Group 1: Red Rocks Reservoir and Upper West Plum Creek – 2023

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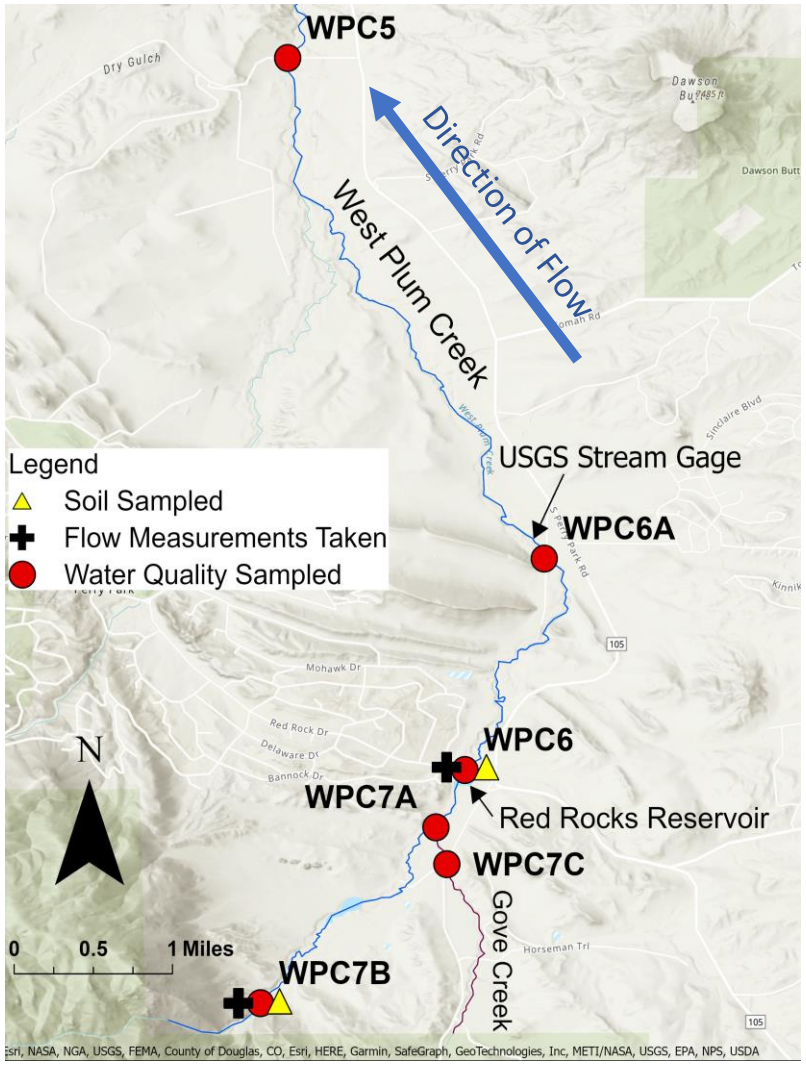

Figure 1. Site map

Table 1. Site information

Site ID	Latitude	Longitude	Site Description
WPC5	39°18'14.66"N	104°58'30.10"W	W. Plum Cr. at Dakan Road
WPC6A	39°15'34.32"N	104°57'5.70"W	W. Plum Cr. at Plum Creek Hollow Farm
WPC6	39°14'26.62"N	104°57'31.76"W	W. Plum Cr. below Red Rocks Reservoir
WPC7A	39°14'10"N	104°57'44"W	Joining of W. Plum Cr. and Gove Cr. with beaver lodges
WPC7B	39°13'13"N	104°58'36"W	W. Plum Cr. exits Pike-San Isabel NF
WPC7C	39°13'56"N	104°57'38"W	Gove Cr. at blown out levee

Main Findings

- Coliform and *E. coli* levels elevated by ranching/agriculture
- Soluble phosphorous possibly flushed from soil
- Majority of phosphorous from non-anthropogenic source
- Phosphorous, nitrogen, arsenic, selenium in compliance
- Upstream beaver activity likely reduced sedimentation in Red Rocks Reservoir
- Observed undercutting of main culvert
- Failure of overflow culvert
- Deterioration of water quality towards Chatfield Reservoir

Table 2. Measured water quality parameters and flow rates

Date	Site ID	pH*	Conduct-ivity (µs/cm)	Temp** (°C)	Dissolved Oxygen▲ (mg/L)	Alkalinity• (mg $CaCO_3$/L)	Turbidity (NTU)	Flow Rate (cfs)
5/16/2023	WPC5	7.4	100	11	8.8	26	94	N/M
5/16/2023	WPC6A	7.0	61	9.7	8.9	14	29	92
5/16/2023	WPC6	6.9	57	12	8.7	12	15	80
5/16/2023	WPC7A	6.9	53	18	7.9	10	46	N/M
5/16/2023	WPC7B	7.1	42	8.8	9.4	8.2	16	30
5/16/2023	WPC7C	7.2	58	10	8.8	14	29	N/M

N/M = Not Measured; *Standard limit 6.5 to 9 [4]; **Daily Max 24.3°C; ▲Standard min 6.0 mg/L [4]; •Standard limit 20 mg $CaCO_3$/L [1]; Flow rates taken May 19, 2023

Table 3. Metals, anions, solids, organics, nutrients, and pathogens

2023 Group 1 – Red Rocks Reservoir and Upper West Plum Creek			Concentrations												
			Metals (mg/L)					Anions (mg/L)		Solids (mg/L)	Organics (mg/L)	Nutrients (mg/L)		Pathogens (mpn/100 mL)	
			As	Fe	Mn	Se	Tl	NO_2^-	NO_3^-	TSS	TOC	P	TN	Coliform	*E. coli*
EPA	Aquatic Life Chronic [1]		0.15	1.0	-	-	-	-	-	-	-	-	-	-	-
	Aquatic Life Acute [1]		0.34	-	-	-	-	-	-	-	-	-	-	-	-
	Human Recreation [2]		1.8E-05	-	0.05	0.17	2.4E-04	-	10	-	-	-	-	-	-
	Drinking Water [3]		0.01	-	-	0.05	0.002	1	10	-	-	-	-	-	-
	Secondary Drinking Water [3]		-	0.3	0.05	-	-	-	-	-	-	-	-	-	-
CDPHE	Regulation 38 Chronic [4]		2.0E-05*	1.0*	1.7**	0.0046	-	0.05	-	-	-	0.11▲	0.53•	-	126
	Regulation 38 Acute [4]		0.34	-	3.1**	0.0184	-	-	10	-	-	-	-	-	-
USDA	USDA Livestock [5]		0.01	0.3	0.05	0.05	-	10	30	-	-	-	-	200	-
	Detection Limit (mg/L)		0.0168	0.0003	0.0001	0.0109	0.0049	0.1	0.1	-	0.17	0.029	0.17	1	1
Sample	**Site ID**	**Date**	**As**	**Fe**	**Mn**	**Se**	**Tl**	**NO_2^-**	**NO_3^-**	**TSS**	**TOC**	**P**	**TN**	**Coliform**	***E. coli***
Water	WPC7B	5/16/23	BDL	0.21	0.005	BDL	BDL	BDL	0.03	16.7	9.49	BDL	0.22	140	BDL
	WPC7C	5/16/23	BDL	0.20	0.014	**0.015**	BDL	BDL	0.17	28.6	7.48	BDL	0.34	270	98
	WPC7A	5/16/23	BDL	0.19	0.01	BDL	BDL	BDL	0.05	19.1	9.62	BDL	0.29	630	10
	WPC6	5/16/23	BDL	0.26	0.009	BDL	BDL	BDL	0.05	0	8.96	BDL	0.29	330	31
	WPC6A	5/16/23	BDL	0.26	0.019	0.016	0.008	BDL	0.06	20.2	8.99	BDL	0.26	460	20
	WPC5	5/16/23	BDL	0.10	0.026	BDL	BDL	BDL	0.18	113	8.44	**0.059**	0.37	1900	350
Soil	WPC6-S	5/16/23	N/M	1.5	0.028	BDL	0.027	BDL	0.24	N/M	N/M	0.03	N/M	N/M	N/M
	WPC7B-S	5/16/23	N/M	1.6	0.024	BDL	0.013	0.037	1.02	N/M	N/M	0.49	N/M	N/M	N/M

Notes:
A/BDL = Above/Below Detection Limit
N/M = Not Measured
*Total Recoverable Standards (all other standards are for dissolved metals)
**Calculated using Table Value Standards assuming 111 mg $CaCO_3$/L average low flow hardness [6]
• Average of Regulation 38 proposed standards for cold and warm waters
▲Phosphorus standard is 0.03 mg/L within Chatfield Reservoir and 0.11 mg/L for most tributaries
Bold values represent total metal concentrations. All other concentrations are dissolved
For information on other constituents, please see Data Appendix

[1] US EPA National Recommended Water Quality Criteria - Aquatic Life Criteria Table; freshwater standards (https://www.epa.gov/wqc/national-recommended-water-quality-criteria-aquatic-life-criteria-table)
[2] US EPA National Recommended Water Quality Criteria - Human Health Criteria Table; consumption of water & organisms (https://www.epa.gov/wqc/national-recommended-water-quality-criteria-human-health-criteria-table)
[3] US EPA Drinking Water (https://www.epa.gov/ground-water-and-drinking-water/national-primary-drinking-water-regulations)
[4] CDPHE Regulation 38 for Upper South Platte River Basin (https://cdphe.colorado.gov/water-quality-control-commission-regulations)
[5] USDA Livestock Drinking Water (https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs144p2_051302.pdf)
[6] Chatfield Reservoir Storage Reallocation Feasibility Study 2013

Recommendations

- Pathogen levels should be monitored at all sites except WPC7B
- Monitor risk posed by accumulation of sediment and constituents of concern in beaver habitat
- Assess how beaver ponds can reduce sedimentation in Red Rocks Reservoir
- Quantify seepage from Red Rocks Reservoir and develop remediation strategies
- Promptly repair failed overflow culvert