain, and operate water quality control, nonpoint source, and drainage facilities
- Conduct studies concerning the development of water quality solutions
- Develop and implement programs to provide credits, incentives, and rewards for water quality projects
- Recommend erosion controls and urban runoff control standards
- Conduct educational programs
- Recommend septic system maintenance programs

In addition to general administrative functions, the Statute identifies several methods by which the Authority can raise funds, as well as implement various water quality control mechanisms. Guidelines include:

- Funds must be spent on improving, protecting, and preserving water quality of Cherry Creek Reservoir and the watershed, and on achieving and maintaining the existing water quality standards.
- At least sixty percent of revenues collected by the Authority must be spent on construction and maintenance of Pollution Abatement Projects.

Many of these water quality control techniques are already being implemented, as discussed in this report. For example, the Authority is currently exploring ideas to help preserve water quality in the basin, through developing reservoir and watershed models, and exploring expanded riparian protection options.



# How We Fund Authority Activities

Our Statute provides several [funding mechanisms](#) that the Authority can use in a manner that is consistent with its statutory purpose to improve, protect, and preserve the water quality of Cherry Creek and Cherry Creek Reservoir.

The Authority levies property taxes (one-half mill) on all taxable property within the Authority's boundaries. Current development fees include \$60 per single family residence and \$0.04 per square foot of impervious area in commercial and multi-family developments; agricultural lands are exempt from the collection of these fees. Wastewater fees are \$0.25 per 1,000 gallons of treated wastewater discharged in the Cherry Creek basin.

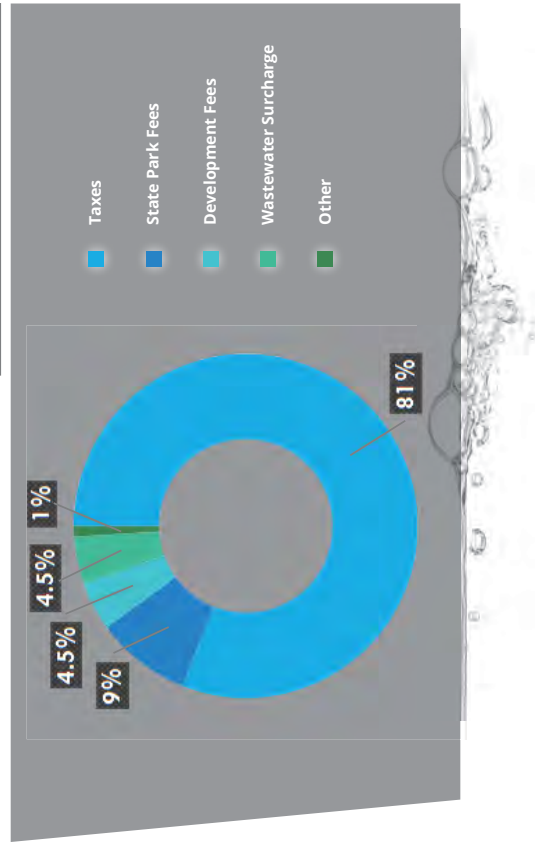
The Authority also receives \$3 on annual passes and \$1 on single-day passes user fees from Cherry Creek State Park visitors.

The 2018 budget shows \$2.6 million in revenues.

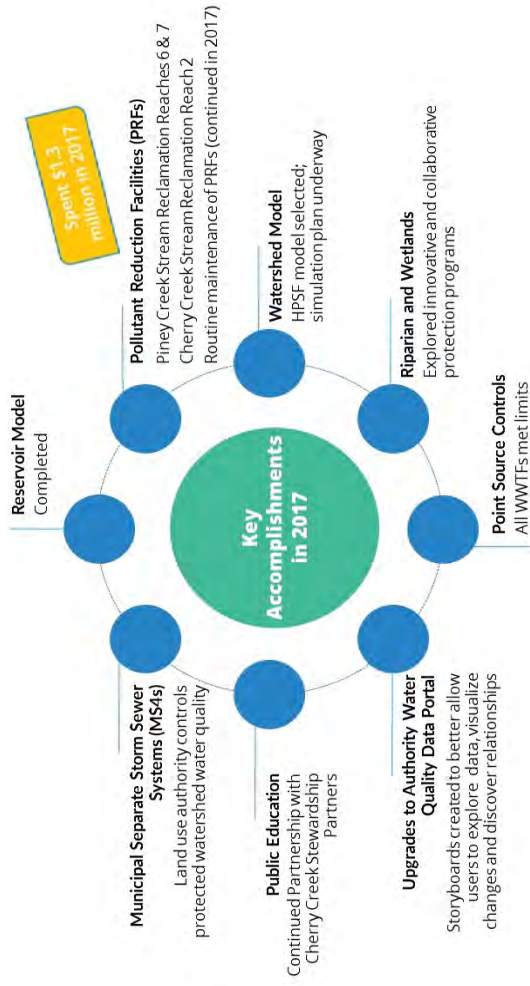
Expenditures and revenues are often not matched each calendar year because implementation and timing of project costs for the Capital Improvement Plan (CIP) can vary significantly from year to year.

The Statute mandates that the Authority spend at least 60% of the annual revenues on the construction and maintenance of Pollution Abatement Projects. The remaining 40% is allocated towards monitoring, special studies, planning documents, technical reports or memoranda, and administrative costs. Because expenditures and revenues are not matched each calendar year, the Authority interprets the 60/40 split referenced above as a multi-year mandate and does not account for this in any one year. In 2017, the Authority did not achieve the 60% requirement, and needs to spend approximately \$180,000 on Pollution Abatement Projects in future years to be compliant.

Projected 2018 Revenues



# Key Accomplishments in 2017



## RESERVOIR UPDATE

The seasonal average chlorophyll  $\alpha$  in 2017 was 18.8  $\mu\text{g/L}$  (the water quality standard is 18  $\mu\text{g/L}$ ). The data showed that DO concentrations were above the standard of 5.0 mg/L throughout the majority of time in the top layers of the reservoir. However, an average value of 4.62 mg/L was observed in the reservoir's top layer (0.5 to 2.0m) on August 8, 2017 at CCR-1. Average upper layer oxygen levels at CCR-2 and CCR-3 were 5.075 mg/L and 5.315 mg/L respectively, which show compliance with the standard on the same day. Despite the Authority's efforts, the above numbers show that the reservoir was not in compliance with the [chlorophyll  \$\alpha\$](#)  and [dissolved oxygen \(DO\) standards](#) in 2017.

# Pollutant Reduction Facilities (PRFs)

PRFs are structural measures that include, but are not limited to, detention, wetlands, filtration, infiltration, and other technologies with the primary purpose of reducing pollutant concentrations entering the reservoir and protecting the beneficial uses of the reservoir. A PRF reduces pollutants in stormwater runoff; it does not discriminate as to the source of the stormwater. It removes pollutants from all upstream stormwater, whether regulated or not. In-channel PRFs effectively treat runoff from recent as well as past development.

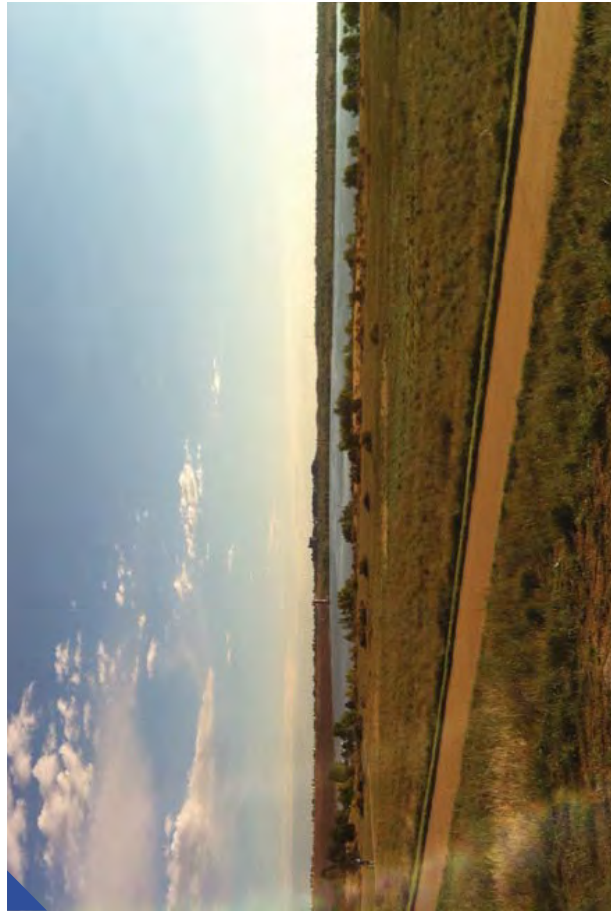
## Stormwater Controls

Stormwater controls consist of PRFs constructed by the Authority and similar type projects constructed by local governments. Authority PRFs include water quality controls

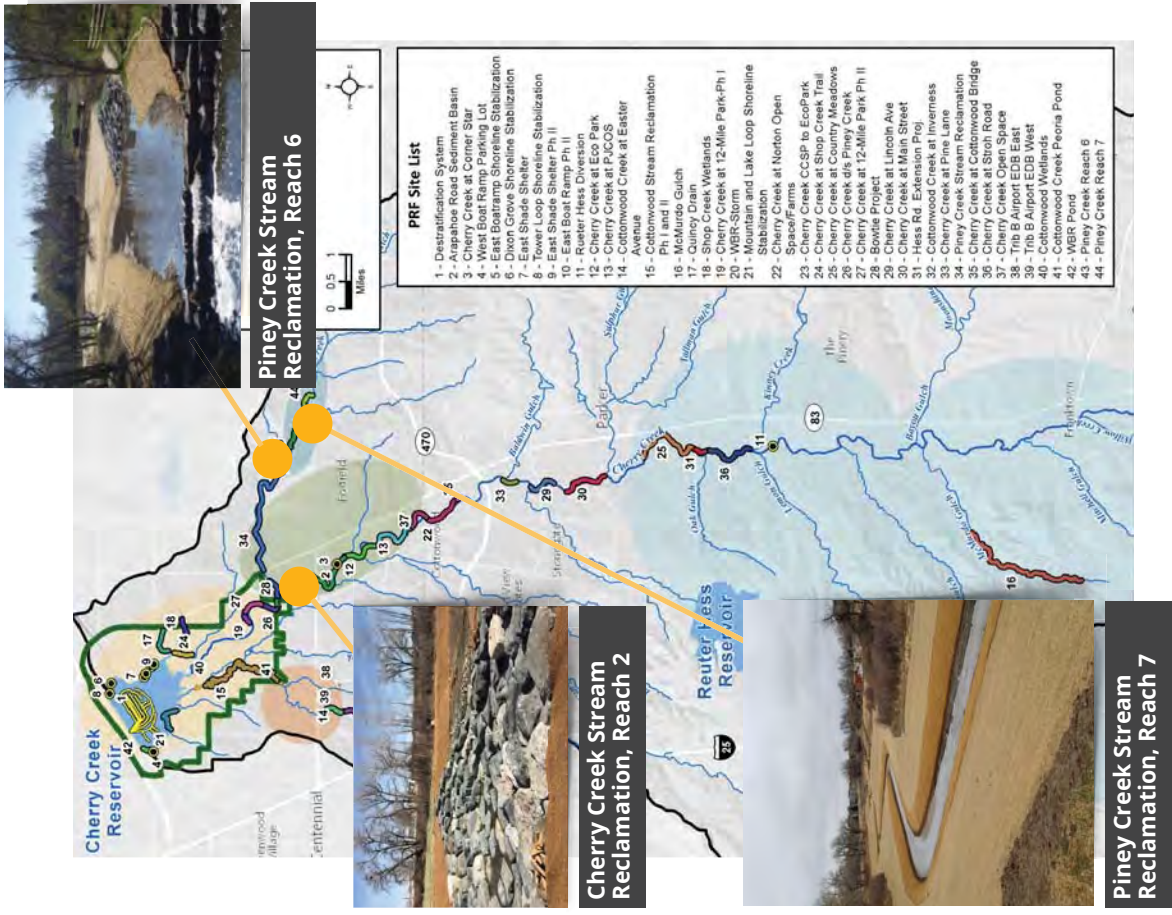
such as stream reclamation, shoreline stabilization, detention, wetlands, and other activities that provide water quality benefits for the reservoir by reducing pollutants carried by stormwater from existing and future land disturbances.

## Funding of PRFs

The costs and benefits of all potential PRFs are evaluated at the conceptual level. If these appear to be reasonable, the PRF is added to the master list maintained by the Authority. Each year the Authority compiles its 10-year CIP, a list of projects to fund in the coming years. Annually, the Board selects projects from the 10-year CIP (see table on page 18) for implementation, based on recommendations from the TAC and subject to available funds.



# Past and Current PRF Activity



# Highlighted PRF Projects

In 2017, there were 3 key pollutant reduction facilities projects either under construction or completed:

- Cherry Creek Stream Reclamation - Reach 2
- Piney Creek Stream Reclamation - Reach 6
- Piney Creek Stream Reclamation - Reach 7

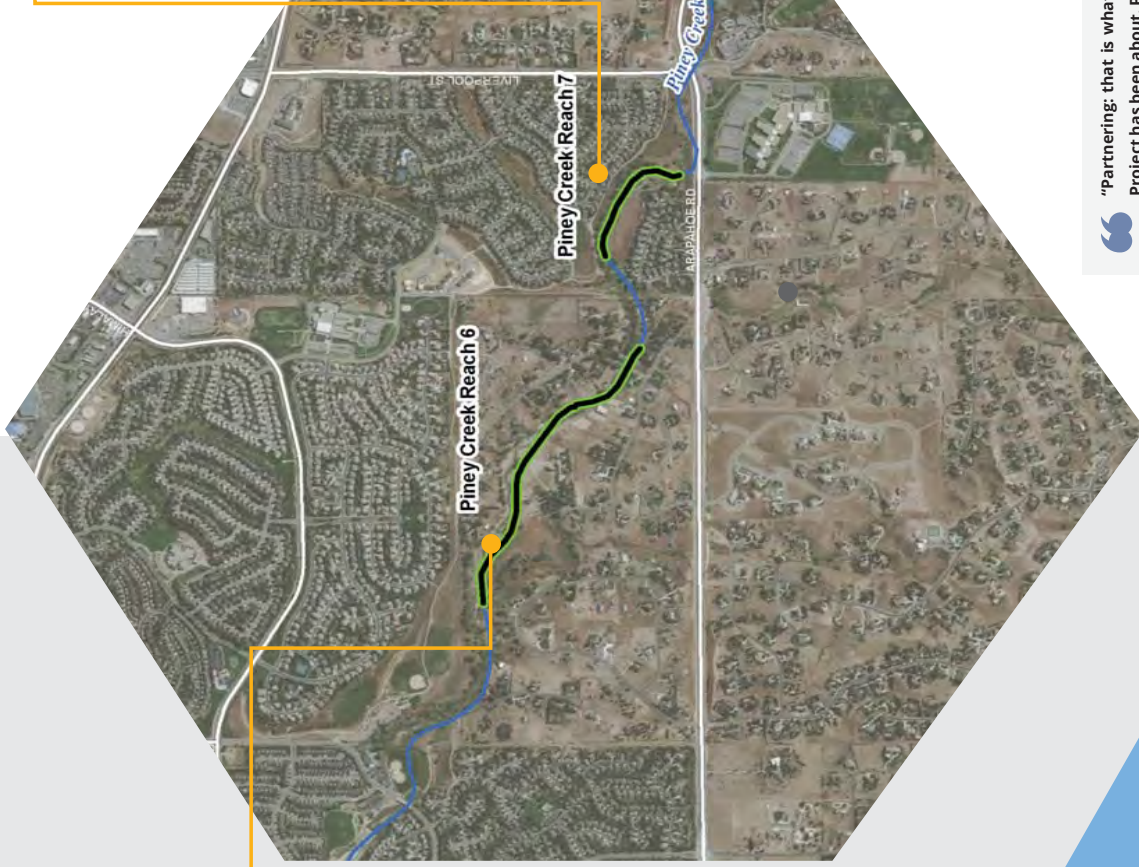
## Piney Creek Stream Reclamation - Reach 7

**Total Cost:** \$2,693,034  
**Authority Share:** \$ 682,556

**Piney Creek Reach 7 has also severely eroded and continues to experience significant erosion during storm events, which threatens water quality within the basin, sensitive riparian areas, and wildlife habitat as well as existing trails and utilities.**

The project constructed grade control / drop structures and bank stabilization to mitigate existing erosion and minimize future erosion on Piney Creek. Pre, during, and post-project conditions are shown below in Photos 1, 2 and 3.

Four constructed grouted boulder drop structures and two riffle drops were incorporated to flatten and control the longitudinal grade. The overall project goal is restoring and enhancing the aquatic, wetland, and riparian functions of Piney Creek.



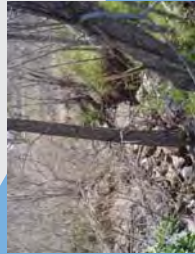
## Piney Creek Stream Reclamation - Reach 6

**Total Cost:** \$2,100,935  
**Authority Share:** \$ 525,234

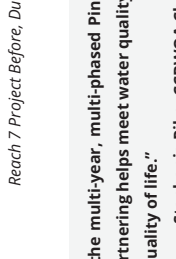
**Piney Creek Reach 6 has severely eroded and continues to experience significant erosion during storm events.** This continued erosion threatens water quality within the basin, sensitive riparian areas, and wildlife habitat as well as existing trails and utilities.

The project includes construction of grade control / drop structures and bank stabilization to mitigate the existing erosion and minimize future erosion on Piney Creek. Pre, during, and post-project conditions are shown below in Photos 1, 2, and 3.

The project raised the streambed and re-established the water table to prevent further loss of vegetation and down-cutting, erosion, and sediment transport. The overall project goal is restoring and enhancing the aquatic, wetland, and riparian functions of Piney Creek.



Reach 6 Project Before, During, and Post-Construction (counter-clockwise)



Reach 7 Project Before, During, and Post-Construction (clockwise)

“Partnering: that is what the multi-year, multi-phased Piney Creek Stream Reclamation Project has been about. Partnering helps meet water quality issues in a rapidly urbanizing watershed and improves quality of life.”

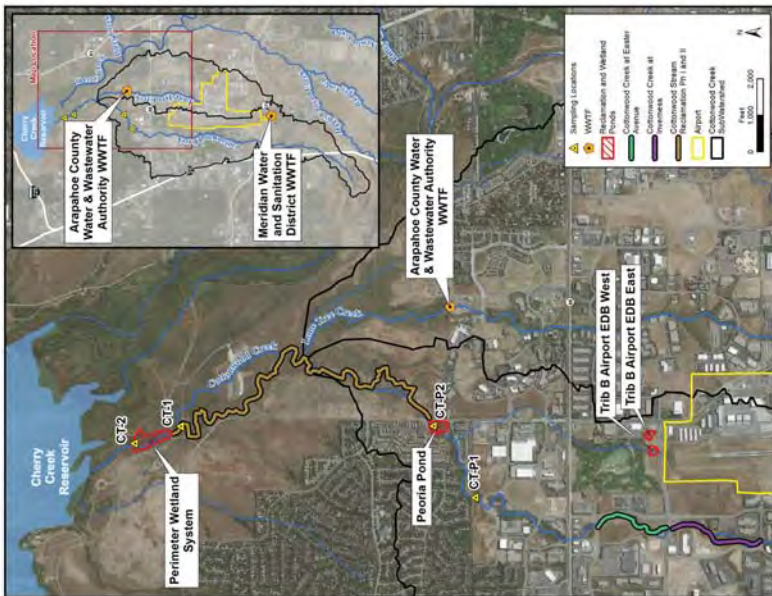
- Stephanie Piko, CCBWQA Chairman and Centennial Mayor

# PRF Effectiveness

The Cottonwood Creek Pollutant Reduction Facilities provide phosphorus and sediment reduction during storm events. Together, stream reclamation and wetland detention systems comprise a passive detention train approach widely implemented by the Authority throughout the basin since the 1990s as an effective water quality strategy.

The combined PRFs are very effective in removing total phosphorus (TP) and total suspended sediments during storm events (see table on next page showing monitoring results for the six storm events monitored during 2017.)

The upstream Peoria Pond and the downstream Perimeter Wetland System (within the State Park) were each also effective in removing TP and total suspended solids during baseflow periods. The Perimeter Wetland System was monitored 12 times during WY2017.



**WATER YEAR: The Authority uses a Water Year system that runs from October 1 - September 30, abbreviated "WY".**

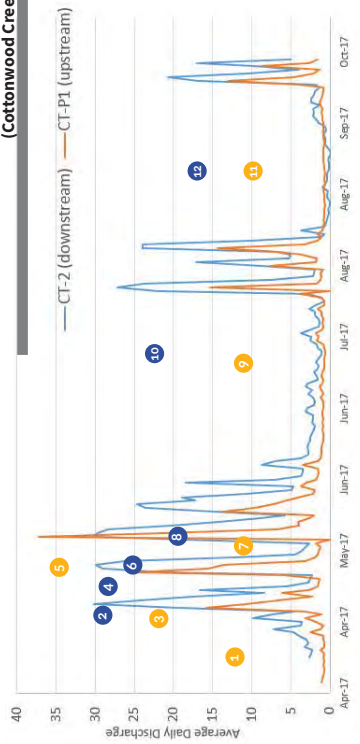
Storm events occurred either right before or right after the baseflow sampling at both PRFs twice, once in May and once in August. During both of these events, TP, total nitrogen, and total suspended sediments decreased across each individual PRF, but both TP and total nitrogen increased significantly in the reach between the two PRFs (total suspended sediments also significantly increased between the two ponds during the August storm event).

The map on the previous page shows other potentially significant water quality influences, positive and negative, in the section between Peoria Pond and the Perimeter Wetland System. Potential influences include Lone Tree Creek, discharges from two wastewater treatment plants, and runoff from the airport and its water quality detention ponds.



2017 Storm Sampling Events on Cottonwood Creek Treatment Train, Sites CT-P1 (upstream) and CT-2 (downstream)							
Date Sample Collected	Location	Total Phosphorus (mg/L)	Total Dissolved Phosphorus (mg/L)	Soluble Reactive Phosphorus (orthophosphate) (mg/L)	Total Nitrogen (mg/L)	Ammonia + Nitrate + Nitrite, as N (mg/L)	Total Suspended Solids (mg/L)
1 4/29/2017	CT-P1 (upstream)	0.274	0.011	0.003	1.56	0.366	80
2 4/30/2017	CT-2 (downstream)	0.044	0.019	0.015	1.65	1.34	6
3 5/8/2017	CT-P1 (upstream)	0.562	0.029	0.002	1.84	0.411	230
4 5/9/2017	CT-2 (downstream)	0.065	0.025	0.013	1.44	0.852	8
5 5/17/2017	CT-P1 (upstream)	0.21	0.008	0.003	1.34	0.511	106
6 5/18/2017	CT-2 (downstream)	0.063	0.045	0.032	1.54	1.225	7
7 5/28/2017	CT-P1 (upstream)	0.11	0.045	0.035	0.851	0.46	41
8 5/29/2017	CT-2 (downstream)	0.041	0.027	0.019	1.15	0.884	3.6
9 8/9/2017	CT-P1 (upstream)	0.099	0.021	0.014	1.14	0.16	19
10 8/9/2017	CT-2 (downstream)	0.111	0.059	0.046	1.13	0.359	12
11 9/23/2017	CT-P1 (upstream)	0.334	0.091	0.082	3.55	0.569	117
12 9/23/2017	CT-2 (downstream)	0.141	0.084	0.071	3.67	1.395	26

Graph of 2017 Storm Sampling Events (Cottonwood Creek)



TP was reduced in all but one sampling event, and total suspended solids were reduced during all 12 events. Total nitrogen increased during 10 of these sampling events.

The Peoria Pond was sampled seven times; about half of the time TP and total suspended sediments increased, while they decreased during the remaining sampling events. Total nitrogen increased across the Perimeter Pond during all but one sampling event.

Concentrations of pollutants were more likely to increase between the upstream pond and downstream wetland system. Of the seven paired sampling events, total phosphorus increased five times, total nitrogen increased six times, and total suspended solids four times.

# CIP Table

Summary of Recommended PRFs (Capital and O&M) 2018 – 2027 Budget Projects (1000\$)						
Project Title	Current Project Budget		Proposed 2018 Budget	Out-year Budget	Funding Year(s)	
	Total	Authority Portion			2018	2019
Cherry Creek Stream Stabilization at Main Street (Parker)	\$1,776	\$200	---	\$200	---	2025
Cherry Creek Stream Stabilization at Lincoln Avenue (Parker)	\$1,447	\$304	---	\$304	---	2026
Cherry Creek Stream Reclamation – Reach 2	\$2,771	\$475	\$270	---	---	---
Cherry Creek Stream Reclamation – Reach 3	\$2,567	\$640	---	\$640	---	2020-2021
Cherry Creek Stream Reclamation – Reach 4	\$2,720	\$680	---	\$680	---	2019-2020
Cherry Creek Stream Reclamation – Cherry Creek State Park Reach 1	\$2,220	\$2,220	\$230	\$2,060	---	2021-2024
Cherry Creek Stream Reclamation upstream of Scott Road (Parker)	\$650	\$163	---	\$163	---	2019
Piney Creek Stream Stabilization at Caley Avenue	\$11,000	\$2,750	\$500	---	---	---
McMurdo Gulch Reclamation (Castle Rock)	\$1,515	\$379	\$34	\$345	---	2019-2022
Stream Corridor Preservation	\$100	\$100	---	\$450	---	2019-2027
East Boat Ramp Shoreline Stabilization Phase II	\$80	\$80	---	\$80	---	2020
East Shade Shelter Shoreline Stabilization Phase II	\$60	\$60	---	\$60	---	2020
West Shade Shelter Shoreline Stabilization PRF	\$950	\$950	\$120	\$740	---	2019
Tower Loop Shoreline Stabilization Phase II	\$100	\$100	---	\$100	---	2020
Nonpoint Pollutant Management	\$100	\$100	---	\$450	---	2019-2027
Install 1 Meteorological Station at CCSP	\$20	\$20	\$20	---	---	---
Interpretive PRF Signage at 12-Mile Park (2 signs) & West Boat Ramp (1 sign)	\$30	\$30	\$30	---	---	---
<b>Total Capital Projects</b>	<b>\$28,106</b>	<b>\$9,251</b>	<b>\$1,204</b>	<b>\$6,272</b>	---	---
Rehabilitation	---	---	\$43	\$360	---	2019-2027
Restorative	---	---	\$60	\$920	---	2019-2027
Routine	---	---	\$173	\$1,788	---	2019-2027
<b>Total Operations and Maintenance</b>	<b>---</b>	<b>---</b>	<b>\$276</b>	<b>\$3,068</b>	<b>---</b>	<b>---</b>

”The Authority continues to prioritize CIP funding to new reclamation projects and maintenance of existing PRFs that benefit the watershed as a whole.”

- Jim Swanson, CIP Manager

# Annual PRF Inspection Results

The annual inspection is a requirement of the Operations and Maintenance Agreement between the Authority and CCSP dated January 14, 2006.

The inspection assesses whether the PRFs are functioning as designed and identifies rehabilitative, restorative, and routine maintenance requirements. The TAC uses this report to provide recommendations to the Board for the following fiscal year budgeting of maintenance activities.

In 2017, the inspection of PRFs fell into 2 groups:

- **Group 1 (inspected at least annually and after significant storm events):** Shop Creek, Cottonwood Creek, Cottonwood Wetlands (aka Perimeter Wetland System) and Cherry Creek at 12-Mile Park
- **Group 2 (inspected as needed, or upon recommendation/request of authorized agencies):** East Boat Ramp, East Shade Shelter, Dixon Grove, Tower Loop, Quincy Drain, Mountain/Lake Loop Shoreline Stabilization and West Boat Ramp

All areas in both groups were inspected at least once between June 7 and June 19, 2017.



## Other Capital Project Work



12-mile Dog Off-leash Area Fence Extension Project



Educational/Interpretive Signage Replacement at Cherry Creek State Park

- ✓ **Cherry Creek Stream Reclamation – Arapahoe Road**  
Design and construction of stream reclamation in partnership with SEMSWA, UDFCD, Aurora, and Arapahoe County. Overall project extends from Cherry State Park boundary to Eco-Park (Reaches 2 - 5). SEMSWA is the lead agency. The project is approximately 50% complete.

- ✓ **Reservoir Destratification Operations**  
Seasonal routine operations and maintenance of aeration distribution system and compressor.

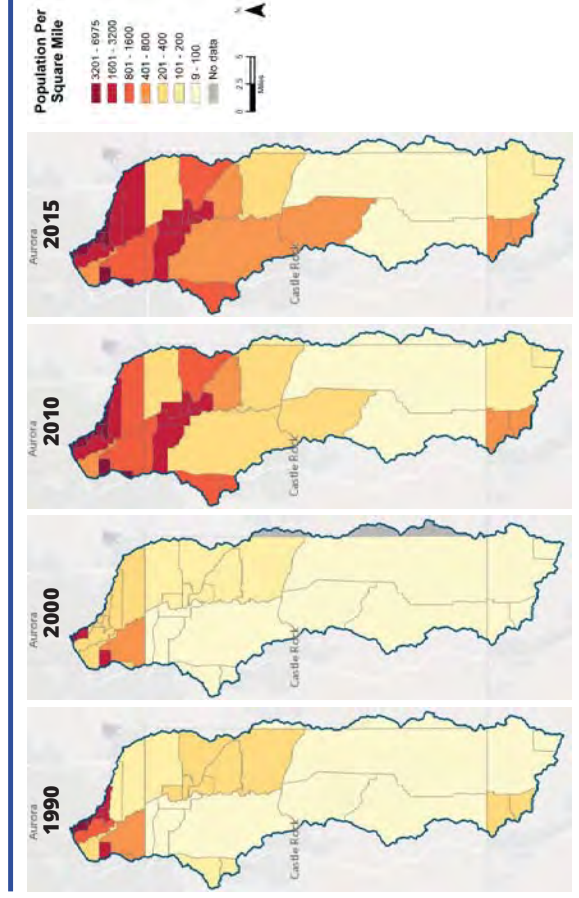
- ✓ **PRF Weed Control**  
Weed control at PRFs within Cherry Creek State Park performed annually (spring and fall applications) in accordance with the Authority's maintenance agreement with Parks.

- ✓ **PRF Reseeding at CCSP**  
Routine restoration of PRF vegetation at Cherry Creek State Park.

## Population

The 2015 population in the basin was 3½ times higher than it was in 1990. Population increases generally impact water quality with increased runoff and point and nonpoint source pollutants. However, through strong partnerships

with local, state, and federal stakeholders, the Authority has worked to moderate nutrient productivity in the reservoir. The tables on the next page show land use data that correlate with population growth in the basin.



Click Here 

Explore trends in population growth throughout the Cherry Creek Basin watershed.



## Land Use Referrals

Year	Annual Summary of Authority 2017 Land Use Reviews				
	Total LURS Reviewed	Commercial	Residential	Mixed-Use	Other <sup>1</sup>
2017	198	128	43	2	25
2016	265	147	60	4	54
2015	198	96	54	2	46
2014	154	81	44	0	29

<sup>1</sup> Other includes Open Spaces/ Parks / Rec. Ctrs, Highway / Roadway / Bridge, Utility, and Other.

Year	Approximate Areas of Land Disturbance <sup>1</sup> From the Summary of Authority 2017 Land Use Reviews				
	Total Land Disturbance <sup>1</sup> (Acres)	Commercial	Residential	Mixed-Use	Other <sup>2</sup>
2017	1641	777	735	28	101
2016	1338	533	510	18	277
2015	1351	270	1021	0	60
2014	1732	389	1168	0	175

<sup>1</sup> All acreages shown are those of the parcel / lot or tract, are approximate, don't represent the specific area of disturbance with in the parcel / lot or tract and are taken from referral submittal documents. Some referral submittals contain large tracts of land that many develop over a multi-year period.

<sup>2</sup> Other includes, Open Space, Parks, Recreation Centers, Highways and Bridges.





# Reservoir Model

Cherry Creek Reservoir is a flood control reservoir that has had periodic problems with cyanobacteria (blue-green algae) blooms and high chlorophyll *a* concentrations.

To increase oxygen at the bottom of the reservoir and reduce the amount of internal nutrient loading, a destratification system was installed in the reservoir in 2008. The system was also intended to help control cyanobacteria in the reservoir by disrupting their buoyancy. However the destratification system has not achieved these goals. Additionally, there has not been enough evidence to show that the destratification system reduced cyanobacteria blooms.



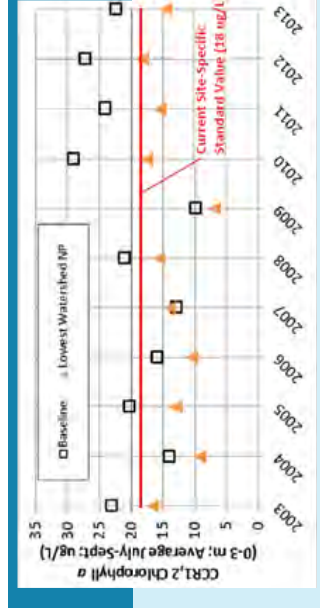
Due to continued water quality concerns, a [water quality model of the reservoir](#) was developed to:

- Better understand the causes of chlorophyll *a* standard exceedances and cyanobacteria blooms;
- Determine the impacts of the destratification system; and
- Provide a tool to help predict the effects of future management strategies.

The Authority chose a two-dimensional hydrodynamic and water quality model of the Cherry Creek Reservoir that simulated in-reservoir water quality for 2003-2013 (an update with data through 2017 is in progress). The model included a sensitivity analysis, which identified five management scenario runs that to consider changes to:

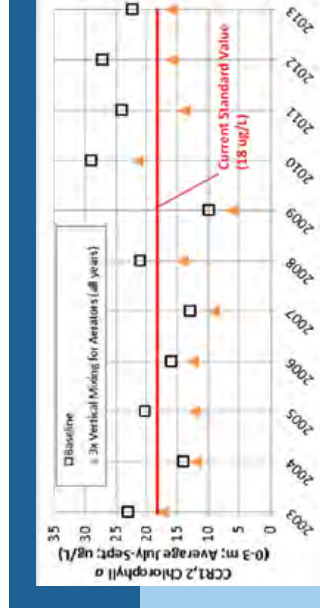
- 1) Inflow nutrient concentrations,
- 2) Destratification system mixing effectiveness, and
- 3) Inflow nitrogen-to-phosphorus ratios.

## Reservoir Model Example Runs



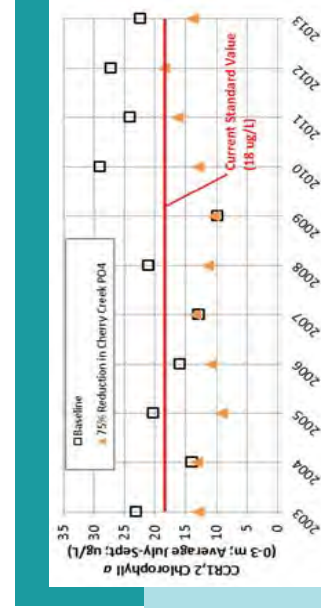
### 1 Best Currently Anticipated Watershed Control of Nutrients

The model shows that if major reductions in both phosphorus and nitrogen are assumed, concentrations of chlorophyll *a* would decrease from July - September by an average of 6.4 ug/L.



### 2 Increase Destratification System Mixing

Increasing the Vertical Mixing of the current system three times would result in at least 5 mg/L of dissolved oxygen (DO), and it would also decrease chlorophyll *a* concentrations during the summer months.



### 4 Inflow PO<sub>4</sub> % Reduction to Meet Chlorophyll Standard

The model indicates that a 75% reduction in inflow PO<sub>4</sub> concentrations from Cherry Creek was needed to meet the chlorophyll *a* value in all of the simulated years.

## FIVE DIFFERENT MANAGEMENT SCENARIOS WERE TESTED; EXAMPLE RUNS ARE SHOWN ON THE FOLLOWING PAGE.

### 1 Best Anticipated Watershed Control of Nutrients

How would the reservoir respond to the best currently anticipated reduction of nutrients (nitrate [NO<sub>3</sub>-], ammonia [NH<sub>4</sub>], and orthophosphate [PO<sub>4</sub>]) through watershed controls?

### 2 Increased Destratification System Mixing

How much increased vertical mixing is needed for the destratification system to meet the original bottom DO design target of 5 mg/L?

### 3 Best Watershed Controls Plus Increased Destratification

How would the reservoir respond to a combination of the best anticipated watershed controls and destratification mixing that achieves 5 mg/L DO at the bottom?

### 4 Inflow PO<sub>4</sub> % Reduction to Meet Chlorophyll Standard

What percent reduction in inflow PO<sub>4</sub> concentration is needed to meet the 18 ug/L chlorophyll *a* standard value for all simulated years?

### 5 Nitrogen-to-Phosphorus Ratio

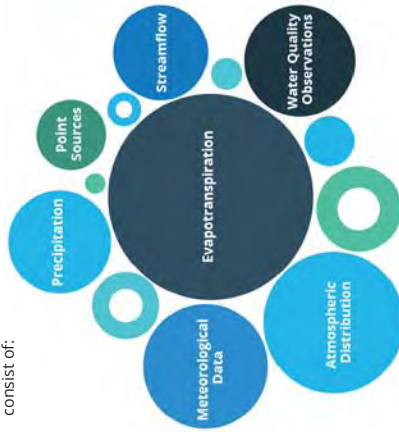
Does the model indicate an adverse effect of increased cyanobacteria in response to a disproportionate reduction of inflow nitrogen (NO<sub>3</sub> and NH<sub>4</sub>) relative to PO<sub>4</sub> in this nitrogen-limited system?

# Watershed Model

In 2017, the Authority initiated development of a new watershed model, to be used in conjunction with the reservoir model. The [modeling software selected](#) to model the Cherry Creek Watershed was the US Environmental Protection Agency Hydrologic Simulation Program-FORTRAN (HSPF). The primary goal of the Cherry Creek Watershed Model is to provide detailed information on hydrologic, sediment and nutrient loading as inputs to the Cherry Creek Reservoir and as boundary conditions for the reservoir model. In addition, the Cherry Creek Watershed Model must represent and quantify loadings from multiple land uses, pollutant sources, along with impacts of water quality controls, and instream processes that affect the pollutant loadings to the reservoir.

The [Simulation Plan](#) for Cherry Creek details the model setup, procedures, and assumptions, calibrations, and validation time periods, constituents to be simulated, model scales and resolution, model performance targets, and an initial discussion of potential management scenario runs to be investigated as part of the project.

Hydrology and water quality simulation input data will consist of:

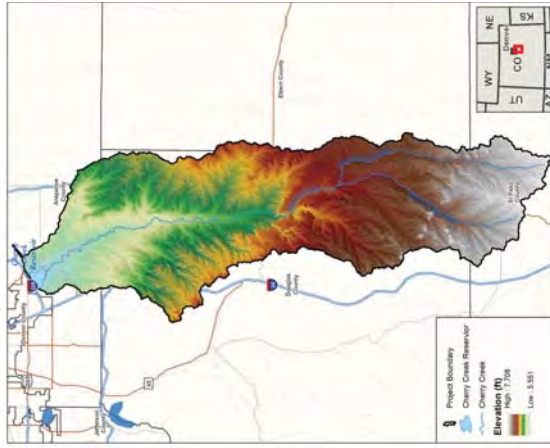


In addition to the hydrology and water quality, the simulation will incorporate segmentation and characteristics of the Cherry Creek Watershed. Watershed segmentation is based on spatial characteristics of the watershed which include:

- ◊ Topography
- ◊ Drainage Patterns
- ◊ Land uses and Distribution
- ◊ Meteorological Variability
- ◊ Soils Conditions

We anticipate that the model will be completed in 2018. The watershed model will be used to more accurately assess the level of watershed nutrient controls that can be achieved. These will then be used as inputs to the reservoir model.

## Watershed Elevations



# How We Protect Riparian Areas & Wetlands

Many of the Authority projects aim to re-integrate the stream channel and floodplain along the corridor of Cherry Creek and its tributaries. Re-integration will cause more frequent stormflows to spill out of the channel onto the riparian and floodplain area, and increase filtration/infiltration of the overflow banks. Revegetation along the corridor with wetland plants, grasses, shrubs, and trees provides an aesthetic buffer and promotes enhanced riparian habitat.

Riparian preservation is protection of natural or present condition of a riparian area to prevent its destruction, degradation, or alteration in any manner.

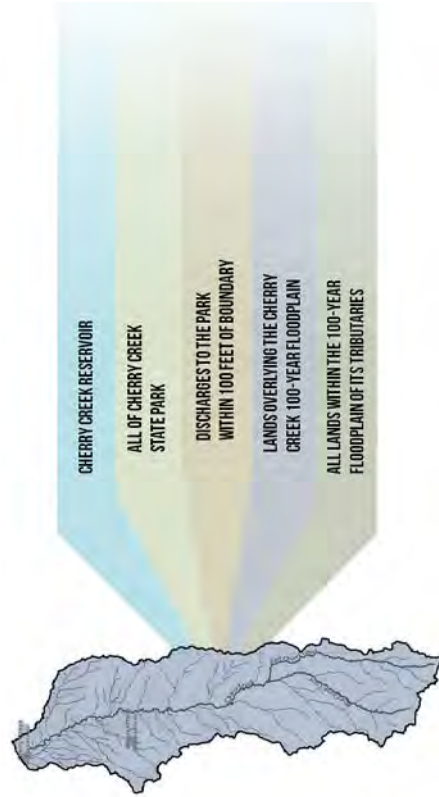
Stream Preservation Areas are specifically called out in Regulation 72, with additional water quality requirements for Cherry Creek Reservoir, all of Cherry Creek State Park, surface drainage and discharges to the Park within 100 feet of the Park boundary, lands overlying the Cherry Creek 100-year floodplain, and all lands within the 100-year floodplain of Cherry Creek tributaries.

The Authority began exploring riparian protection programs that have been implemented in other areas in Colorado, such as:

- Land acquisition
- Conservation easements
- Riparian Buffers and Setbacks
- Overlay Zoning
- Cluster Development

Next steps will be dependent on both the findings of the watershed model, and interest from potential partners.

## Stream Preservation Areas Defined in Regulation 72



“The Town of Parker and UDFCD are investigating opportunities to implement native preservation and creation within development areas to encourage increased stormwater infiltration. This collaborative approach with developers will provide healthy native vegetation areas within development as an amenity and provide a watershed approach to runoff reduction and increased water quality.”

- Jacob James, PE - Stormwater Manager, Parker Water and Sanitation District

## WHY STREAM PRESERVATION?



A stream corridor encompasses an active channel, and floodplain surfaces above and outside of the channel banks. Riparian areas are adjacent to streams, rivers, lakes, ponds, and wetlands. Riparian areas act as buffers between upland areas and the stream, and help filter pollutants like nutrients and sediment. Properly functioning

stream and riparian areas are critical to maintain water quality, water quantity, riparian habitat, wildlife, fish populations, and diversity, as well as protect downstream beneficial uses.

*Note the beaver prints crossing the bridge.*

## Benefits to a Healthy Riparian Vegetation Area



Reduces stream bank erosion which maintains stable stream channel geomorphology and reduces the velocity of flow



Provides support of sediment deposition on floodplains during periods of overbank flow, which removes total suspended sediments and attached phosphorus that can degrade water quality



Provides shade, which works to lower water temperatures (lower water temperatures support higher dissolved oxygen levels which are important to maintain fisheries)



Removes phosphorus, nitrogen, and sediment from surface runoff (through plant uptake and filtering) where approximately 80% or more of nitrogen in surface runoff and shallow groundwater can be removed after passing through riparian zone

# How We Implement Public Education

The Authority is responsible for developing and implementing a public information and education program, which it fulfills by partially funding and utilizing the service of the Cherry Creek Stewardship Partners ([www.cherry-creek.org](http://www.cherry-creek.org)).

The Partners formed in response to the need for cross-jurisdictional coordination and communication on watershed issues such as open space, recreation, and water quality in our streams and reservoir.

The Partners bring together representatives from land use jurisdictions, state and federal resource management agencies, conservation, recreation and historic preservation groups, business communities, and interested citizens. In 2017, the Partners held more than 40 public activities for more than 6,000 participants. Recurring events included the Annual Hawk Walk, Solstice and Equinox Walks at the Cherry Creek Valley Ecological Park, the annual Cherry Creek Stewardship Conference, and the Unique to the Creek walks.

For almost 20 years, the Partners have provided a forum for active engagement with the natural resources of the Cherry Creek watershed.



## Education and Outreach

The Authority has been a sponsor of the Denver Metropolitan Regional Science Fair since 2007. In 2017, the Fair included more than 500 students in grades 6 to 12. The Partners engaged with businesses, schools, churches, stormwater permit holders, Colorado Parks and Wildlife, and other scientific and cultural organizations to support water quality goals for the Cherry Creek Basin. The Partners hosted over 500 school-age students and parents at the 17-Mile House Farm Park to promote outdoor education, explore the landscape and practice outdoor observation skills.



## PRFs and Water Quality Education

PRFs and stream stabilization projects have been constructed in the upper watershed of the Cherry Creek Reservoir. These projects help slow the transport of sediment and create a natural connection filled with native grasses, forbs and shrubs that are home to hundreds of bird, insect, reptile and mammal species. The publicly accessible Cottonwood Creek PRFs provide an opportunity for residents to learn about long-term maintenance of PRFs.

The Partners regularly invite bird and wildlife fans to walk the Cherry Creek basin trails and learn about benefits of stream stabilization and riparian buffers. The annual Hawk Walk on Cottonwood Creek in Cherry Creek State Park is the perfect opportunity to explore the ecology of our watershed and consider the effects of human activity in the Cherry Creek Basin. Additionally, backyard birders and botanists have enjoyed the annual Unique to the Creek walks near Tagawa Garden Center.



## The Right Message at the Right Time and Place

In 2017, Tagawa Gardens invited the Partners to repeat their successful soil chemistry classes, geared to local homeowners, to promote good fertilizing practices. In addition, the Partners were asked to participate with users at the Dog Off-leash Area at Cherry Creek State Park to promote good dog etiquette.



## Annual Stewardship Partners Conference

This conference brings a broad range of watershed interests together to learn from one another. In 2017, the Partners explored topics such as "Cherry Creek Tributaries Master Drainage Plan Everyday Life: Using App Technology for Worldwide Citizen Science", and "Ask an Ungulate: What Ranchland Data Collection Can Tell Us About Stream Health in the Upper Cherry Creek Basin".

## 2017 Educational Flyers

Cherry Creek Stewardship Partners

**Walk in the Park**  
**Saturday, June 24, 2017**  
**8:00 am - 10:00 am**  
 Exhibits: The Ecology of Cherry Creek

Zoe Marie Binder from the Audubon Society and representative from local nurseries who are engaged in riparian habitat restoration will be on hand to answer questions about riparian habitat and the unique plants and animals that live in the riparian zone. This is a great opportunity to learn more about the riparian zone and how we can help restore it. From a bird's eye view.

The Cherry Creek Stewardship Partners will lead a Summer Solstice Tour as part of the quarterly series of walkable activities on the Park. Who likes to hike? How about they adapted their hike to their needs? How have they adapted their homes to their lifestyle? Learn about nature and science at this amazing open space park in Englewood, County.

There is our sixth annual Summer Solstice walk.  
 Here is a short list of what we see at the Park:

Turkey Vulture	Western Woodpecker	Killdeer	Say's Phoebe
Belted Owl	Red-naped Hawk	Song Sparrow	Pine Grosbeak
House Wren	Vermont Snowbird	Goldfinch	Dusky Woodpecker
Flicker	Cabbage White butterfly	Titmouse & King	
Downy Woodpecker	Chimney Swift	Robin	Coyote tracks and scat

7500 S. Jasper Ct., Centennial, CO 80112  
 The Park will be open from 8:00 am to 10:00 am. The walk will be on the 1.2 mile, loop trail for Junco (Great and Red) on Jasper Court. The Park is open from 8:00 am to 10:00 am. The walk will be on the 1.2 mile, loop trail for Junco (Great and Red) on Jasper Court. The Park is open from 8:00 am to 10:00 am.

Cherry Creek State Park, 7500 S. Jasper Ct., Centennial, CO 80112  
 Contact: Cherry Creek Stewardship Partners, 303-945-1675  
 Email: [info@cherry-creek.org](mailto:info@cherry-creek.org)  
 Direct: [Gardner@cherry-creek.org](mailto:Gardner@cherry-creek.org)

## Join Your Friends and Neighbors to Learn What is Unique to the Creek

Sunday, June 4, 2017

9:30 am

Meet at the Broncos Parkway Trailhead  
 13400 E. Broncos Parkway in Centennial

Walk the newly reclaimed floodplain of Cherry Creek and see the birds, bugs and botany that make Cherry Creek such a valuable community resource.

You will be joined by local experts who will help us explore native and exotic plants and animals that live on the grasslands in the Cherry Creek landscape that provide your round beauty.



Hosted by the Cherry Creek Stewardship Partners  
 Contact Casey D'Arnell  
 303-945-1675  
[casey@cherry-creek.org](mailto:casey@cherry-creek.org)  
 To RSVP or for further information

# What's New with Point Source Controls in 2017

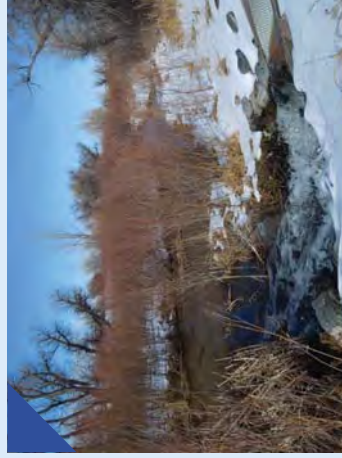
Wastewater treatment facilities (WWTFs) in the basin provide TP removal through advanced wastewater treatment processes, followed by direct discharge, or further treatment through land application. Some WWTFs also remove total inorganic nitrogen (TIN) to meet permit limits (10 mg/L). There are currently five permitted WWTFs in the basin that discharge to Cherry Creek waters. Another, Plum Creek Water Reclamation Authority, is located outside the watershed but applies some of its treated effluent as irrigation water within the watershed.

Wastewater and industrial process wastewater sources are limited in the amounts of phosphorus they are allowed to discharge to the Cherry Creek Reservoir watershed.

Limits contained in the point source discharge permits in the basin effectively reduce nutrient concentrations in the receiving streams. For example, TP discharge limits for WWTFs, which for most dischargers are less than 0.05 mg/L TP as a 30-day average, are significantly less than the flow-weighted TP concentrations currently entering the reservoir from aggregated sources (surface and groundwater inflows, precipitation). Actual concentrations discharged by wastewater treatment plants continue to be consistently below their permit limits and well below the 0.200 mg/L flow-weighted phosphorus concentration goal established for flows into the reservoir.

## Evaluation of Permit Compliance and Effectiveness in Reducing Nutrient Concentrations

All WWTFs in the basin met their phosphorus discharge limits. Required effluent limits for TP concentrations discharging from wastewater facilities and industrial process wastewater sources (i.e., for most dischargers, less than 0.05 mg/L TP concentration as a 30-day average) are significantly less than the flow-weighted TP concentration goal of 0.200 mg/L. Actual effluent concentrations were consistently below their limits. WWTFs also met their TIN limits in 2017.



Monthly TP and TIN concentrations for each WWTP are outlined in the table on the following page. Concentrations are based on monthly Discharge Monitoring Reports that are discharger-submitted. In 2017, no permits were in violation of phosphorus concentration limits. All wastewater treatment facilities are removing substantial amounts

of phosphorus, especially the forms of phosphorus that are readily available for algal or bacterial uptake in the reservoir.

As of 2017, only three WWTFs have TIN limits on their permits: Pinery, Parker, and Stonegate. All three facilities were in compliance with their TIN limits.

## Phosphorus and Nitrogen Effluent Concentrations

Facility	Parameter	30-day Avg. TP Limit (mg/L) or Daily Maximum TIN Limit (mg/L)	Reporting Requirements	Maximum Reported Value (mg/L)	Met Permit Limits? (Yes/no)	
					TP	TIN
Arapahoe County Water & Wastewater Authority	TP	≤ 0.05 (30-day avg) Discharges to Lone Tree Creek.	Monthly	0.036 (30-day avg)	Yes	
	TIN	No Limit or Reporting Requirement.	--	--		***
Pinery Water & Sanitation District	TP	≤ 0.05 (30-day avg) (Outfall 002A: Discharges to Cherry Creek)	Monthly	0.04 (30-day avg)	Yes	
	TIN	10 (daily max) (Outfall 002A: Discharges to Cherry Creek)	2 Days/Month	9.34 (daily max)		Yes
Parker Water & Sanitation District	TP	≤ 0.05 (30-day avg) (Outfall 002A-NT: Combined North & South WRFs Discharge to Regional Reservoir)	2 Days/Month	0.04 (30-day avg)	Yes	
		≤ 0.05 (30-day avg) (Outfall 003A: Combined North and South WRFs Discharge to Sulfur Gulch)	2 Days/Month	0.04 (30-day avg)	Yes	
		10 (daily max) (Outfall 002A-NT: Combined North and South WRFs Discharge to Regional Reservoir)	3 Days/Week	6.7 (daily max)		Yes
Meridian Metropolitan District	TIN	10 (daily max) (Outfall 003A: Combined North and South WRFs Discharge to Sulfur Gulch)	3 Days/Week	8.07 (daily max)		Yes
		≤ 0.5 * (90-day avg) ** Land Application.	Quarterly	no 30-day reporting requirements in Notice of Authorization **	Yes	
Stonegate Village Metropolitan District	TIN	No Limit or Reporting Requirement	--	--		***
	TP	≤ 0.25* (30-day avg) (Outfall 001A: Discharges to storage)	Monthly	0.14 (30-day avg)	Yes	
		≤ 0.05 (30-day avg) (Outfall 002A: Discharges to Cherry Creek)	Monthly	0.04 (30-day avg)	Yes	
TIN	10 (daily max) (Outfall 002A: Discharges to Cherry Creek)	2 Days/Month	9.08 (daily max)		Yes	
Plum Creek Water Reclamation Authority	TP	≤ 0.05 (30-day avg) (Outfall 007A: Cherry Creek Basin)	Monthly	0.03 (30-day avg)	Yes	
	TIN	No Limit or Reporting Requirement	--	--		***

\* The flow-weighted average phosphorus concentration must be ≤ 0.05 mg/L TP, divided by the land application return flow factor.

\*\* TP limit is a 30-day average, unless a 90-day average is approved by the Division at the request of the discharger.

\*\*\* No TIN permit limit

## Approved Site Location Applications

As the designated regional water quality management agency for the Cherry Creek Reservoir watershed, the Authority reviews site applications for domestic wastewater treatment works, including WWTFs and lift stations. Application reviews address protection of Cherry Creek Reservoir and the watershed with respect to phosphorus and nitrogen, general water quality, protection of downstream water quality to protect water supplies, and adequacy of proposed design processes and capacity to protect water quality. As required by Regulation 72, the Authority must report annually on approved site applications. In 2017, only one site application was received by the Authority.

The [Happy Canyon Interceptor Sewer](#) will convey future

wastewater flows from the RidgeGate development to the First Street Lift Station. The interceptor sewer crosses Happy Canyon Creek at one location. The preliminary construction plans show the interceptor sewer installed within a casing pipe with all pipe joints restrained.

Additionally, the interceptor sewer crosses the floodplain in one location. At this location the pipe is encased in concrete.

Parker Water and Sanitation District will own and operate the system following construction and acceptance of the force main. The Emergency Response Plan (an additional regulation of the Authority) includes a list of personnel roles and emergency notifications / response procedures and how they are to be managed and completed.

### RidgeGate Happy Canyon Interceptor Sewer Site Application



**STATUS**  
Board Approved 1/18/2018

**APPLICANT**  
Parker Water and Sanitation District (PWSD)

**OWNER**  
PWSD

Control requirements for point source dischargers were effective in reducing phosphorus concentrations to the watershed and reservoir.



# What's New with Our MS4s in 2017

All MS4s in the watershed have adopted stormwater regulations that set water quality requirements, consistent with [Regulation 72](#), for construction and post-construction of new development and redevelopment projects within their jurisdictions

The following table summarizes the 2017 stormwater permits, inspections, and enforcement actions for construction and post-construction development. Further information on each MS4's program can be found in their annual reports, due to the Division on March 10 (Phase II MS4s) and April 1 (Phase I MS4s).

Land Use Agency	Construction Sites		Construction BMPs			Permanent BMPs	
	Total Sites	Number of Inspections	Number of Enforcement Actions	Number of BMPs (or BMP Sites Constructed)	Number of Inspections	Number of Enforcement Actions	
Arapahoe County							
Douglas County	1,338	10,428	332	2 (New)	53 (Total for all BMPs, new and existing)	26 (Total for all BMPs, new and existing)	
City of Aurora	69	761	37	0	6	0	
SEMSWA (City of Centennial)							
City of Greenwood Village							
City of Lone Tree	9	128	3	0	0	0	
City of Castle Pines	6	31	0	3	3	0	
Town of Castle Rock							
Town of Parker	124	1370	63	26	322	0	
CDOT	1 Arapahoe/Cherry Creek	12 (Completed Sites)	0	0	0	0	

## MS4 Public Information & Education

**Aurora Youth Water Festival:** Held every May, this event is a free one-day festival for 5th graders at the Community College of Aurora. Aurora Water helps these students learn about water through fun hands-on activities and exhibits. Aurora Water also continued their program "Forests to Faucets", a free three-day workshop for educators who can earn 1.5 semester hours of K-12 graduate/recertification.

**Arapahoe County SPLASH Education and Outreach Program:** This program teaches community members how local actions can impact stormwater and water pollution. The SPLASH program prepares educational materials such as flyers, soil test kits, and other ways community members can help reduce excess nutrients (nitrogen and phosphorus) from entering the Cherry Creek Reservoir.

**Parker Water and Sanitation District continued to partner with Tagawa Gardens** to offer free community workshops on ways to introduce drought-tolerant landscaping that can save water and reduce water bills.

Parker Water and Sanitation District has completed the master plan for Rueter-Hess Reservoir, which will serve as storage, and a source of clean drinking water as well as provide recreational opportunities.

**SEMWASA Staff** are involved with numerous varied outreach activities that strengthen the connection between people and their watershed.



# Data Portal

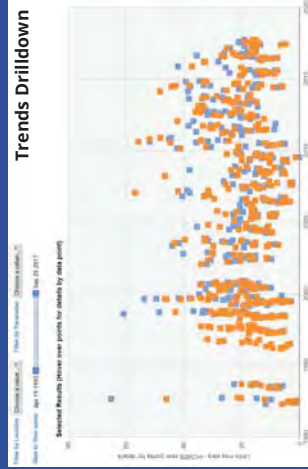
Over the last 25 years, the Authority has developed an expansive water quality dataset throughout the Cherry Creek Basin. Working with large datasets and parsing out the stories they have to tell can be a tall order, requiring expertise and large investments of time. Recognizing these complexities, the Authority sought to develop an interactive online data portal that allows users to easily explore water quality throughout the basin.

The Portal is a secure online data exploration platform that can be accessed from any web browser and is found at <http://ccbqwportal.org/>. See next page for instructions on obtaining a login.

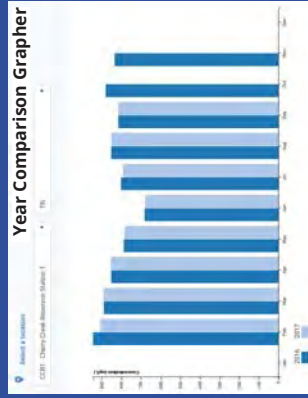
Available tools for the Portal match questions identified for exploration throughout the watershed. Users can dive into the data and explore relationships between parameters and locations, compare changes in water quality data seasonally over many years, and discern correlation between parameters. Users can also export data from the portal through the data download tool.

## What Questions Can Be Explored?

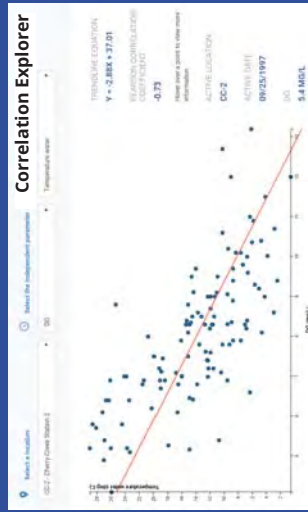
A variety of questions can be explored through the storyboards provided on the Portal. The storyboards are a set of tools designed to answer specific questions regarding water quality throughout the Cherry Creek Basin.



Easily explore water quality data throughout the Basin using the Data Explorer page. Visualize individual sampling results through graphs and tables to learn more about water quality throughout the basin.



Use the Year Comparison Grapher tool to select a location and parameter and explore how water quality has changed over the years. Easily compare year-to-year changes in water quality throughout the basin on a monthly basis.



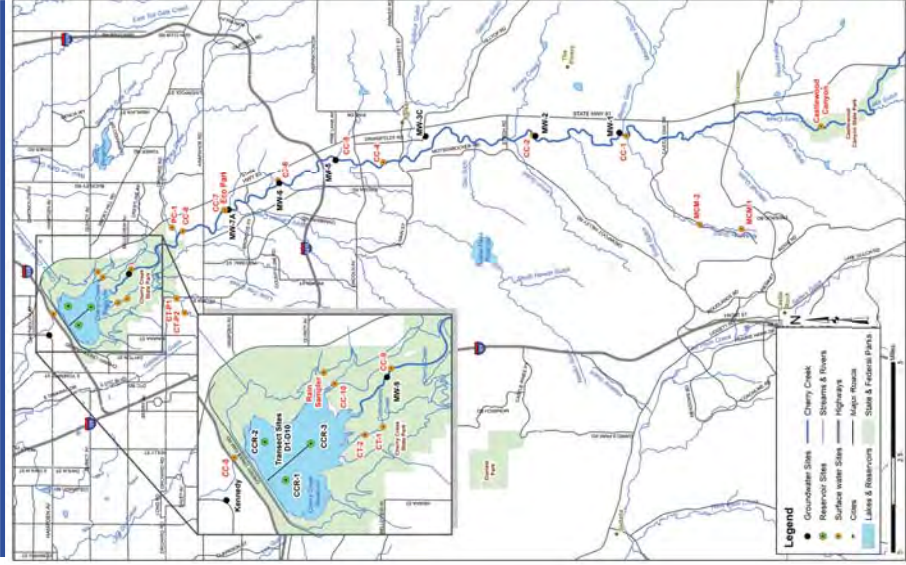
Curious how two parameters might be related to one another? Use the Correlation Explorer to plot any two parameters against each other for a selected location and view the results in the graph.

# 2017 Monitoring Results

In accordance with Regulation 72, the Authority has implemented a water quality monitoring program in both the watershed and the reservoir to characterize water quality of inflows and of the Reservoir to determine regulatory compliance.

- Surface water, groundwater, reservoir, and precipitation are sampled at 26 sampling locations.
- Over 2,700 lab analyses are completed annually.
- The data are used to evaluate attainment of water quality goals, compliance with water quality standards, and to characterize water quality trends.

The Authority's monitoring program is conducted in accordance with Cherry Creek Reservoir Control Regulation No. 72 and the Cherry Creek Sampling and Analysis Program and Quality Assurance Procedures and Protocols.



[Click Here](#)



## What Data is Available Through the Portal?

### Monitoring Areas

- Cherry Creek
- Physical Parameters
- Hydrology
- Cherry Creek Reservoir
- Shoop Creek
- Monitoring Wells
- Cherry Creek Reservoir Sediment Sites

### Parameter Groups

- Nutrients, Algae and Bacteria
- Physical Parameters
- Hydrology
- Chemistry
- Sediments
- Radioactivity

Links to the Portal are included in the following pages; we invite you to explore the data yourself! To obtain a portal login, email your request to [CCBWQportal@gmail.com](mailto:CCBWQportal@gmail.com)

# 2017 Regulatory Results

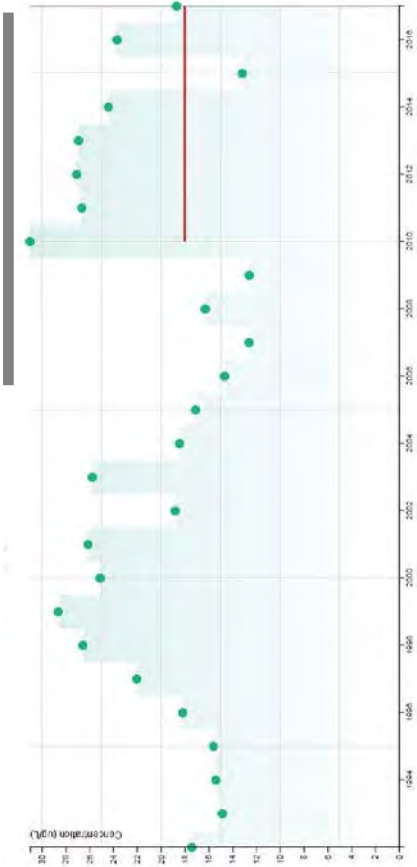
## Water Quality Standards Compliance

In WY2017, the [temperature](#) and [pH](#) reservoir standards were met. Chlorophyll  $\alpha$  and dissolved oxygen standards were not achieved.

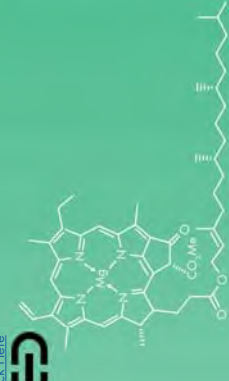
## Chlorophyll $\alpha$

The seasonal average [chlorophyll  \$\alpha\$](#)  in 2017 was 18.8  $\mu\text{g/L}$ , exceeding the water quality standard of 18  $\mu\text{g/L}$ . The seasonal mean concentration is measured in the upper three meters of the water column (photic zone), with an allowable exceedance frequency of once in five years. The reservoir has exceeded the chlorophyll  $\alpha$  standard in four of the last five years.

**Seasonal Mean Concentrations of Chlorophyll  $\alpha$  Measured in Cherry Creek Reservoir**



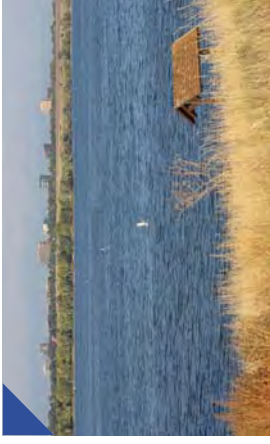
[Click Here](#)



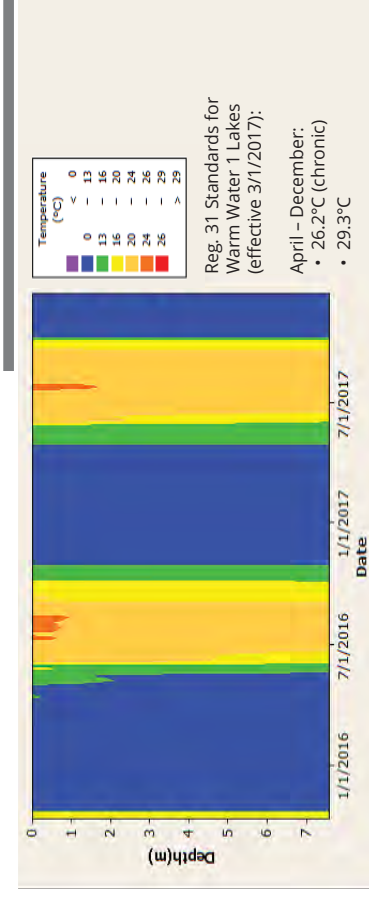
Explore Chlorophyll- $\alpha$  levels throughout the reservoir and understand annual and seasonal trends. Use the seasonal trends tool to compare seasonal mean concentrations in the reservoir to the water quality standard. For a deeper dive, use the CCR Drilldown tool to investigate individual sampling events at all three reservoir sites.

## Dissolved Oxygen (DO)

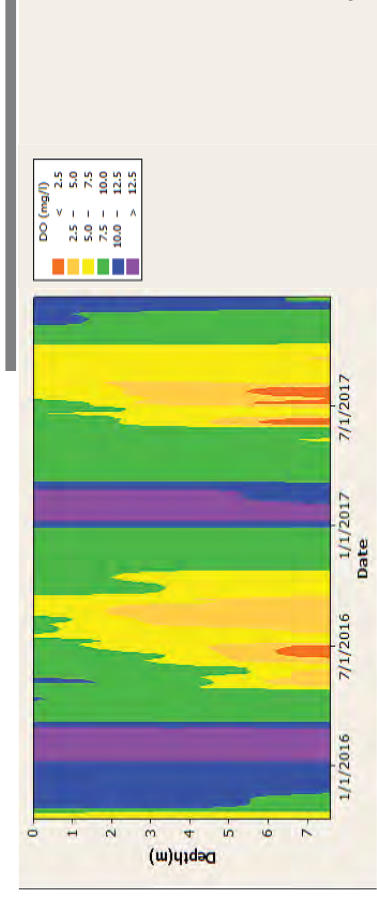
The data showed that DO concentrations were above the standard of 5.0  $\text{mg/L}$  throughout the majority of the time in the top layers of the reservoir; however, an average value of 4.62  $\text{mg/L}$  was observed on August 8th at CCR-1. Average same-day oxygen levels at CCR-2 and CCR-3 were 5.08  $\text{mg/L}$  and 5.32  $\text{mg/L}$ , respectively, which met the standard.



**Temperature at CCR-2**



**Dissolved Oxygen at CCR-2**





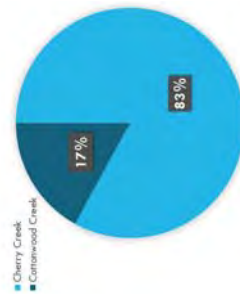
## Flow Data

In WY2017, higher than normal [streamflow](#) was measured in Cherry Creek. For example, at the USGS gage near Parker, located approximately 9 miles upstream of the Cherry Creek Reservoir, WY2017 flows totaled 11,052 ac-ft, with an average daily discharge rate of 15.3 cfs. This is approximately 37 percent higher than the long-term (WY1992-WY2017) average daily rate of 11.1 cfs.

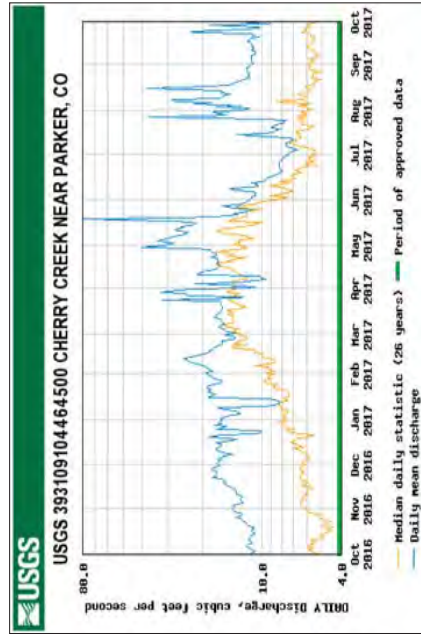
Compare this to the Authority's continuous recording gage at site CC-10, just upstream of the reservoir on Cherry

Creek, where WY2017 flows totaled 17,362 ac-ft, with an average daily discharge rate of 24.0 cfs. These values are approximately 57 percent greater than those observed at the USGS gage near Parker.

The Authority also operates continuous recording equipment on Cottonwood Creek. WY2017 flows at site located just upstream of the reservoir, CT-2, totaled 3,431 ac-ft, with an average daily discharge rate of 4.7 cfs.



Cherry Creek contributes the majority of surface water into the reservoir.



Visualize changes in streamflow over time at three different locations along Cherry Creek.

Locations: Near Franktown, CCR, Below CCR

## Nutrient Inputs to Reservoir

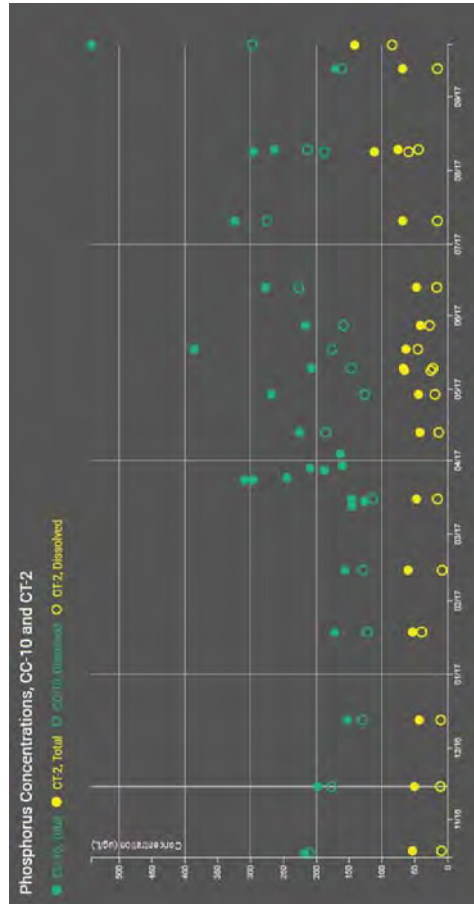
### Surface Water Quality

**Phosphorus** at the mouth of Cherry Creek was mostly dissolved, except during storm-related high flows when large amounts of sediment (and associated phosphorus) were transported in Cherry Creek.

The flow-weighted TP concentration at CC-10 for WY2017 was 229 µg/L, which was lower than concentrations during the previous 8 years, which ranged between 231 µg/L and 276 µg/L.

The WY2017 flow-weighted average concentration for Cherry Creek station CC-10 remains much higher than the WY2017 flow weighted total phosphorus concentration of 62.2 µg/L calculated for station CT-2 in lower Cottonwood Creek.

The level of phosphorus is lower in Cottonwood Creek than in Cherry Creek in WY2017, but concentrations of nitrogen measured at CT-2 in lower Cottonwood Creek in WY2017 were higher than that observed in Cherry Creek.



CT-2 Cottonwood Creek before it enters the Reservoir

CC-10 Cherry Creek before it enters the Reservoir

Explore Nutrient levels in both Cottonwood Creek and Cherry Creek right before they enter the reservoir.

## Long-term Watershed Input Trends

In 2009, the Commission adopted a [concentration-based management strategy](#) for phosphorus control in the Cherry Creek Basin. The goal is to achieve an average flow-weighted phosphorus at or below 200 µg/L for all inflows to the reservoir. The 200 µg/L value was determined by the Authority and the Commission to be the background concentration for phosphorus in the basin.

## Cottonwood and Cherry Creek

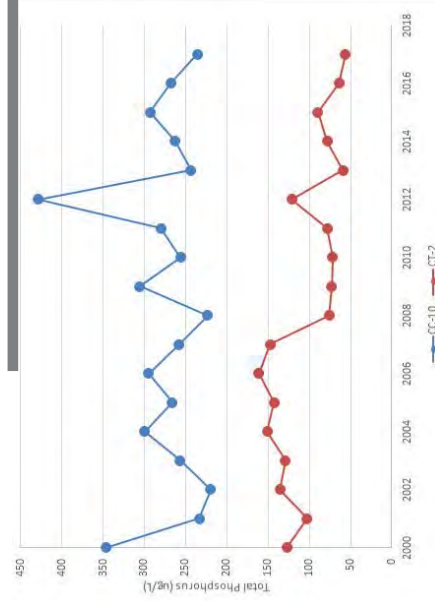
The average TP concentration at CC-10 during WY2017 was 233 µg/L, 10% less than the WY2016 TP average of 256 µg/L. During the period 2000-2017, [Cottonwood Creek](#) TP concentrations measured just upstream of the reservoir at CT-2 are approximately ¼ of the average TP measured in Cherry Creek.

Since 2008, when the Cottonwood PRFs were completed, the CT-2 station demonstrates a decreasing trend in TP concentration, showing the effectiveness of the PRFs and projects of others. During the last 17 years, the Cherry Creek site CC-10 trend does not appear to decrease or increase over time.

**Concentration-Based Control of Phosphorus** means the flow-weighted concentration of total phosphorus in the inflow to Cherry Creek Reservoir that is intended to result in the attainment of water quality standards for Cherry Creek Reservoir.

**Flow-weighted Phosphorus Concentrations** means the total external load, including precipitation, groundwater, stream flow, and ungaged runoff, divided by total inflow volume.

## Concentrations of Total Phosphorus Over Time in Cherry Creek and Cottonwood Creek



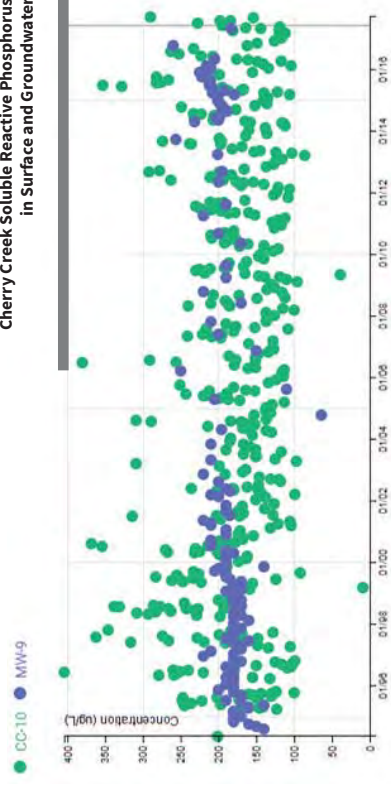
[Click Here](#)

Visualize changes in water quality over time using the year comparison grapher.

## Groundwater vs Surface Water Long-term Watershed Inputs to Reservoir

Long-term concentrations of total phosphorus in the alluvial inflow (MW-9) to Cherry Creek Reservoir are more stable than surface water inflows (CC-10). Note that the alluvial groundwater concentrations consistently hover around the 200 µg/L background phosphorus level.

### Cherry Creek Soluble Reactive Phosphorus in Surface and Groundwater



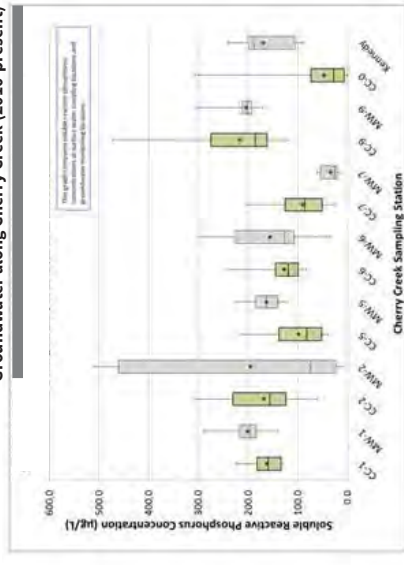
## Cherry Creek Surface and Groundwater

### Median soluble reactive phosphorus

(SRP) levels in the Cherry Creek alluvial groundwater (2010–present) were generally similar to median concentrations observed in nearby Cherry Creek surface water.

The Cherry Creek alluvial SRP data support the TP trend observed in WY2017. Upstream of the reservoir, the median SRP levels (the horizontal line located in rectangle of each box and whisker plot) in the alluvial groundwater were generally similar to median concentrations observed in nearby surface water.

### Soluble Reactive Phosphorus in Surface Water and Groundwater along Cherry Creek (2010–present)

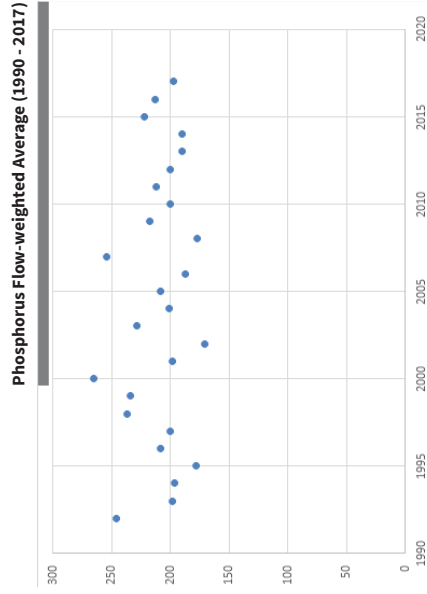


[Click Here](#)

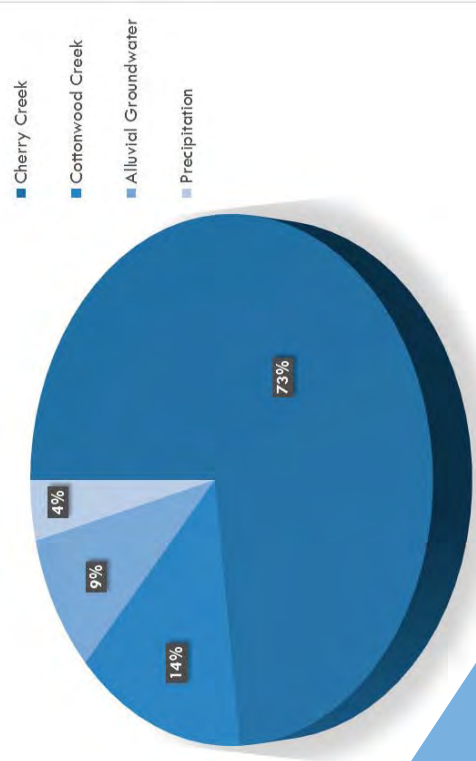
Discover the relationship between surface water and groundwater by exploring nutrient concentrations at Cherry Creek surface water sampling sites and monitoring wells.

## Flow Weighted Concentrations from All Reservoir Inputs

The overall WY2017 [flow-weighted TP\\_inflow concentration](#) was 197 µg/L. This includes inputs from Cherry Creek, Cottonwood Creek, alluvial groundwater, and precipitation. This is very close to the long-term median of 201 µg/L.



**Relative Contribution of Cherry Creek Inflows to Reservoir Phosphorus Balance in WY2017**



# 2017 Reservoir Highlights

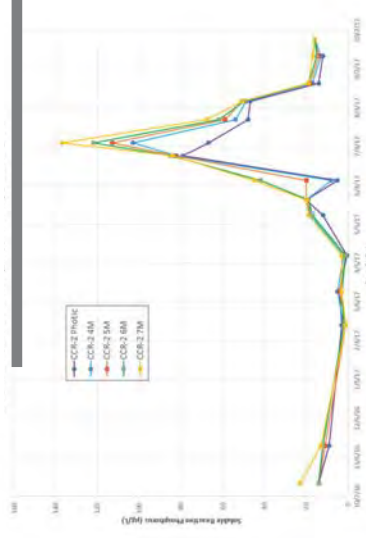


## Flow and Nutrients

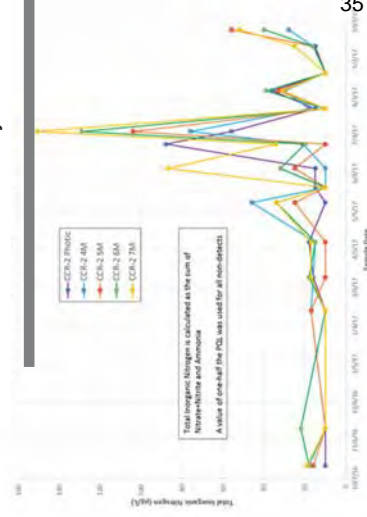
**Increased flushing rate benefitted the reservoir's water quality in 2017.** The US Army Corps of Engineers operates Cherry Creek Reservoir for flood control purposes. The higher 2017 inflows from the Cherry Creek watershed resulted in a higher-than-average annual pass-through volume from the reservoir outlet works, an average of 28.6 cfs, or approximately 20,700 acre-feet. This was three times the 56-year average daily discharge of 9.2 cfs. The increased flushing rate of the reservoir helped water quality improve in WY2017.

While the reservoir continued to retain much more phosphorus and nitrogen on a mass basis than it was flushing, the increased flush in the outflow provided an improvement that would have otherwise resulted in greater water quality impacts to the reservoir.

**WY 2017 Soluble Reactive Phosphorus in Cherry Creek Reservoir**



**WY 2017 Total Inorganic Nitrogen in Cherry Creek Reservoir**



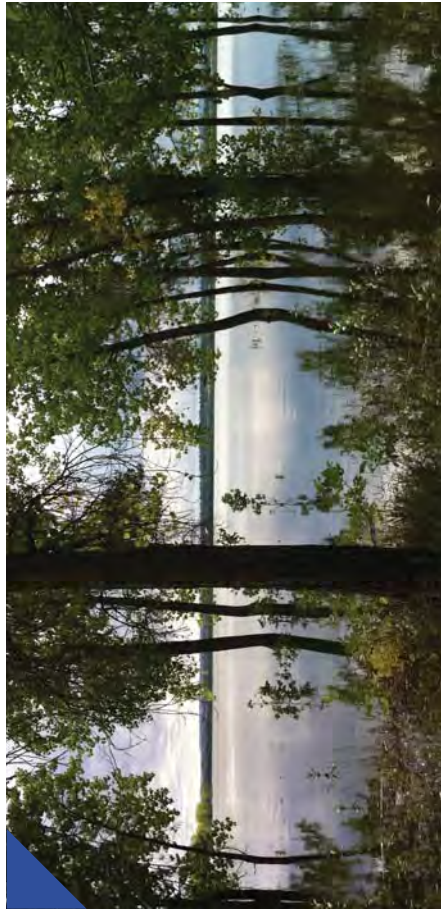
## Phytoplankton and Zooplankton Data

In WY2017, there were no harmful algal blooms observed in the reservoir. The Authority works in close coordination with Colorado Parks and Wildlife to protect recreational and aquatic life uses in the reservoir.

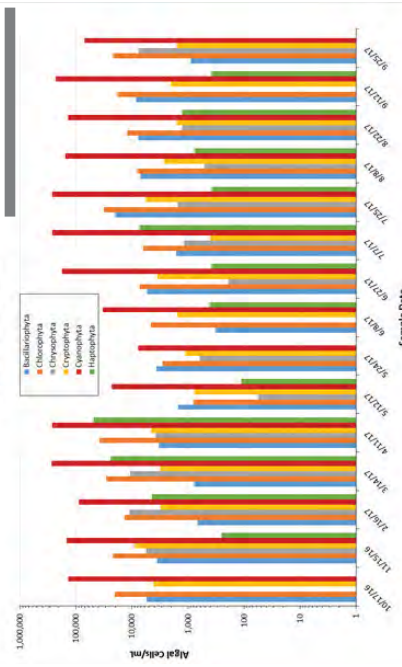
**Phytoplankton and zooplankton data indicated an over-productive and nutrient-rich reservoir.** The reservoir continued to exhibit characteristics of an over-productive, nutrient-rich waterbody as indicated by WY2017 planktonic communities. The phytoplankton taxa of biggest concern included an abundance of Cyanophyta ("blue-green algae", depicted in red) and Chlorophyta ("green algae", depicted in orange).

Cell concentrations in excess of 100,000 cells/mL for blue-green algae and over 10,000 cells/mL for green algae can cause water quality issues in the reservoir throughout the summer, including elevated chlorophyll a concentrations.

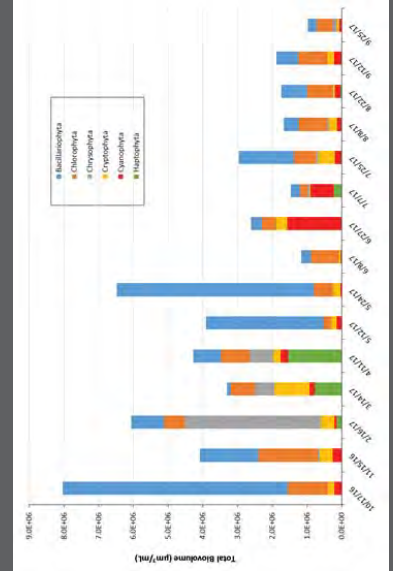
The best water quality conditions were observed in the reservoir in early June, as reflected in the plankton data, as well as low concentrations of chlorophyll a and TP, as well as greater water clarity. This was following a period of higher than normal precipitation and resultant increased reservoir inflow and releases and during a period of destratification system operation.



Algal Cell Concentrations



## Algal Total Biovolumes



**Algal biomass in WY2017 was dominated by diatoms and green algae.** Chlorophyta ("green algae", depicted in orange) and Bacillariophyta ("diatoms", in blue) were dominant, although different phytoplankton briefly dominated the community. A significant amount of biomass energy from phytoplankton and bacteria was also stored in the sediments as organic carbon, which contributed to excess nutrient production during this timeframe.

### BACILLARIOPHYTA "DIATOMS"

**PERIOD OF OCCURRENCE, ECOLOGICAL BENEFITS AND/OR STRESSORS**

- Typically the first algae to bloom in early spring; when nutrients and light conditions in upper mixed layer are right, their growth rate allows them to dominate phytoplankton
- Important contributors to the food chain; food resource for zooplankton
- Freshwater diatoms commonly observed in reservoir are indicators of eutrophic (over-enriched) conditions; their degradation contributes to increased oxygen demand and phosphorus recycling

### CHLOROPHYTA "GREEN ALGAE"

**PERIOD OF OCCURRENCE, ECOLOGICAL BENEFITS AND/OR STRESSORS**

- Appear during periods of high nutrient concentrations; indicates both nitrogen and phosphorus are in excess supply
- Colonial and single-celled greens are a good food source for zooplankton
- Filamentous and large colonial greens do not add to food web, and create water quality problems

### CYANOPHYTA ("CYANOBACTERIA") "BLUE-GREEN ALGAE"

**PERIOD OF OCCURRENCE, ECOLOGICAL BENEFITS AND/OR STRESSORS**

- Over-abundant enrichment and with very high nutrient levels, especially phosphorus
- Do not contribute greatly to food web; few people view cyanobacteria as beneficial organisms in a lake
- Create water quality problems; e.g., oxygen depletion when excessive growth produces blooms
- Some species may produce cyanotoxins under certain conditions

### CRYPTOPHYTES "CRYPTOMONADS"

**PERIOD OF OCCURRENCE, ECOLOGICAL BENEFITS AND/OR STRESSORS**

- Cryptophytes can live through the winter, under ice-cover and with little solar radiation for photosynthesis
- Important food for zooplankton; zooplankton, in turn, are food for fish and other organisms in food web

**Zooplankton.** A generally higher Daphnid biomass was present in May and June, and again in August and September, indicating this preferred fish food was available and abundant for the fishery.

**DAPHNIDS  
"WATER FLEA" - DAPHNIA"**

**BOSMINIDS**

**PERIOD OF OCCURRENCE, ECOLOGICAL BENEFITS AND/OR STRESSORS**

- Historically conditions are ideal for Daphnids around the early June timeframe
- These are the most effective phytoplankton harvesters and food source for fish
- Excellent zooplankton that play a significant role in the food web as major source of oils and proteins for fish
- Large in size and preferred fish food (over 10 times the size of Bosminids)

**PERIOD OF OCCURRENCE, ECOLOGICAL BENEFITS AND/OR STRESSORS**

- High percentage of Bosminids indicates that Cryptophytes and single-celled chlorophytes are the major algal food base
- Provides food base, but because of their small size, not a preferred food source
- This indicates that most of the primary production is not being used by higher aquatic biota and hence contributes to over-enrichment of reservoir

# Key Takeaways 2017

**Reservoir Model**

- Will use this tool to investigate which strategies and activities will best improve the reservoir

**Riparian and Wetlands**

- Critical for stormwater management
- In-park wetlands work well as final step in water quality improvement

**Public Education**

- Partners engaged over 6000 participants to promote the watershed's natural resources
- Educating the new generation of citizen stewards is key

**Municipal Separate Storm Sewer Systems (MS4s)**

- Expanding upon past work done by Authority
- Advancements make it easier and more cost-effective to implement meaningful water quality controls

**Pollutant Reduction Facilities (PRFs)**

- Cottonwood Creek treatment train is the best-performing PRF; we strive to match this in the entire basin
- Annual maintenance keeps PRFs working
- PRFs improve stream health and reduce sediment and nutrient loads

**Watershed Model**

- Watershed model will better predict reservoir contributions of nutrients from various watershed sources
- Data inputs to reservoir model

**Point Source WWTFs**

- WWTFs are doing a good job at removing pollutants while meeting some of the lowest phosphorus limits in the State

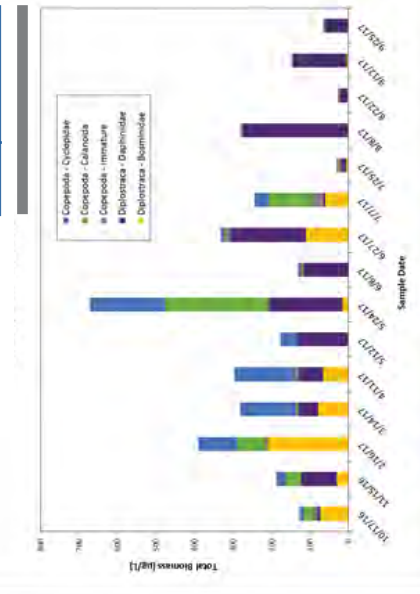
**Upgrades to Authority Water Quality Data Portal**

- Choose your own adventure using the flexible tools and focused storyboards on the Authority's data portal to investigate and answer questions

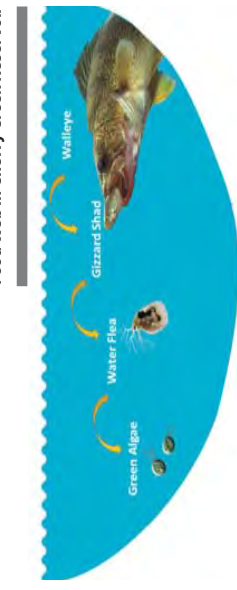
**Monitoring Program**

- Rigorous and comprehensive monitoring program contributes to the 25-year warehouse of watershed information
- Next-generation monitoring on the horizon
- Reservoir was very close to achieving compliance for chlorophyll a and TP in 2017

**Total Zooplankton Biomass**



**Food Web in Cherry Creek Reservoir**



**Gizzard Shad** have the potential to be a keystone species in Cherry Creek Reservoir. They are likely an important food source for walleye, but they also have the ability to limit walleye recruitment, and worsen water quality by depleting zooplankton grazers and recycling sediment nutrients.

**Walleye.** Cherry Creek Reservoir is a high-quality walleye fishery, and one of the top producers of walleye eggs in the State. Understanding fluctuations in fish populations is important from a recreational fishery perspective and also as it relates to interpretation of zooplankton, phytoplankton, and general water quality response. A 2014 study concluded that, during the preceding 40-year period, the walleye population in Cherry Creek Reservoir appears to have been quite strong. Growth was good, body condition was very good, medium and large size fish were always present, and recruitment was consistent.

# List of Abbreviations and Acronyms

WY2017	Water Year 2017	CCR	Cherry Creek Reservoir
Authority	Cherry Creek Basin Water Quality Authority	DO	Dissolved Oxygen
Board	Authority's Board of Directors	mg/L	Milligram per Liter
TAC	Technical Advisory Committee	µg/L	Micrograms per Liter
CPW	Colorado Parks and Wildlife	NO <sub>3</sub>	Nitrate
SEMSWA	Southeast Metro Stormwater Authority	NH <sub>4</sub>	Ammonia
UDFCD	Urban Drainage and Flood Control District	PO <sub>4</sub>	Orthophosphate
TCHD	Tri-County Health Department	WWTF	Wastewater Treatment Facility
Commission	Water Quality Control Commission	TP	Total Phosphorus
PRF	Pollutant Reduction Facility	TIN	Total Inorganic Nitrogen
BMP	Best Management Practices	IGA	Intergovernmental Agreement
OWTS	On-site Wastewater Treatment System	CCSP	Cherry Creek Stewardship Partners
Division	Water Quality Control Division	SRP	Soluble Reactive Phosphorus
M54	Municipal Separate Storm Sewer System	HAB	Harmful Algae Bloom
CIP	Capital Improvement Program	cfs	Cubic Feet per Second

## Key Links

- [Statute Regulation 72](#)
- [Annual Monitoring Report](#)







Cherry Creek Basin Water Quality Authority  
8390 East Crescent Parkway, Suite 500  
Greenwood Village, Colorado 80111  
303.779.4525  
cherrycreekbasin.org

Nancy Sharpe  
Arapahoe County

TO: Colorado Water Quality Control Commission

Lora Thomas  
Douglas County

FROM: Cherry Creek Basin Water Quality Authority

Francoise Bergan  
City of Aurora

SUBJECT: Triennial Review Informational Hearing for Regulation #72 – Cherry Creek Reservoir Control Regulation – Recommendations of CCBWQA

George Teal  
Town of Castle Rock

DATE: March 15, 2018

Stephanie Piko  
City of Centennial

The Cherry Creek Basin Water Quality Authority (Authority) is hereby submitting its recommendations for the May 7, 2018 Triennial Review Informational Hearing for Regulation #72 (5 CCR 1002-72), the “Cherry Creek Reservoir Control Regulation”, for consideration by the Water Quality Control Commission. **As discussed further below, the Authority recommends that in this review cycle Regulation 72 be continued without change in its current form.**

Judy Hilton  
Greenwood Village

Susan Squyer  
City of Lone Tree

Joshua Rivero  
Town of Parker

The Authority operates pursuant to the provisions of Title 25, Article 8.5, Colorado Revised Statutes and is charged with the responsibility for preserving, protecting, and enhancing the water quality in Cherry Creek and Cherry Creek Reservoir. Since its inception, the Authority has been involved in the regulation of nutrients pursuant to its Control Regulation #72.

Pieter Van Ry  
Special Districts

Ron Weidmann  
Governor’s Appointee

Myrna Poticha  
Governor’s Appointee

Pursuant to its Statute, the Authority is also authorized to “develop and implement, with such revisions as become necessary in light of changing conditions, plans for water quality controls for the reservoir, applicable drainage basin, waters, and watershed to achieve and maintain the water quality standards” (CRS 25-8.5-111(1)(a)).

Roger Kilgore  
Governor’s Appointee

John A. McCarty  
Governor’s Appointee

Alan Milan Vajda  
Governor’s Appointee

As noted in our most recent Annual Report on Activities, which was submitted to the Commission on March 31, 2018 in compliance with Regulation #72, the chlorophyll  $\alpha$  standard was exceeded in Cherry Creek Reservoir in 2017. The 2017 seasonal average was 18.8  $\mu\text{g/L}$ , which is just above the standard of 18.0  $\mu\text{g/L}$ . There is an allowed exceedance frequency of once in five years; the standard has now been exceeded in four of the past five years. As discussed in the Annual Report, the Authority is currently evaluating water quality controls and measures needed to achieve the standard.

Christopher Lewis  
Governor’s Appointee

John Woodling  
Governor’s Appointee



Specifically, in 2017, the Authority completed a two-dimensional hydrodynamic and water quality model of Cherry Creek Reservoir, and has used it to evaluate potential watershed and in-reservoir management scenarios to identify which schemes could potentially be implemented to achieve the water quality standard. The Authority also is currently developing a watershed model to better quantify nutrient loadings from multiple land uses and sources within the Cherry Creek watershed, under both current conditions and after the addition of future pollutant reduction facilities and other best management practices. This model will also incorporate the impacts of instream and alluvial processes that affect pollutant loadings to the reservoir. The watershed model inputs will serve as more refined boundary conditions for the reservoir model.

The Authority anticipates that the watershed model will be completed in 2018. Next steps, likely in 2019, will include linking of the two models to enable and improve prediction of which management scenario(s) could be used to achieve the standard. Results of this exercise are anticipated to be available in time for the currently-scheduled June 2020 South Platte (Regulation #38) water quality standards rulemaking hearing.

Therefore, the Authority recommends that in this review cycle the Commission continue Regulation #72 in its current form, and set the next triennial review for Regulation #72 in 2021, after the above steps are completed.

## **AS NEEDED CONSULTING SERVICES AGREEMENT**

**THIS AS NEEDED CONSULTING SERVICES AGREEMENT** (“Agreement”) is entered into as of the 15<sup>th</sup> day of March 2018, to be effective as of January 1, 2018, between the **CHERRY CREEK BASIN WATER QUALITY AUTHORITY**, a quasi-municipal corporation and political subdivision of the State of Colorado (“Authority”), whose address is c/o CliftonLarsonAllen, LLP, 8390 Crescent Parkway, Suite 500, Greenwood Village, Colorado 80111, and **HYDROS CONSULTING INC.**, a Colorado corporation (“Consultant”), whose address is 1628 Walnut Street, Boulder, Colorado 80302, telephone number 303-284-1841. Consultant and Authority may hereinafter singularly be referred to as a “Party” and collectively as the “Parties.”

### **RECITALS**

**WHEREAS**, the Authority was established for the purpose of preserving, protecting and enhancing the water quality in the Cherry Creek Reservoir (“Reservoir”) and the Cherry Creek Watershed (“Watershed”); and

**WHEREAS**, Consultant has worked with and developed for Authority a comprehensive water-quality model for the Reservoir (“Reservoir Model”), pursuant to an agreement dated to be effective August 12, 2013, as amended (“Reservoir Model Agreement”); and

**WHEREAS**, at times, questions arise with respect to the Reservoir and the Reservoir Model that Consultant is uniquely qualified to address; and

**WHEREAS**, separate and apart from the Reservoir Model Agreement and Consultants obligations thereunder, Authority desires to confer with Consultant from time to time for the purpose of obtaining advice and information with respect to the Reservoir Model and Reservoir management issues; and

**WHEREAS**, Consultant is willing to consult with Authority on an as needed basis from time to time and Authority is willing to utilize Consultant for that purpose, upon the terms and conditions hereinafter set forth.

**NOW, THEREFORE**, in consideration of the promises set forth herein, Authority and Consultant agree as follows:

1. **Scope of Services.** Consultant agrees to make its representatives, including, but not limited to, Jean Marie Boyer available to assist Authority and Authority’s consultants in answering questions and providing information with respect to management scenarios and other questions that are related to the Reservoir Model and the Reservoir.

2. **Authorization to Provide Services.** Any services that Consultant is requested to perform by any Authority consultants other than Chuck Reid, the Authority's ("Administrator") must be approved in advance by the Administrator who may authorize such services either verbally or in writing. Services requested from Consultant, which Consultant reasonably believes will entail less than \$500 in billable time for any particular request may be performed by Consultant without obtaining the prior approval of the Administrator, but the Administrator will be notified of the request as soon as is reasonably practical and in no event later than three (3) days after the request has been submitted.

3. **Compensation.** For the services performed for Authority during the Term of this Agreement, Consultant shall be compensated in accordance with Consultant's 2017 fee schedule, a copy of which is attached hereto as Exhibit A and incorporated herein by this reference, and to which Consultant has agreed to use for 2018 services. Notwithstanding any other provision contained herein to the contrary, total compensation for services provided by Consultant under this Agreement shall not exceed \$15,000 without the Authority's Board of Directors prior express written consent.

4. **Separate Agreement.** This Agreement is a new agreement that is being entered into between the Authority and Consultant and is in addition to the Reservoir Model Agreement. Services chargeable to and/or authorized under the Reservoir Model Agreement shall not be charged to or performed under this Agreement. Nothing contained in this Agreement shall be deemed to modify or anyway amend or supersede the existing Reservoir Model Agreement.

5. **Binding Effect.** This Agreement shall be binding upon and inure to the benefit of the Parties hereto and their respective successors and assigns.

6. **Severability.** In the event any one of more of the provisions of this Agreement shall for any reason be held to be invalid or unenforceable, the remaining provisions of this Agreement shall be unimpaired, and shall remain in full force and effect and shall be binding upon the Parties hereto.

7. **Compliance with Laws.** In performing this Agreement, Consultant shall comply with all applicable laws, rules and regulations, including but not limited to all federal, state and local laws. By way of explanation and not limitation, Consultant certifies that Consultant shall comply with the provisions of § 8-17.5-101, *et seq.*, C.R.S. Consultant shall not knowingly employ or contract with an illegal alien to perform Services under this Agreement, or enter into a contract with a subconsultant or subcontractor that knowingly employs or contracts with an illegal alien. Consultant represents, warrants and agrees that: (i) it has confirmed the employment eligibility of all employees who are newly hired for employment to perform Service under this Agreement through participation in either the E-Verify Program or the Department Program described in § 8-17.5-101, C.R.S. Consultant shall not use either the E-Verify

Program or the Department Program procedures to undertake pre-employment screening of job applicants while this Agreement is being performed. If the Consultant obtains actual knowledge that a subconsultant performing Services under this Agreement knowingly employs or contracts with an illegal alien, the Consultant shall: (i) notify the subconsultant and Authority within three (3) days that Consultant has actual knowledge that the subconsultant is employing or contracting with an illegal alien; (ii) terminate the subcontract with the subconsultant if within three (3) days of receiving such notice, the subconsultant does not stop employing or contracting with the illegal alien, unless the subconsultant provides information to establish that the subconsultant has not knowingly employing or contracting with an illegal alien. Consultant shall comply with all reasonable requests made in the course of an investigation by the Colorado Department of Labor and Employment. If Consultant fails to comply with any requirement of § 817.5-102(2), C.R.S., the Authority may terminate this Agreement for breach, and Consultant shall be liable for actual damages to Authority. If the Consultant participates in the Department Program, Consultant shall provide the affirmation required under § 8- 17.5-102(5)(e)(III), C.R.S., to the Authority.

8. **Counterpart Signatures.** This Agreement can be executed in counterparts, each of which taken together shall constitute one original document.

9. **Governing Law.** This Agreement shall be governed by and construed in accordance with the laws of the State of Colorado.

**IN WITNESS WHEREOF**, the Parties have executed this Agreement in duplicate original as of the dates set forth below. This Agreement must have the signature of an authorized person of Consultant on both original copies.

AUTHORITY:

CHERRY CREEK BASIN WATER QUALITY  
AUTHORITY

By: \_\_\_\_\_  
Chuck Reid, Administrator

Date: \_\_\_\_\_

CONSULTANT:

HYDROS CONSULTING INC.

By: \_\_\_\_\_  
Jean Marie Boyer, P.E., Principal

Date: \_\_\_\_\_

## Exhibit A

**Hydros Consulting Inc.**  
**Hourly Rate and Expense Schedule**

**Hourly Labor Rates**

<b>Name</b>	<b>Title</b>	<b>Hourly Rate</b>
Jean Marie Boyer, PhD, PE	Principal	\$210
John Carron, PhD	Principal	\$210
Christine Hawley, MS	Senior Managing Environmental Engineer	\$184
Steve Setzer, MS, PE	Senior Water Resources Engineer	\$178
Kevin Bierlein, PhD	Environmental Engineer	\$145
Jarrod Gasper, MS	Environmental Engineer	\$145
Taylor Adams, MS	Environmental/Water Resources Engineer	\$138
Nick Mander, MS	Water Resources Engineer	\$138
John Craven, MS	Water Resources Engineer	\$132
Lianne Daugherty, MS	Water Resources Engineer	\$128
Jennifer Thomasson	Administrative Support	\$75

Rates valid through December 31, 2017.  
Expenses billed at cost; mileage at published Federal rate.

**CHERRY CREEK BASIN WATER QUALITY AUTHORITY  
2018 Capital Project and Maintenance Status Report**

March 5, 2018

1. **Cherry Creek Stream Reclamation – CCSP to EcoPark (aka: Arapahoe Rd, CCB 5.14)**
  - a. Description: Design and construction of stream reclamation in partnership with SEMSWA, UDFCD, Aurora, and Arapahoe County. Overall project extends from Cherry State Park boundary to Eco-Park (Reaches 2 - 5).
  - b. Status: Board approved \$25,000 for design funding on 12/20/12 which provided \$150,000 for design. Board approved additional funding as follows: \$500,000 in 2013, \$250,000 in 2014, \$60,000 in 2015 and \$150,000 in 2017. SEMSWA is project lead agency on Reach 2.
  - c. Action Items: Assist project partners with engineering planning, design and construction.
    - i. Reach 2 - CH2MHill was selected as the Engineer for this project. Bids are received on July 25, 2017. ECI Construction was selected as the Project Contractor with a bid of \$2,138,843.80. *Construction work is approximately 85% completed.*
  
2. **Piney Creek Stream Reclamation - at Caley Avenue (CCB 6.5)**
  - a. Description: Design and construction of the stream reclamation in partnership with UDFCD and SEMSWA.
  - b. Status: CH2MHill was selected as the Engineer for both the Piney Creek Reach 6 and 7 projects. Olsson was selected as the Engineer for the Piney Creek project upstream of Caley. Board approved \$50,000 IGA amendment for project design on 8/21/14, an additional \$500,000 on 8/20/15, an additional \$600,000 on 2/18/16, an additional \$150,000 on 8/18/16 and \$700,000 on 3/16/17.
  - c. Action Items: Assist project partners with engineering design & construction. Project approach combines stream reclamation details from Stantec's geomorphic approach with CH2M Hill's hydraulic analysis / traditional stream design approach. Edge Contracting, Inc., was selected as the project contractor:
    - i. Reach 6 - Phase 2 stream reclamation at the Ranches. The Notice to Proceed was issued on November 6, 2017 for the contract amount of \$2,013,518.50. *Construction work is approximately 70% completed.*

## MAINTENANCE

1. **Reservoir Destratification Operations (OM-7)**
  - a. Description: Routine operations and maintenance of aeration distribution system and compressor.
  - b. Status: The system is currently shut-down for the season.
  
2. **PRF Weed Control (OM 14.1)**
  - a. Description: Weed control at PRFs within Cherry Creek State Park is performed annually (spring and fall applications) in accordance with the Authority's maintenance agreement with Parks.
  - b. Status: The 2018 spring and fall weed control program is scheduled to begin in May.
  
3. **PRF Reseeding at CCSP (OM 14.2)**
  - a. Description: Routine restoration of PRF vegetation at Cherry Creek State Park.
  - b. Status: The 2018 revegetation program is in the planning phase.

Cherry Creek Basin Water Quality Authority  
Land Use Referral Summary

Prepared: March 5, 2018

February has yielded 16 referrals, which is eleven less than the number reviewed in January. Nine were commercial land use submittals, two were residential and five were other (1-master plan, 3-utility and 1-recreation). To date in March 2018, the Authority has received five referrals that are currently being processed.

**February 2018 Summary**

Referral Agency	Proposed Development	Type of Land Use	Review Date	Review Deadline	Approx. Dev. Size (acres)	Comments
City of Centennial	Inova ROW Improvements	commercial	2/2/18	2/6/18	1.4	No exceptions taken as submitted.
Douglas County	Sierra Ridge Exemption Parcel 1	commercial	2/2/18	2/14/18	4.94	The Authority takes no exception to this Site Improvement Plan as resubmitted. The Authority reserves the right to review and comment on future submittals for this development.
Town of Parker	Stonegate F27 L1A-1	utility	2/2/18	2/22/18	0.01	No exceptions taken as submitted.
Town of Parker	Dransfeldt Place AMD1L5A	commercial	2/2/18	2/27/18	0.96	No exceptions taken as submitted.
City of Aurora	Quincy & Parker Retail Subdivision F1	commercial	2/13/18	2/21/18	0.91	The Cherry Creek Basin Water Quality Authority has reviewed the subject project for pollutant impacts and water quality considerations in the Cherry Creek Watershed and for compliance with Control Regulation No. 72 and the Authority's CR-72.2 Stormwater Guidance Document. This project is categorized as a Tier 3 disturbance requiring construction and post-construction BMP's. Applicable sections of Control Regulation 72 pertinent to this project include CR 72.2(c)(6) Post-Construction BMPs; CR 72.2(c)(7) Addn'l BMP Requirements (commercial activities) and CR72.2(c)(8) Stream Preservation Areas. Provide documentation that post-construction BMPs provide WQCV per CR72.2(c)(6); that all car wash fluids are contained within the building and no illicit discharges enter to the storm sewer and that the requirements of CR72.2(c)(8) are met. Authority recommends the City require the applicant to address each of these concerns and resubmit for Authority review and comment.
Douglas County	6735 Dahlberg Road	commercial	2/13/18	2/23/18	35	It is unclear from the submittal, what the schedule and details for construction of the "Proposed Manure Containment Area" will be. Construction BMPs and post-construction BMPs will be required in accordance with the Authority's Control Regulation 72. Additional BMPs in accordance with <u>CR 72.2( c )(7) Additional BMP Requirements</u> will also be required.
SEMSWA	Fellowship Community Church - The Legends at Centennial	commercial	2/13/18	2/28/18	5.3	No exceptions taken as submitted.
City of Castle Pines	Castle Pines Town Center F1	residential	2/13/18	2/27/18	63.5	No exception taken to this Preliminary Plan as submitted; however, the Authority reserves the right to review and comment on future submittals for this development.



Douglas County	Mineral Extraction Plan Update	master plan	2/14/18	3/2/18	n/a	No comments.
City of Aurora	Kings Point F1	utility	2/15/18	3/2/18	1.38	The Cherry Creek Basin Water Quality Authority has reviewed the subject project for point and non-point source pollutant impacts and water quality considerations in the Cherry Creek Watershed. The Authority reviews land disturbance referrals for compliance with Control Regulation No. 72 and the Authority's CR-72.2 Stormwater Guidance Document. This project is categorized as a Tier 3 disturbance. Utility line construction excludes this project from the post construction BMP requirement; however, construction BMPs are required. The Authority takes no exception to the project as submitted provided construction BMPs are incorporated in accordance with Control Regulation 72.
Town of Parker	Reata North F6	residential	2/19/18	3/12/18	17.9	No exceptions taken as submitted.
Arapahoe County	Cherry Creek Vista 06	recreation	2/23/18	3/5/18	2.95	No exception taken with this final development plan submittal provided construction BMPs and post-construction BMPs are incorporated in accordance with the requirements of Control Regulation 72. The Authority reserves the right to review and comment future submittals for this re-development.
SEMSWA	All American Records Mgmt Addn	commercial	2/23/18	3/5/18	5.17	No exceptions taken as submitted.
Town of Parker	Parker Auto Plaza F2 L2 B1	commercial	2/23/18	3/15/18	1.41	No exceptions taken as submitted.
Town of Parker	Reata West Water Main Extension	utility	2/23/18	3/21/18	6	No exceptions taken as submitted.
Douglas County	Compark Planned Development	commercial	2/23/18	3/16/18	n/a	No comments.

# MEMORANDUM

JRS ENGINEERING CONSULTANT, LLC

**TO:** CCBWQA Technical Advisory Committee and Board of Directors  
**CC:** Chuck Reid, Authority Manager  
**FROM:** James R. "Jim" Swanson, P.E.  
**DATE:** February 20, 2018  
**SUBJECT:** WERF Stream Restoration as a BMP: Crediting Guidance Report Discussion

At the January 18, 2018 Board of Director's meeting, Director Kilgore noted that the Water Environmental and Reuse Foundation (WERF) has established a new methodology for stream reclamation. He requested staff look into the methodology to determine if there is value to the Authority.

WERF, in 2016, published a Final Report titled "Stream Restoration as a BMP; Crediting Guidance". The following paragraphs and tables within this memo, include information extracted from the WERF Final Report in an effort to aide in providing an overview of the methodology used and to provide the Authority's TAC and Board with information included in the above referenced WERF Final Report.

The Report provides a general technical framework for quantifying the water quality benefit of a specific suite of stream restoration practices, focusing on sediments and nutrients, primarily phosphorus and nitrogen. The four practices addressed include:

- Stream stabilization.
- Riparian buffers.
- In-stream enhancement.
- Floodplain reconnection.

Guidance for assigning credits for each of the four stream restoration practice groups includes:

- Background information.
- Project information / data requirements.
- Regional geomorphic considerations.
- Longevity and response time.
- Uncertainty and simplifying assumptions.
- Recommended crediting approach.

It's noted that stream restoration crediting concepts are rooted in the concept of water quality trading, with early policy statements from the U.S. Environmental Agency (EPA) issued over twenty years ago. Water quality trading can provide greater efficiency in achieving water quality goals in watersheds by allowing one source to meet its regulatory efficiency in achieving water quality goals by using pollutant reductions created by another source that has lower pollution control costs.

This Report outlines methods for quantifying these water quality credits for stream restoration projects which become the currency for the water quality trading programs. The focus of this Report includes protocols for quantifying pollutant loads and reductions from stream restoration practices.

Table 3-1 Examples of Stream Restoration Practices Potentially Suitable for Water Quality Crediting, attached on the following page, is copied from the WERF Final Report. The specific techniques identified on the table are stream reclamation techniques being implemented by the Authority and our project partners on current and past Stream Reclamation Projects within the Cherry Creek basin.

**Table 3-1. Examples of Stream Restoration Practices Potentially Suitable for Water Quality Crediting.**

	Practice Category			
	Bed and Bank Stabilization	Riparian Buffers	In-Stream Enhancement	Floodplain Reconnection
Specific Techniques	<ul style="list-style-type: none"> <li>Bioengineering</li> <li>Vanes (partial or full channel span)</li> <li>Drop structures and weirs (bendway or channel spanning) <ul style="list-style-type: none"> <li>Spur dikes</li> <li>Toe wood</li> <li>Rock walls</li> <li>Riprap</li> <li>Constructed riffle</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>Active planting (grass and/or trees)</li> <li>Grazing management (livestock exclusion/fencing)</li> </ul>	<ul style="list-style-type: none"> <li>Log jams</li> <li>Beaver dams</li> <li>See Bed and Bank Stabilization for others</li> </ul>	<ul style="list-style-type: none"> <li>Breaching levees</li> <li>Bank lowering</li> <li>Raising stream bed</li> <li>Floodplain (e.g., legacy) sediment removal</li> </ul>
Metrics of Interest	<ul style="list-style-type: none"> <li>Erosion rates (mass or volume per time per stream length)</li> <li>Soil nutrient content (mass nutrient per mass soil)</li> <li>Total nutrient and sediment loading rates</li> </ul>	<ul style="list-style-type: none"> <li>Groundwater inflow and outflow rate</li> <li>Inflow and outflow sediment &amp; nutrient concentrations</li> <li>Inflow and outflow loads (product of above)</li> <li>Nutrient uptake/ removal rates on per area basis (e.g., denitrification)</li> </ul>	<ul style="list-style-type: none"> <li>Nutrient uptake/removal rates on per area basis (e.g., denitrification)</li> <li>Hyporheic flow rates/ percentage of total flow</li> <li>Biochemical potential of subsurface (may be qualitative)</li> </ul>	<ul style="list-style-type: none"> <li>Floodplain inundation frequency</li> <li>Nutrient uptake/removal rates on per area basis (e.g., denitrification)</li> <li>Sediment and nutrient deposition rates</li> </ul>
Scales	Can be sited to reach to watershed scale. Larger scale implementation will result in more effective pollutant retention overall.	Can be sited to reach to watershed scale. Larger scale implementation (i.e., fewer "gaps" in buffers) will lead to greater nutrient and sediment retention.	All spatial scales, although site to reach scale typical. Hyporheic exchange potential increases with number of structures	Typically reach scale but could be larger.
Interactions	Stabilization techniques will be more successful if root causes of degradation (e.g., altered hydrology, livestock trampling) are also addressed	Riparian buffers can increase bank stability (i.e., root reinforcement) and provide organic carbon and large wood to streams, which can increase nutrient processing	Many in-stream structures are installed to increase bed and bank stability but also encourage in-stream processing. Particle size and carbon content of bed material may influence reduction rates	Similar in function to riparian buffers with the addition of overbank deposition
Suitability	Appropriate where fine-grained banks are unstable and eroding. Not suitable where only outside of meander bends are subject to erosion in a naturally migrating stream	Suitable for areas with significant loading of sediment and/or nutrients from upland sources	Suitable for streams with high potential for hyporheic exchange (e.g., coarse bed material) where loss of bedforms or complexity has limited this natural process	Appropriate in systems with regular flood peaks and unconfined valleys. Less suitable where overbank flows are naturally infrequent (e.g., ephemeral streams)

At this time, the WERF Crediting Guidance program is limited to include only sediment and nutrients (Phosphorus and Nitrogen). Pre and post stream restoration monitoring and data collection are

necessary in determining the appropriate credit values. The guidance document has identified technical procedures and considerations for developing these credit values. The Report has identified some challenges and technical constraints associated with developing and assigning credits to stream restoration projects including;

- Practical constraints related to cost and duration of monitoring for stream restoration projects, both before and after projects are implemented.
- Limited empirical data for some stream restoration practice types.
- Availability of sufficient data to populate existing theoretical equations is often lacking.
- Evaluation of monitoring data can be challenging because stream restoration results and benefits are not “steady-state” conditions.

In summary, it appears that several of the stream restoration techniques identified for each of the four practice categories in Table 3-1 above, are identical to, or very similar to, the stream reclamation practices and techniques incorporated into the past and on-going stream reclamation projects being constructed within the Cherry Creek basin by the Authority and our project partners.

It is understood that individuals from Wright Water Engineers are working closely with Urban Drainage and Flood Control District and Muller Engineering, to apply some of the principles of the Report through development of a spreadsheet that quantifies water quality benefits of the stream restoration project on Cherry Creek from Iliff Street to Quebec Street in Denver. It is understood this spreadsheet will quantify benefits of this stream restoration project including stabilizing banks and reducing erosion, promoting a stable stream invert and exchange between surface and subsurface flow, and improvements at outfalls to reduce erosion and improve water quality.

I believe there is benefit for the Authority to monitor this ongoing Cherry Creek from Iliff Street to Quebec Street project and to review the project crediting methodology and required data collection for comparison to data and information collected by the Authority on constructed PRF projects within the basin.



**CHERRY CREEK BASIN  
WATER QUALITY AUTHORITY**

***TECHNICAL ADVISORY COMMITTEE  
MEETING AGENDA***

CliftonLarsonAllen LLP - 8390 E. Crescent Parkway, Suite 500  
Greenwood Village, CO 80111

<b>Date:</b>	<b>March 1, 2018</b>
<b>Time:</b>	<b>9:00 AM *NOTE NEW START TIME*</b>
<b>Place:</b>	<b>CliftonLarsonAllen LLP 8390 E. Crescent Parkway, Suite 500 Greenwood Village, CO 80111</b>

<b>9:00am</b>	<b>Call to Order</b>
<b>9:05am</b>	<b>TAC Administration Items</b> <i>(Chuck, 10 minutes)</i> <ol style="list-style-type: none"> <li>1. Board/TAC Coordination</li> <li>2. Board's Conversation About the Bubble Plume Model and Next Steps</li> </ol>
<b>9:15am</b>	<b>Action Items</b> <ol style="list-style-type: none"> <li>1. Approval of February 1, 2018 Minutes <i>(Chuck, 2 minutes, handout)</i></li> <li>2. Discuss and Consider the Recommendation from the Sampling &amp; Analysis Program RFP Committee for Awarding the 2018 Contract <i>(Chuck, 10 minutes, recommendation to be presented at the meeting)</i></li> <li>3. Discuss and Consider Approval of the draft 2018 Annual Report <i>(Katie, 20 minutes, emailed separately on February 19)</i></li> <li>4. Discuss and Consider CCBWQA's Memo to the Water Quality Control Commission Regarding the Control Regulation #72 Triennial Information hearing <i>(Chuck &amp; Katie, 15 minutes, attachment 1)</i></li> </ol>
<b>10:05am</b>	<b>Presentation and/or Discussion Items</b> <ol style="list-style-type: none"> <li>1. Presentation on the WERF Stream Restoration as a BMP Crediting Guidance Report <i>(Jim, 20 minutes, attachment 2)</i></li> </ol>

10:25am	<p><b>Capital Project &amp; Maintenance Reports</b></p> <ol style="list-style-type: none"> <li>1. 2018 Capital and Maintenance Status Report, <u>February 20</u>, 2018 (<i>Jim, 3 minutes, attachment 3</i>)</li> </ol>
10:30am	<p><b>Cherry Creek Stewardship Partners Report</b> (<i>Casey, 10 minutes</i>)</p>
10:40am	<p><b>Subcommittee &amp; Committee Reports</b></p> <ol style="list-style-type: none"> <li>1. Watershed Model Update (<i>Katie, 5 minutes</i>)</li> <li>2. Wetland Harvesting Committee Update (<i>Jim, 2 minutes</i>)</li> </ol>
10:45am	<p><b>Demonstration (for those who want to stay)</b></p> <ol style="list-style-type: none"> <li>1. Demonstration of Data Portal Annual Report Tool (<i>Carolyn Nobel - LRE</i>)</li> </ol>
	<p><b>Upcoming Meetings</b></p> <ol style="list-style-type: none"> <li>1. Next scheduled TAC meeting  Thursday, April 5<sup>th</sup>, 2018, 9:00 a.m. CliftonLarsonAllen LLP - 8390 E. Crescent Parkway, Suite 500 Greenwood Village, CO 80111</li> <li>2. Next scheduled Board meeting  Thursday, March 15<sup>th</sup>, 2018, 9:00 a.m. CliftonLarsonAllen LLP - 8390 E. Crescent Parkway, Suite 500 Greenwood Village, CO 80111</li> </ol>
	<p><b>Adjournment</b></p>
	<p><b>Attachments:</b></p> <ul style="list-style-type: none"> <li>▪ Triennial Review Informational Hearing for Regulation #72</li> <li>▪ WERF Stream Restoration as a BMP: Crediting Guidance Report Discussion</li> <li>▪ CIP &amp; Maintenance Status Report, January 19, 2018</li> </ul>

## Hydros Responses to Roger Kilgore's Questions

### 1. What experience does Hydros have in linking a bubble plume model with CE-Qual-W2?

Hydros has as much or more experience linking and applying bubble plume models with water-quality models as any other consulting firm in the country. Dr. Kevin Bierlein, whose primary area of expertise is the numerical modeling of oxygenation and circulation (destratification) systems, brings a full suite of direct experience in this area. Titles of his peer-reviewed published works include:

- Increased sediment oxygen flux in lakes and reservoirs: The impact of hypolimnetic oxygenation; and
- Mixing potential of a surface-mounted solar-powered water mixer (SWM) for controlling cyanobacterial blooms.

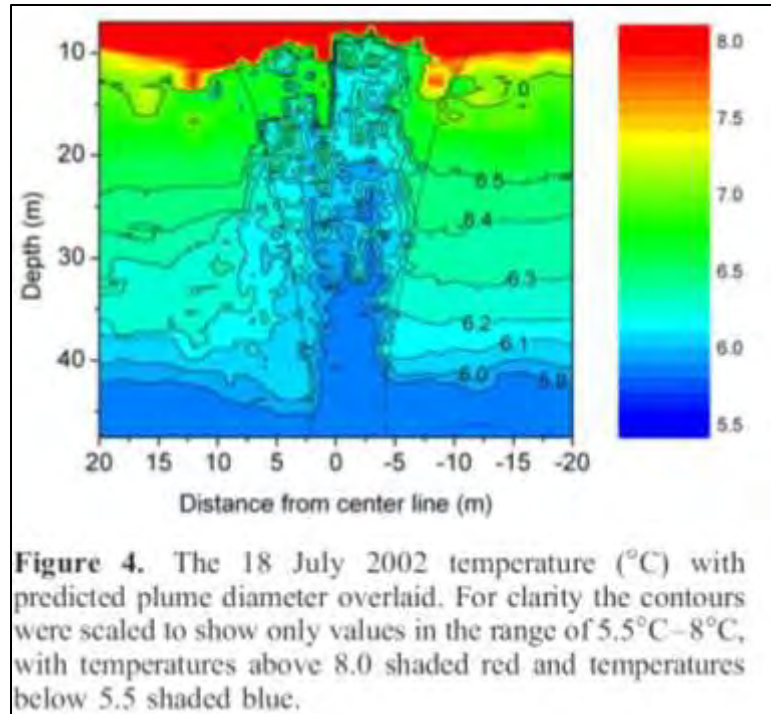
In addition, Dr. Bierlein is co-author of the Water Research Foundation's "Alternative and Innovative Methods for Source Water Management of Algae and Cyanobacteria." To clarify, the bubble plume work to be conducted by Hydros for Cherry Creek Reservoir (if approved) will involve the use of an already linked (by Hydros) bubble plume model with CE-QUAL-W2.

### 2. Which bubble plume model would be used and why?

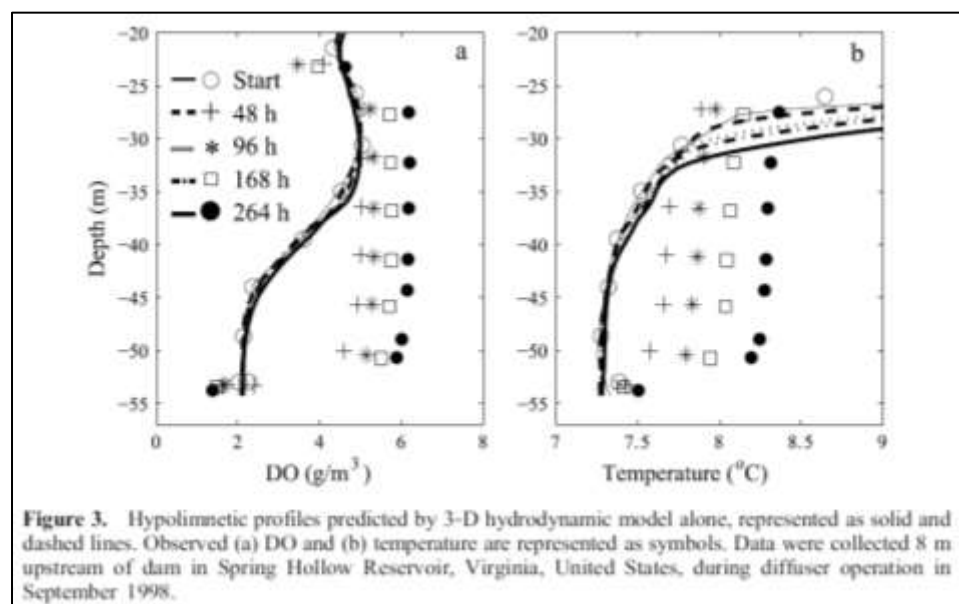
The discrete bubble plume model, originally published by Wüest et al. (1992), would be used for Cherry Creek Reservoir. The use of this bubble plume model, within the context of 2-D and 3-D hydrodynamic water-quality models, has been successfully validated with excellent results. This is why it was chosen.

This bubble plume model accounts for gas transfer (DO and nitrogen) between the bubbles and ambient water, changes in bubble size and rise velocity due to changes in bubble volume (based on the amount of gas in the bubble and changes in hydrostatic pressure), calculates the volume of water entrained by the bubble plume as the plume rises, and predicts where water detrains from the plume. The plume model uses the physical location, size, and operation of the diffusers, as well as temperature, DO, and salinity profiles. Thus, the effects of this plume-induced mixing are accounted for in a mechanistic manner in the hydrodynamic water quality model. The in-reservoir response in terms of all simulated constituents can then be predicted.

Examples of the performance of the discrete bubble plume model are illustrated below. The first figure (McGinnis et al, 2004) shows that the bubble plume model predictions for plume diameter strongly agree with observed data.



The figures below, from Singleton et al. (2010), show that the bubble plume model representation is necessary to match observed temperature and DO profiles in a reservoir while the diffuser system is operating. In the first figure (Figure 3), the bubble plume model is not used, resulting in notable differences between simulated and observed profiles. In the second figure (Figure 4), with the bubble plume model operating, the simulated and observed profiles show very good agreement.





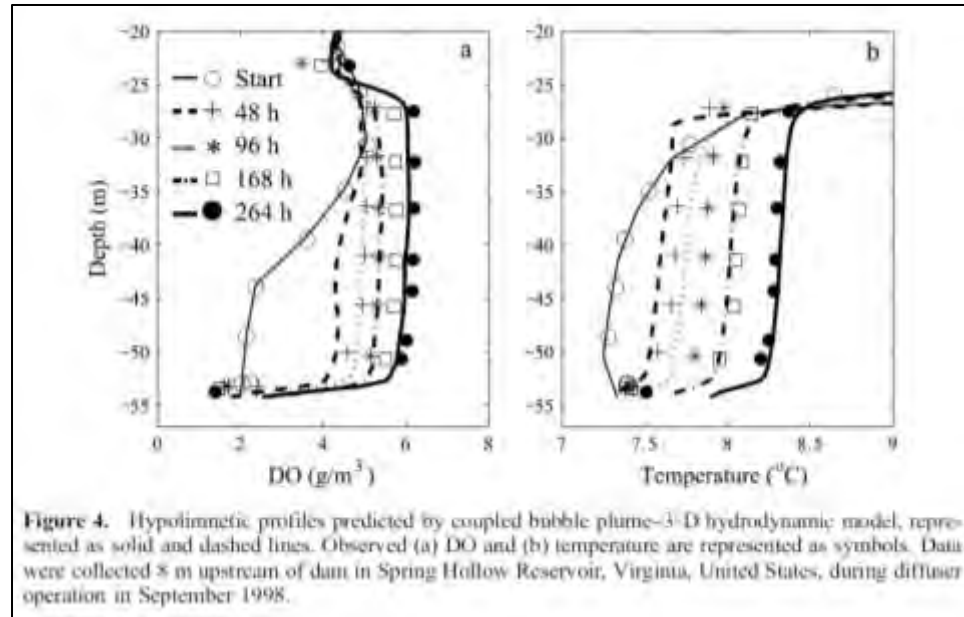


Figure 4. Hypolimnetic profiles predicted by coupled bubble plume-3-D hydrodynamic model, represented as solid and dashed lines. Observed (a) DO and (b) temperature are represented as symbols. Data were collected 8 m upstream of dam in Spring Hollow Reservoir, Virginia, United States, during diffuser operation in September 1998.

3. Will linking the bubble plume model to CE-Qual-W2 require resegmentation (vertically or longitudinally) of the 2D CE-Qual-W2 model?

No, the vertical and longitudinal segmentation would be the same.

4. What are the “engineering” inputs or outputs of the bubble plume model, e.g. air volume, power consumption, etc.?

The bubble plume model accounts for the key engineering design inputs that describe the system being modeled. These include the size and number of diffuser heads, the depth and location of the diffuser heads, the total volumetric flow to the diffuser system, the volumetric flow of gas released at each diffuser head, initial bubble size, and the gas mix (fractions of nitrogen and oxygen). As such, varying the inputs (such as flow rate, diffuser head size, etc.) can be used to inform design requirements for the system (e.g., compressor sizing, piping, etc.).

As a side note, Hydros sees the value in collaborating with another engineering firm (e.g., EATON Energy Solutions – the firm who conducted the Destratification System Evaluation for Cherry Creek Reservoir in 2013) during the plume modeling process to outline operating constraints and/or feasible upgrades to the existing system that could be simulated with the coupled bubble plume/CE-QUAL-W2 model. Additionally, based on interest expressed for consideration of alternative approaches, Hydros could provide a white paper describing different options to address Cherry Creek Reservoir objectives. This paper would review in-reservoir treatment options to reduce internal loading and algae growth, including pros, cons and likely effectiveness. This information would also be useful to the Authority to help guide decisions regarding reservoir management.

## References:

- Bierlein, K. A.**, M. Rezvani, S. A. Socolofsky, L. D. Bryant, A. Wüest, and J. C. Little. 2017. Increased sediment oxygen flux in lakes and reservoirs: The impact of hypolimnetic oxygenation. *Water Resources Research*, 53, 4876-4890. DOI:10.1002/2016WR019850.
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