BEAR CREEK WATERSHED ASSOCIATION

2024 ANNUAL REPORT

BEAR CREEK WATERSHED ASSOCIATION
PO BOX 15038
LAKEWOOD, CO 80215
WWW.BEARCREEKWATERSHED.ORG

Table of Contents

Figures

Images

Tables

Acronyms

Acronym	Definition
BCWA	Bear Creek Watershed Association
BMP	Best Management Practice
CDPHE	Colorado Department of Public Health and Environment
chl α	chlorophyll-a
CPW	Colorado Parks and Wildlife
DM	daily maximum
DO	dissolved oxygen
lbs/yr	pounds per year
m	meter
mg/L	milligrams per liter
MS4	Municipal Separate Storm Sewer System
MWAT	Maximum Weekly Average Temperature
NOAA	National Ocean and Atmospheric Administration
OWTS	Onsite Wastewater Treatment Systems
Reservoir	Bear Creek Reservoir
Reg	Colorado Water Quality Control Regulation
RMH	Rule Making Hearing
SRP	soluble reactive phosphorus
TDP	total dissolved phosphorus
TIN	total inorganic nitrogen
TN	total nitrogen
TMDL	Total Maximum Discharge Limit
TP	total phosphorus
TSI	Trophic State Index
TSS	total suspended solids
ug/L	micrograms per liter
WLA	wasteload allocation
WWTFs	wastewater treatment facilities
WQCC	Colorado Water Quality Control Commission
WQCD	The Colorado Water Quality Control Division

Key Takeaways

During 2024, the Bear Creek Watershed Association (BCWA) worked with its members to monitor water quality in Bear Creek Reservoir and its tributaries. This work includes an extensive reservoir and watershed monitoring program, operation and maintenance of the aeration system in Bear Creek Reservoir, education and outreach, and many other efforts.

More notably, in 2024, the Colorado Department of Public Health and Environment (CDPHE) advanced the development of a Total Maximum Daily Load (TMDL) for Bear Creek Reservoir, targeting impairments related to phosphorus and chlorophyll-a. This initiative aims to address nutrient pollution that contributes to eutrophication and harmful algal blooms, thereby protecting aquatic life and recreational uses. The BCWA has been actively involved in this process, implementing nutrient reduction programs and monitoring efforts to support water quality improvements.

Highlights of the 2024 activities and results of the monitoring program are summarized below.

Bear Creek Watershed Association Activities and Updates

The BCWA has engaged experienced technical and administrative consultants, who bring valuable insight from their work with other watershed groups and phosphorus control programs across Colorado. Through member collaboration, institutional knowledge, and a shared commitment to protecting water quality, the BCWA remains focused on monitoring and maintaining the progress made in the Bear Creek Watershed.

Bear Creek Reservoir Highlights

Bear Creek Lake Park (which includes Bear Creek Reservoir) remains a popular destination for outdoor recreation, drawing over half a million visitors annually. In 2024, the park continued to support a wide range of activities including fishing, boating, camping, hiking, and archery. Bear Creek Lake is home to species such as rainbow trout, smallmouth bass, saugeye, yellow perch, tiger muskie and walleye.

In 2024, the proposed expansion of Bear Creek Lake remained a high interest issue, drawing significant public comments and questions. The U.S. Army Corps of Engineers and the Colorado Water Conservation Board continued their feasibility study to assess the potential of increasing the reservoir's capacity by up to 20,000 acre-feet, aiming to address projected water supply gaps in the South Platte Basin. The proposed expansion raises environmental questions, particularly regarding water quality. Increasing the reservoir's capacity may inundate existing wetlands and riparian zones, disrupting natural filtration systems that help maintain water quality and may lead to increased nutrient loading and sedimentation, potentially resulting in algal blooms and

decreased oxygen levels. The BCWA continues to monitor the expansion progress and associated activities.

Water Quality

Water quality and ecological conditions in Bear Creek Reservoir can vary considerably from year to year due to several factors, many of which are outside the scope of management control. Weather patterns including seasonal temperature fluctuations, wind, and precipitation all play a major role. In 2024, total annual precipitation was close to average; however, rainfall highlights a wetter-than-average spring and late fall.

Nutrient inputs from Bear Creek and Turkey Creek surrounding watershed and the internal release of phosphorus from lakebed sediments also influence reservoir conditions. To help manage these internal sources, the City of Lakewood operates an aeration system between April and October which helps maintain more favorable oxygen conditions in the lower layers of the reservoir with the goal of suppressing the release of phosphorus from sediments.

Bear Creek Reservoir did not meet the chlorophyll-a standard of 12.2 micrograms per liter (µg/L) during the 2024 growing season. The seasonal average was 26.4 ug/L from July through September.

The Reservoir attained the applicable Regulation 38 standards for temperature, pH, and dissolved oxygen, supporting aquatic life and recreational uses throughout the season. The seasonal average concentration from the surface of Bear Creek Reservoir was 40 ug/L which is not in attainment of the total phosphorus standard of 22.2 ug/L established in Reg 38.

Water quality and ecological conditions in Bear Creek Reservoir can vary considerably from year to year due to several factors, many of which are outside the scope of management control. All data collected in 2024 is available in Appendix A.

Bear Creek Watershed Highlights

In 2024, precipitation remained a key driver of hydrologic and water quality dynamics in the Bear Creek Watershed. Evergreen generally received higher precipitation than lower in the watershed particularly in spring and late fall, with March, April, and November showing significant departures above historical averages. Summer precipitation followed typical patterns, except for a notable increase in Evergreen in August. Early and late-year months remained relatively dry across the watershed.

Bear Creek Reservoir’s inflows are dominated by Bear Creek (72% of total) and Turkey Creek (28%), with additional contributions from direct precipitation. These inputs, along with losses from evaporation and outflows, form the basis of the reservoir's water balance calculations.

Precipitation patterns influenced streamflow timing and volume, and ultimately, nutrient transport to the reservoir.

Nutrient dynamics were evaluated using total phosphorus (TP) and nitrogen (TN) concentrations from monthly monitoring throughout the watershed. In 2024, TP concentrations remained relatively low in upper watershed sites (e.g., Vance Creek, Cemetery), moderate in mid-watershed sites (e.g., Cub Creek, North Turkey Creek), and elevated in some tributaries such as Troublesome Creek and South Turkey Creek near Myers Ranch. TP concentrations just upstream and downstream of Bear Creek Reservoir were slightly above historical medians, suggesting limited but notable nutrient accumulation near the reservoir.

Paired upstream and downstream monitoring showed consistent or slightly elevated concentrations downstream, supporting the importance of continued nutrient control strategies. These findings provide a foundation for understanding eutrophication risks, improving reservoir management, and evaluating progress under the watershed's phosphorus control programs.

Reservoir Nutrient Loading Highlights

Watershed nutrient concentrations, combined with streamflow data provided by the upstream USGS gages on Bear Creek (BC MP) and Turkey Creek (TC BCP), along with change in storage and the reservoir outlet (LBC D/S BCR), were used to assess nutrient loading, export, and storage within the reservoir.

Bear Creek is the main inflow to the Reservoir, contributing approximately 76% followed by Turkey Creek at 24%, and precipitation less than 1% in 2024. Although Bear Creek was responsible for 76% of the phosphorus loading, the elevates concentrations of nitrogen in Turkey Creek during high flows resulted in 29% contribution of the nitrogen loading.

In 2024, the reservoir experienced a net loss in storage of 246 AF and 4,831 lbs of phosphorus and 33,756 lbs of nitrogen were stored in the Reservoir.

2025 and Near Future Plans

The BCWA will continue its routine monitoring activities, continue and implement new stormwater Best Management Practices (BMPs), support the Waste Water Treatment Facility (WWTF) dischargers and Regulation 85 (Reg 85) requirements, track the status and review process of the TMDL and will begin outlining potential implementation requirements and phosphorus control management strategies to include in a future update to the BCWA Watershed Plan.

Specific activities and plans for 2025 are described below:

- In early 2025, revisions and updates to the sampling and analysis plan (SAP) were made to outline the monitoring efforts to support Reg 74 requirements and supplemental monitoring to maintain a comprehensive understanding of the nutrient concentrations across the watershed. This SAP is a working document to be updated as needed based on changes or updates.

- Watershed Education Program In 2025, Evergreen Audubon and Evergreen Metro District are launching a new community science initiative to engage the public in protecting the watershed from Summit Lake on Mount Blue Sky to its confluence with the South Platte River. The program includes a six-part educational series featuring three informational workshops and three hands-on field days focused on watershed health and macroinvertebrate sampling. Participants will gain practical skills in evaluating stream health while contributing to ongoing watershed monitoring efforts.

- In addition to the educational series, the new Watershed Warriors Annual Competition will encourage community members to earn points by participating in conservation activities such as litter cleanups, recycling fishing line, and attending workshops. Top participants will be recognized with prizes and community honors at the end of the year.

- These efforts aim to build public awareness, foster stewardship, and support long-term protection of the Bear Creek Watershed.

- Concrete vaults for the toilets have been ordered for installation at the Summit Lake Parking lot in Clear Creek County in the fall of 2025.

- BCWA may apply for funding from the Wildfire Ready Watersheds program in late July 2025, funded through CWCB's Colorado Water Plan Watershed Health and Recreation Grant Program.

2024 Bear Creek Watershed Annual Report

1.0 Watershed History

The Bear Creek Watershed spans parts of Jefferson, Clear Creek, and Park Counties and includes municipalities, towns and popular recreational areas in and around Evergreen, Morrison, and Lakewood. Bear Creek and Turkey Creek are the primary tributaries to Bear Creek Reservoir, located approximately 10 miles west of Denver, Colorado in Bear Creek Lake Park (Figure 1).

The Bear Creek Watershed in Colorado has experienced notable population growth since the early 2000s, primarily driven by suburban development and increased residential demand requiring expansion from the Denver metropolitan area. This population increase has implications for water quality and watershed management where new and continued development has led to increased base flows and larger stormwater flows into the watershed. This growth underscores the importance of integrated land-use planning and watershed management, necessitating ongoing monitoring and adaptive strategies to maintain the ecological health of the watershed and address emerging environmental challenges.

1.1 What is the BCWA?

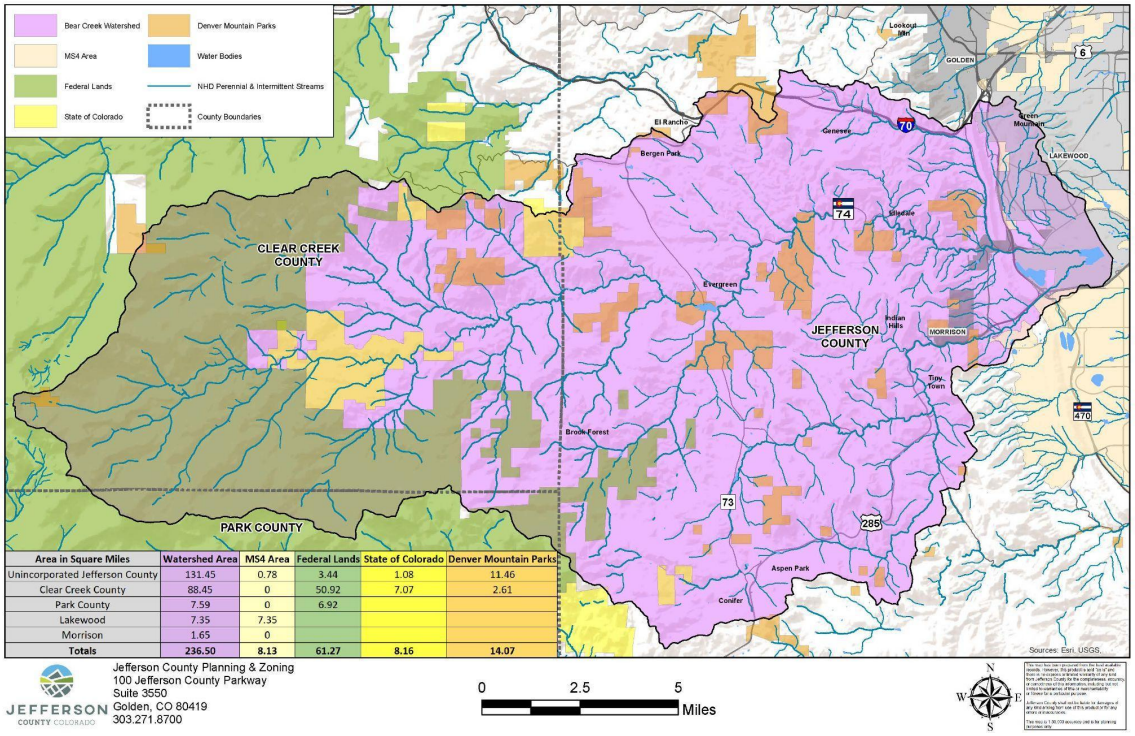
The BCWA was established through an intergovernmental agreement (IGA) after the Bear Creek Reservoir total phosphorus standard was adopted in 1981 and serves as the local agency responsible for monitoring and tracking water quality throughout the Bear Creek Watershed, shown in Figure 1. The BCWA brings together a diverse membership that includes local governments, special districts, wastewater discharge permit holders, water providers, businesses, youth camps, representatives from local, regional, state, and federal agencies to collaboratively manage the Bear Creek Watershed. Members collaborate to implement state and federal water quality regulations within a watershed and provides a forum for information sharing and coordinated action to meet state and federal water quality regulations requirements in a watershed context and encourages public participation.

The BCWA is entirely funded through a cost-share program and oversees both point source monitoring and the tracking of nonpoint source practices, programs, and pollutant loadings and management and implementation efforts are carried out at the watershed level.

Regulation 74, officially titled the Bear Creek Watershed Control Regulation (5 CCR 1002-74), is a rule adopted by the Colorado Water Quality Control Commission (WQCC) to protect and manage water quality within the watershed. It outlines responsibilities for local agencies and stakeholders to monitor and control both point and nonpoint sources of pollution, implement

best management practices to reduce erosion and sedimentation, and oversee phosphorus trading programs.

Under this regulation, the BCWA is required to submit Annual Reports to the WQCC that address five key elements: (1) a summary of the watershed's water quality status for the previous year; (2) wastewater treatment facility loading and permit compliance; (3) nonpoint source loading and best management practices; (4) analysis of in-stream and reservoir data to assess progress toward water quality goals and standards; and (5) characterization of any active phosphorus trading programs.



Area in Square Miles	Watershed Area	MS4 Area	Federal Lands	State of Colorado	Denver Mountain Parks
Unincorporated Jefferson County	131.45	0.78	3.44	1.08	11.46
Clear Creek County	88.45	0	50.92	7.07	2.61
Park County	7.59	0	6.92		
Lakewood	7.35	7.35			
Morrison	1.65	0			
Totals	**236.50**	**8.13**	**61.27**	**8.16**	**14.07**

Figure 1. BCWA Watershed.

1.1.1 BCWA Board

The governing body of BCWA is its Board, which includes three membership types – Membership Entities, Participants, and Mailing List Status. The Membership Policy requires all permitted wastewater dischargers to be and remain members of the Association and will consist of no more than 25 membership entities and 12 designated participants. The Board meets monthly and is responsible for complying with the conditions of Regulation #74 as well as fiscal and policy matters. A variety of standing committees may be developed to support issues requested by the Board; other standing committees may be formed to address specific issues.

2024 BCWA Membership

Table 1. BCWA Membership Organization and Representatives.

Member Organization	
Aspen Park Metro District	**Geneva Glen Camp**
City & County of Denver	**Jefferson County**
Clear Creek County	**Jefferson County Schools**
Conifer Sanitation Association	**Kittredge Water and Sanitation District**
Denver Water	**City of Lakewood**
Evergreen Metro District	**Town of Morrison**
Forest Hills Metro District	**Tiny Town**
Genesee Water and Sanitation District	**West Jefferson County Metro District**

1.1.2 Vision and Mission

The BCWA monitors water quality within the Bear Creek Watershed and has adopted a clear vision, mission statement, key management objectives, and strategies to support environmental stewardship and water quality improvement throughout the watershed. These strategies guide the development and implementation of a locally driven monitoring program that meets applicable reservoir and watershed water quality standards and beneficial use classifications, as adopted by the WQCC. The BCWA's program elements, including administrative operations, annual work plans, budgets, and monitoring activities are periodically reviewed and maintained to ensure they remain effective and responsive to changing watershed needs. Modifications to these elements can be made during any regular Association Board meeting with a quorum of the membership, ensuring that the program remains adaptive, collaborative, and locally accountable.

1.2 Regulation 74 Responsibilities

The WQCC establishes water quality standards and designated beneficial uses for Bear Creek Reservoir in Regulation 38, which includes a chlorophyll- α standard of 12.2 ug/L as well as other water quality standards. The WQCC also established the Bear Creek Watershed Control Regulation **"Regulation 74"**. A control regulation can contain limitations on pollutants that are discharged, management requirements, and/or precautionary measures to prevent or minimize pollutants entering the water. The Bear Creek Watershed Control Regulation 74 prescribes point source load allocation as well as activities necessary to reduce the inflow of total phosphorus concentrations to Bear Creek Reservoir to attain the chlorophyll-α standard.

Regulation 74 requires:

- **Total Phosphorus Wasteload Allocations:** Wastewater treatment facilities are allocated specific annual total phosphorus loads to control nutrient loading into Bear Creek Reservoir.
- **Phosphorus Effluent Limitation Concentration Cap:** Point source discharges are restricted to a maximum total phosphorus concentration of 1.0 mg/L to prevent excessive nutrient input.
- **Nonpoint Source Management:** Implementation of BMPs is required to control nonpoint source pollution, aiming to reduce pollutant discharges into state waters.
- **Phosphorus Trading Program:** Establishment of a trading program managed by the Association and the Division allows for the exchange of phosphorus allocations among facilities to optimize water quality management.
- **Monitoring and Reporting:** Regular monitoring of nutrient loadings in major inflow streams to Bear Creek Reservoir is mandated, with data used to assess compliance and inform management decisions.
- **Annual Reporting:** BCWA is required to submit an annual report to the Commission summarizing water quality status, wastewater facility loadings, nonpoint source contributions, and the effectiveness of BMPs.

Collaboration through the BCWA is required to protect and improve water quality throughout the Bear Creek Watershed. Under the guidance of Regulation 74, BCWA members, including municipalities, counties, special districts, and state and federal agencies, each play a vital role in implementing coordinated watershed management strategies. These efforts include monitoring, education, regulatory compliance, nonpoint source control, and infrastructure improvements, all of which are essential to maintaining the ecological health of the watershed and the beneficial uses of Bear Creek Reservoir. The activities under Regulation 74 are assigned to different entities.

BCWA: The BCWA is the designated 208 management agency and is responsible for conducting regular water quality monitoring throughout the watershed and Bear Creek Reservoir to track conditions and inform management decisions. In addition to monitoring, BCWA supports education, public involvement, and implementation of best practices to protect water resources. The group operates through a cost-share program funded by its members and encourages broad stakeholder participation. BCWA must report annually to the Commission and Division on activities required under Regulation 74.

Colorado Water Quality Control Division: Under Regulation No. 74, the Colorado Water Quality Control Division (WQCD) serves as the 208 planning agency tasked with implementing measures to manage nutrient levels in the Bear Creek Watershed. This includes establishing total phosphorus effluent limitations for wastewater treatment facilities to control nutrient loading

into Bear Creek Reservoir. Additionally, the Division oversees the implementation of best management practices (BMPs) to address both point and nonpoint source pollution within the watershed. In January 2025, the Division released a draft Total Maximum Daily Load (TMDL) assessment for Bear Creek Reservoir, focusing on impairments related to chlorophyll-a and total phosphorus, with a public comment period extending through March 4, 2025.

Jefferson County Public Health: Jefferson County Public Health (JCPH) plays a pivotal role in safeguarding water quality within the county by collaborating with the state health department to prevent both manmade and naturally occurring contaminants from entering drinking water supplies. JCPH oversees the permitting, inspection, and regulation of Onsite Wastewater Treatment Systems (OWTS), ensuring they function effectively to prevent groundwater contamination. Jefferson County prohibits the construction of new OWTS within the Special Flood Hazard Area and designated floodplains. Additionally, JCPH enforces regulations related to stormwater management, aiming to reduce pollutants in runoff that could compromise local water bodies.

1.3 BCWA Section 208 Responsibilities

The BCWA is a Governor-designated Management Agency under Clean Water Act (CWA) Section 208 that focuses on areawide water quality management planning and implementation, particularly in areas with substantial urban-industrial concentrations or other factors causing water quality problems. This section establishes a network of state, regional, and local agencies to develop and implement areawide water quality management plans. As such, it has an important role in the management of water quality in the watershed. Federal Clean Water Act management agencies carry out Section 208 Plans. In Colorado, general-purpose local governments and special districts are designated as management agencies; BCWA is considered a 208-management agency.

1.3.1 Watershed Education

The BCWA and its members are actively engaged in a broad range of outreach and education initiatives to protect and enhance water quality and ecological health throughout the watershed. These efforts reflect a collaborative, science-based approach to watershed management that aligns with the goals of Regulation 74 and addresses both current and emerging challenges. The BCWA's long-term monitoring program, restoration work, and strategic partnerships, help to promote stewardship, reduce nonpoint source pollution, and build community resilience, particularly in the face of increasing wildfire risks. The following section highlights several core program areas that demonstrate BCWA's commitment to protecting the Bear Creek Watershed now and into the future.

Nonpoint Source Education & Outreach: BCWA and its members promote watershed stewardship through public education, outreach events, training classes (e.g., "Watershed 101"), newsletters, and collaborations with schools and community groups to encourage smart land and water management practices.

Watershed Monitoring & Restoration: The BCWA supports long-term water quality monitoring, invasive species control, noxious weed management, stream restoration, and sediment reduction efforts to protect watershed health.

Partnership Projects: BCWA partners with local organizations on stream cleanups, habitat restoration, wildfire risk reduction, and forest management.

Wildfire and Watershed Protection: BCWA contributed to wildfire hazard assessments identifying zones at risk for post-fire flooding and sedimentation impacts, influencing forest and watershed management priorities and may apply for more funding through the Colorado Water Plan Grant program in July 2025.

1.3.2 Planning Overview

Some BCWA members develop Source Water Protection Plans, maintain infrastructure such as catch basins and dams, and undertake sediment and erosion control projects. Efforts include aquatic nuisance species inspections at Bear Creek and Evergreen Lakes, harvesting invasive aquatic plants, and nuisance algae and cyanobacteria identification.

BCWA participates in studies assessing additional storage capacity at Bear Creek Lake, evaluating impacts on water quality, aquatic habitat, and reservoir operations.

1.3.3 Key Management Objectives

The BCWA is committed to monitoring and improving water quality within the Bear Creek watershed by implementing a comprehensive, adaptive, and collaborative management approach. A primary objective is to meet the regulatory requirements established in the Bear Creek Reservoir Control Regulation #74, Regulation #85, and water quality standards outlined in Regulation #38 and Colorado's Basic Standards. The BCWA plays a critical role in monitoring environmental and water quality conditions throughout the watershed to ensure compliance with these standards.

A strong focus is placed on using adaptive watershed-level strategies, maintaining specific water quality and reservoir management targets, and sustaining a viable, long-term organization. The BCWA’s collaborative membership representing counties, municipalities, special districts, state agencies, and citizen groups supports a flexible and effective management plan that addresses the interconnected nature of land use, water supply, and water quality.

The BCWA promotes public education and community involvement, acknowledging the importance of outreach in building stewardship.

1.3.4 Target Strategies

To achieve the BCWA's goals, a wide range of target strategies which include implementing all monitoring, management, and reporting requirements outlined in Regulations 74 and 85, and maintaining close cooperation with the Water Quality Control Division have been established. It functions as an operational water quality management agency and supports trading programs for nutrient reductions, wastewater utility planning, and review of site applications. A robust monitoring program is maintained, with a Quality Assurance Project Plan guiding both routine and special studies of surface, groundwater, and stormwater systems. This data is shared through collaborative processes and helps ensure that recreational, aquatic life, and water supply standards are met throughout the watershed. The Association also supports efforts to protect and enhance fisheries, particularly the Brown Trout population in the Bear Creek mainstem.

Public awareness is a key component of the program. The BCWA supports the development of education initiatives to raise awareness about nonpoint source pollution and fosters citizen involvement in watershed management. It evaluates economic drivers and funding opportunities, assesses regulatory relationships, and identifies technical information needs to support future program planning. The effectiveness of the program is regularly reviewed to ensure alignment with state planning requirements and local compliance goals. The BCWA also reviews wastewater utility plans and actively supports restoration activities that enhance water and environmental quality.

Specific reservoir management strategies are also in place. The BCWA monitors conditions in Bear Creek Reservoir and Evergreen Lake to assess compliance with water quality standards and trends over time. In Evergreen Lake, the BCWA supports the reservoir's use as a direct water supply. For Bear Creek Reservoir, one of the key targets is the reduction of total phosphorus loads from both point and nonpoint sources to enhance water quality, recreational opportunities, and to support the fishery of warm and cold-water species.

1.3.5 Regulatory Considerations

In April of 2023 the Regulation 31 and 38 "Lake Nutrients Criteria" a Rule Making Hearing (RMH) was held. At this RMH, the WQCC adopted chlorophyll-a standards in all lakes and reservoirs 25-acres or larger in surface area. Bear Creek Reservoir already had a chlorophyll-a standard at the time of this 2023 RMH and no changes were made to this standard at this RMH. The WQCC also adopted TP and total nitrogen (TN) standards for certain reservoirs in Colorado located

upstream of qualified permitted wastewater dischargers, meaning no TP nor TN standards were adopted in Bear Creek Reservoir at this RMH. It was stated by the WQCC that their intention was to revisit this topic at a RMH in 2027 for adoption of lake nutrient standards statewide. However, recent communication from the WQCD indicates that it is unlikely that a proposal will be brought to the WQCC until 2030 at the earliest.

2. Point Source Controls

In the Bear Creek Watershed, point source discharges from WWTFs are regulated through a combination of effluent limits, wasteload allocations (WLAs), and nonpoint source control strategies. Regulation 85 establishes nutrient monitoring and reporting requirements, while Regulation 74 sets phosphorus WLAs to protect water quality in the watershed. WWTFs must comply with stringent total phosphorus effluent limits and are supported by a phosphorus trading program and reserve pool, which provide flexibility in meeting regulatory requirements while maintaining watershed-wide nutrient load reductions. These controls work together to reduce nutrient enrichment and support long-term water quality goals.

2.1 Regulation 85

The monitoring requirements established under WQCC Regulation No. 85 (5 CCR 1002-85) are designed to evaluate nutrient sources and loads at selected locations and assess the effectiveness of implemented controls. The BCWA supports the WWTFs within the watershed, assisting with Regulation 85 monitoring requirements.

All WWTFs in the watershed are classified as minor facilities. Consequently, upstream and downstream monitoring is not required for surface-discharging treatment works. However, all surface-discharging facilities must meet Regulation 85 effluent monitoring requirements, including certification and reporting as specified in the regulation. The data collected under Regulation 85 is separate from permit Discharge Monitoring Report (DMR) reporting.

While Regulation 85 monitoring is mandatory for permitted surface water dischargers, its implementation is not BCWA's direct responsibility. However, the BCWA board has determined that incorporating Regulation85 monitoring into BCWA's broader watershed monitoring plan under Reg 74 could enhance water quality management and provide shared funding benefits. This integrated approach meets state requirements while supporting a more comprehensive and coordinated nutrient management strategy. Participation in this joint monitoring effort by wastewater treatment facilities is voluntary.

BCWA coordinates effluent sample collection with participating facilities, with analysis conducted by a separate Analytical Laboratory. Facilities reimburse BCWA for laboratory costs. Sampling occurs during the first or second week of every other month, starting in January.

WWTFs listed in Table 2. sample effluent from their respective facilities, which is conducted according to each associated discharge permit requirements.

Table 2. BCWA WWTF Dischargers and Associated CDPS Permit Numbers

WWTF Entity	CDPS Permit Number
Geneva Glen Camp	COX634037
Conifer Center Sanitation Association	COX047392 (will be updated to COX631082)
Jefferson County Schools - Mount Evans Outdoor Lab School	COG589138
Conifer Metro District	COG589060
Jefferson County Schools - Conifer High School	CO0047988
Town of Morrison	CO0041432
Forest Hills Metro District	CO0037044
Bear Creek Development Corp - Tiny Town	CO0036129
Evergreen Metro District	CO0031429
Brook Forest Inn (Renamed Brookside Chateau LLC)	CO0030261
Kittredge Water and Sanitation District	CO0023841
Genesee Water and Sanitation District	CO0022951
West Jefferson County Metro District	CO0020915
Aspen Park Metro District	CO0000001
West/Brandt Foundation - Singing River Ranch	Converted to OWTS (but still included in REG 74)
The Fort	Closed (but still included in Reg 74)
Davidson Lodge	Closed (but still included in Reg 74)

2.2 WWTF Compliance

WWTFs in the Bear Creek Watershed are regulated under phosphorus WLAs established by Regulation 74 to protect water quality in Bear Creek Reservoir. These WLAs set annual limits on the amount of phosphorus each permitted discharger can release and are a key element of BCWA's nutrient management strategy. The following section summarizes WLA compliance, phosphorus discharge concentrations, and reserve pool status for 2024.

2.2.1 Summary of Permitted WWTF Total Phosphorus Assigned Wasteload Allocations and Effluent Limits

A WLA is the portion of a waterbody's total allowable pollutant load that is assigned to regulated point sources, such as wastewater treatment plants or permitted stormwater discharges. WLAs are established to ensure that these discharges do not cause or contribute to

exceedances of water quality standards. In the Bear Creek Watershed, WLAs are a key part of the phosphorus control strategy under Regulation 74 and are used to guide permitting, trading, and compliance efforts among BCWA members.

The total WLAs of phosphorus from all WWTFs in the Bear Creek Watershed is 5,255 pounds per year (lbs/yr). Each permitted discharger is assigned an annual total phosphorus TP WLA, except where modified through trading provisions. As shown in **Error! Reference source not found.**3, all WWTFs remained within their annual WLAs in 2024 for a total of 1,254.3 lbs/yr.

BCWA wastewater dischargers are also subject to TP effluent concentration limits ranging from 0.5 to 1.0 mg/L as a 30-day average, depending on their discharge permits (Table 3). also presents the monthly phosphorus discharge concentrations (in mg/L) for each permitted WWTF in the watershed, providing additional context on overall compliance and discharge trends throughout the year. Two WWTFs exceeded their permitted concentration-based TP effluent limits: 1) Forest Hills Metro District had three exceedances in February, June, and September, while Geneva Glen Camp exceeded its limit in June, the only month it discharged wastewater. A full summary of monthly WLAs and discharge data for each WWTF is included in Appendix B.

Table 3. Permitted WWTFs in the Bear Creek Watershed and their Associated Total Phosphorus WLAs, Permit Limits, and Compliance Status in 2024.

WWTF	TP Annual Load (lbs/yr)	TP WLA (lbs/yr)	TP WLA Compliance	TP Permit Limit (mg/L)	TP Permit Limit Compliance
Brook Forest Inn (Renamed Brookside Chateau LLC)[1]	0.0	5	Yes	1.0	Yes
Evergreen Metro District	578.9	1,500	Yes	1.0	Yes
Forest Hills Metro District[2]	53.3	80	Yes	1.0	**No**
Genesee Water and Sanitation District	287.6	1,015	Yes	1.0	Yes
Jefferson County Schools - Mount Evans Outdoor Lab School	0.8	20	Yes	1.0	Yes
Kittredge Sanitation District	46.6	240	Yes	1.0	Yes
Town of Morrison	49.6	600	Yes	1.0	Yes
West Jefferson County Metro District	210.9	1,500	Yes	1.0	Yes
Aspen Park Metro District	3.2	40	Yes	0.5	Yes
Tiny Town[1]	0.0	5	Yes	0.5	Yes
Conifer Center Sanitation Association	2.7	40	Yes	0.5	Yes
Conifer Metro District	1.0	40	Yes	0.5	Yes

Geneva Glen Camp[1]	4.1	5	Yes	1.0	**No**
Jefferson County Schools - Conifer High School	15.4	110	Yes	1.0	Yes
Reserve Pool[3]	--	55	--	--	--
Totals	**1,254.3**	**5,255.0**			

1. Brook Forest Inn and Tiny Town did not discharge in 2024 but remain permitted; Geneva Glen only discharged in June 2024.
2. Forest Hills Metro District failed to collect a sample in January of 2024.
3. The reserve pool in the Control Regulation is 2 pounds of total phosphorus, the 55 pounds listed by the BCWA includes pounds from closed WWTFs: Singing River Ranch (30), The Fort Restaurant (18), and Bear Creek Cabins (5).

2.2.2 Phosphorus Trading and Reserve Pool

There were no phosphorus transfers, trades, or alternative reduction agreements in 2024.

The reserve pool as outlined in Reg 74 is 2 pounds of total phosphorus per year. The 55 pounds or reserve pool listed by the BCWA in Table 4 for 2024 includes the baseline reserve pool of 2 pounds per year, plus the pounds originally allocated to, presently, closed WWTFs: Singing River Ranch (30 pounds per year), The Fort Restaurant (18 pounds per year), and Bear Creek Cabins (5 pounds per year). The sum of these allocations plus the original reserve pool allocation of 2 pounds per year results in a total 2024 reserve pool of 55 pounds per year.

3. Non-Point Source Controls

All municipalities with Municipal Separate Storm Sewer System (MS4s) permits from the Colorado Department of Public Health and Environment (CDPHE) in the watershed have adopted stormwater programs consistent with jurisdictional development and redevelopment projects including required construction-phase and permanent stormwater control measures.

BCWA maintains a comprehensive watershed-monitoring program to determine sources of nutrient loading into waterways (including non-point sources).

3.1 Regulated Stormwater MS4 Permittees

Stormwater dischargers in the Bear Creek Watershed operate under MS4 permits, which require implementation of BMPs to reduce pollutants in runoff and protect downstream water quality. Regulated MS4 entities play an important role in meeting the goals of Regulation 74 by addressing nonpoint source pollution, managing construction and post-construction runoff, and supporting public education and outreach. The following section outlines key stormwater program activities and accomplishments from 2024.

3.1.1 City of Lakewood

Lakewood operates MS4 Permit No. COS000002, implementing six programs including illicit discharge control, construction site runoff management, and wet weather monitoring. The City also supports pollution prevention through the Rooney Road Recycling Center (RRRC), which has diverted over 11 million pounds of household hazardous waste from waterways since 1994. Additionally, Lakewood installed floating islands in Horseshoe Pond to reduce nutrient pollution, helping prevent harmful algae blooms and has also continued the EutroSORB treatment program on Big Soda Lake for the 3rd year running to remove internal phosphorous loading.

Lakewood also participates in various other educational / non-point source programs city-wide. For example, Lakewood partners with JeffCo Open Space in the "Lets Doo It" campaign to promote the pick-up and removal of pet waste from parks and open space and in collaboration with "Keep It Clean," the City has placed signage in nearby RTD busses and bus shelters to spread awareness on nutrient and pet waste pollution. Lastly, Lakewood continued the "Inlet Marking Program" which implements the installation of "No Dumping, Drains to Stream" medallions on old and new drainages.

The summary of 2024 MS4 Program Data for inspections and enforcement actions for both Lakewood and Jefferson County are listed below in Table 4.

3.1.2 Jefferson County

Jefferson County's stormwater program covers public education, illicit discharge detection, construction and post-construction runoff control, and pollution prevention. Jefferson County supports RRRC operations, hosts community cleanups along the Clear Creek corridor event (25,000 pounds of trash removed in 2024) and maintains erosion control programs throughout the County. Jefferson County regularly inspects construction and stormwater facilities and reports those activities to BCWA (Table 4).

Table 4. Land Use Agency Activity Summary for MS4 Programs in 2024.

Land Use Agency	Permit Number	Permit Inspection Actions			Permit Enforcement Actions		
		Illicit Discharges	Construction	Post-Construction	Illicit Discharges	Construction	Post-Construction
City of Lakewood	COS000002	11	1,807	287	0	1,415	31
Jefferson County	COR090024	15	205	52	6	39	0

3.2 Watershed Non-Point Source Programs

Evergreen Metro District Phosphorus Removal Effort

To reduce the potential of algae growth, Evergreen Metro District (EMD) is continuing a project to remove phosphorus from the Wilmot drainage that flows into Evergreen Lake based on increased nutrient loading results from the BCWA. The project uses environmentally safe filter media (EutroSORB) that rapidly binds phosphorus found in flowing or still water. Previous years demonstrate that this project has permanently removed over 32 pounds (67% of the load) of total phosphorus, which helps prevent harmful algal blooms in Evergreen Lake, increasing overall drinking water quality and allowing continued safe recreation.

Big Soda Lake Phosphorus Sequestration

Big Soda Lake, in Bear Creek Park, has experienced increased harmful algal blooms in recent years, leading to swim-beach closures and restrictions on other water activities. A preliminary sediment analysis indicated that 1,300 pounds of phosphorus were concentrated in the surface sediments of the deeper areas of the lake, indicating a serious internal phosphorus loading issue.

Image 1. Phosphorus sequestration application at Big Soda Lake, 2025.

During 2022 and 2023, applications of a phosphorus binding product, EutroSORB, composed of lanthanum modified bentonite, were completed to bind excess phosphorus in the water column and sequester the phosphorus in the sediments contributing to nutrient loading. This treatment binds bioavailable phosphorus, reducing the nutrient levels that fuel cyanobacteria (blue-green

algae) blooms. As a result, the frequency and severity of harmful algal blooms have declined, leading to fewer recreational closures of the reservoir. Continued monitoring has shown that the applications have been effective in maintaining water quality and supporting the lake's recreational and ecological uses and are planned to continue through 2027.

Bear Creek Reservoir Aeration System

The aeration system at Bear Creek Reservoir plays a key role in maintaining dissolved oxygen levels and overall reservoir health, particularly during the summer growing season when the risk of low oxygen conditions and internal nutrient release is greatest, typically June through September. The City of Lakewood, in partnership with BCWA, pursued a full system replacement with fine-bubble diffusers strategically placed to optimize oxygen transfer throughout the water column. Since installation in 2016, Lakewood and BCWA have monitored system performance that demonstrates improved oxygen concentrations which is important during critical periods. Based on this success, both parties recommend future expansion of the aeration system to further support water quality and nutrient management goals within the reservoir.

4. Monitoring Program

In accordance with Regulation 74, the BCWA has implemented a long-term water quality monitoring program in Bear Creek watershed and Bear Creek Reservoir to characterize inflow and in-reservoir water quality and assess compliance with select water quality standards, particularly those related to the chlorophyll- α standard.

The Bear Creek Watershed Association Sampling and Analysis Plan (SAP) outlines the details of the monitoring program to systematically collect data on key water quality parameters to assess stream and reservoir health, detect trends, and support regulatory compliance and watershed management efforts.

The primary focus of the monitoring program is analysis of nutrient concentrations to evaluate nutrient loading from sources such as WWTFs, stormwater runoff, and agricultural inputs. Physical parameters including temperature, pH, conductivity and Dissolved Oxygen (DO) are collected throughout the watershed and depth profiles in the Bear Creek Reservoir, Big Soda Lake and Evergreen Lake. These values are used to assess attainment of Aquatic Life Standards specified in Regulation 38.

Flow data is also used and collected to inform variability of seasonal flow, pollutant transport, and to calculate the mass storage of nutrients to the Reservoir on an annual basis. **Error! Reference source not found.** depicts the key monitoring locations included in the monitoring program. Additional context and details for the data collected during 2024 can be found in the BCWA's 2024 Sampling and Analysis Plan (Appendix C).

5. Watershed Monitoring

Watershed monitoring in the Bear Creek watershed is completed under the requirements of Reg 74. Many of the parameters included in the monitoring program align with those established under Reg 38 for supporting healthy aquatic life.

5.1 Precipitation

Precipitation in the watershed plays a major role in stream flows and water quality. In order to represent two different positions within the watershed, both geographically and hydrologically multiple weather stations were used. Evergreen (Station ID: 052790), located at an elevation of 7,002 feet, sits in the upper to mid-watershed area and captures precipitation patterns that are more influenced by mountain and foothill weather systems. In contrast, the Marston Filter Plant (Station ID: 055402), although not in the Bear Creek watershed, at 5,520 feet, lies closer in elevation and location to Bear Creek Reservoir, representing lower watershed conditions.

Because of its higher elevation and position farther upstream, Evergreen typically receives greater precipitation than Marston, as reflected in the 2024 data. This spatial difference is important when assessing water availability, runoff contributions, and timing of flow into Bear Creek Lake.

Figure 2. shows monthly precipitation totals for 2024 at the Marston Filter Plant and Evergreen, compared to long term historical averages from 2000-2024 and the NOAA Normal. Early 2024, particularly March and April, were significantly higher than the historical averages. Overall, Evergreen experienced higher precipitation than Marston in most months.

For the summer months (June through August), precipitation in 2024 generally aligned with historical trends, except for Evergreen in August, which saw a notable increase of nearly 3 inches. Both Marston and Evergreen experienced higher-than-average precipitation in November. In contrast, the beginning and end of the year, particularly January, October, and December were relatively dry across all data series. These trends highlight a wetter-than-average spring and late fall in 2024.

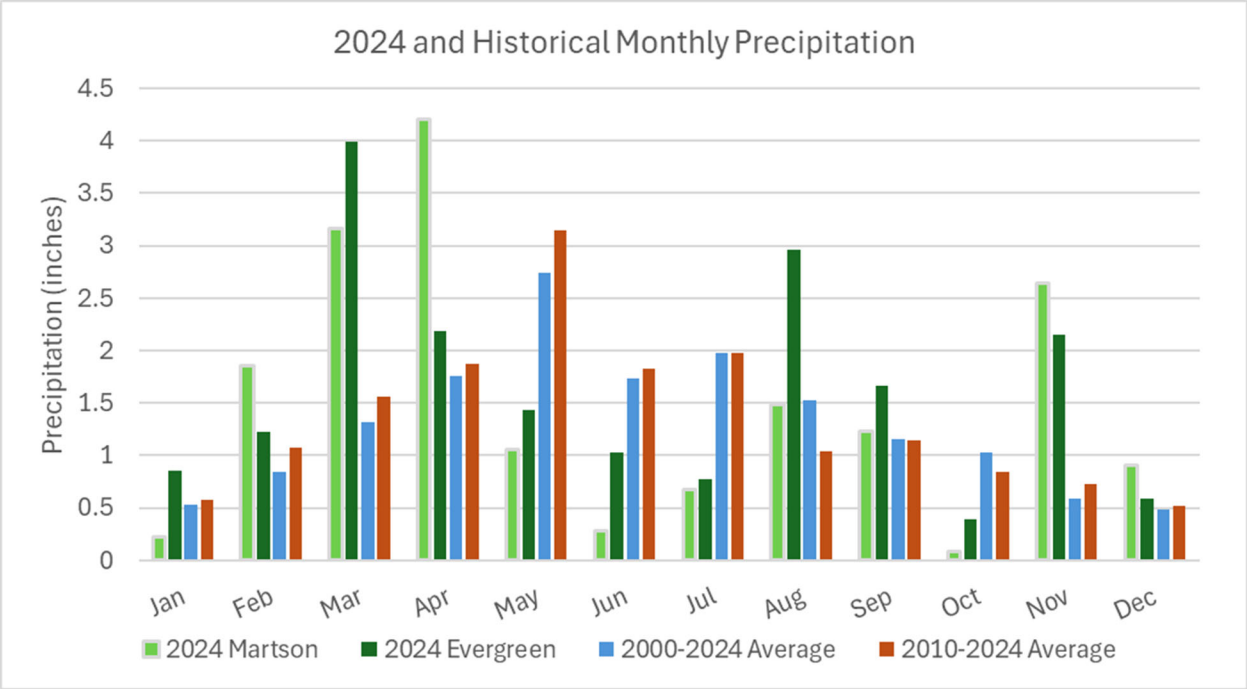


Figure 2. 2024 Monthly Precipitation at Marston Filter Plan and Evergreen and historical averages.

5.2 Inflows to Bear Creek Reservoir

Bear Creek Reservoir receives inflow primarily from two sub watersheds, Bear Creek and Turkey Creek, which together account for the majority of surface water entering the reservoir from runoff, snowmelt, rainfall, and baseflow throughout the year. In addition to stream inflows, direct precipitation falling on the reservoir surface contributes to the overall water volume. Conversely, water is lost from the reservoir through the outlet as flow is released downstream and through evaporation, especially during the warmer months when surface temperatures and solar radiation are highest. Together, Bear Creek and Turkey Creek inflows, direct precipitation, and evaporation form the foundation of the reservoir's water balance calculations.

Bear Creek Reservoir's hydrologic inputs are dominated by surface water inflows from Bear Creek and Turkey Creek, which together drain the Bear Creek watershed and deliver runoff generated from precipitation, snowmelt, and baseflow. Additional inputs include direct precipitation onto the reservoir surface, while evaporation represents a significant water loss, particularly during the summer growing season. These components of stream inflows, precipitation, and evaporation are integrated into water balance calculations to estimate changes in reservoir storage. To evaluate nutrient dynamics, the concentrations of total phosphorus and other constituents in the Bear Creek and Turkey Creek inflows, along with outflow measurements at the reservoir outlet, are paired with flow volumes to calculate nutrient

loading and export. The difference between inflow loads and outflow loads, adjusted for internal cycling processes, provides an estimate of net nutrient accumulation or depletion in the reservoir, which is essential for understanding eutrophication risks and evaluating the effectiveness of watershed nutrient control measures.

5.3 Surface Water Inflow

Of the two sub-basins in the Bear Creek Watershed the Bear Creek sub-basin is the larger of the two, with a drainage area of about 176 square miles. It originates in the Mount Evans Wilderness and flows eastward through communities such as Evergreen, Kittredge, and Morrison before entering Bear Creek Lake. This sub-basin accounts for approximately 72% of the average annual inflow to Bear Creek Lake.

The Turkey Creek sub-basin covers a drainage area of approximately 47.2 square miles. It lies southwest of Denver in the foothills of the Rocky Mountains, with elevations ranging from about 6,000 to 10,500 feet. This sub-basin contributes roughly 28% of the average annual inflow to Bear Creek Lake.

Inflow and storage information and relative inflows were used in WY 2024 to inform the water balance.

5.3.1 In-Situ Field Parameters

Watershed sampling includes in-field measurements of pH, temperature, dissolved oxygen (DO), and specific conductance (also known as conductivity) at the time of water quality grab sample collection to provide context for interpreting laboratory results and help track seasonal changes, flow variability, and watershed activities influence aquatic health. These parameters are critical for understanding baseline stream conditions, identifying temporal and spatial trends, and assessing compliance with state water quality standards.

Temperature

The Bear Creek Watershed temperature highlights seasonal warming and site-specific differences in thermal regimes across the watershed. Figure 3shows monthly water temperature trends for multiple monitoring locations in the Bear Creek Watershed during 2024. Temperatures generally increase from February through August, peaking in late summer before beginning to decline.

The highest temperatures are observed at the LBC D/S BCR site, which reaches approximately 23°C in August, while RNY GLCH U/S and D/S tend to remain among the coolest sites. Most sites show a consistent seasonal warming pattern, with minor variations based on location and

upstream/downstream positions. This data highlights seasonal warming and site-specific differences in thermal regimes across the watershed.

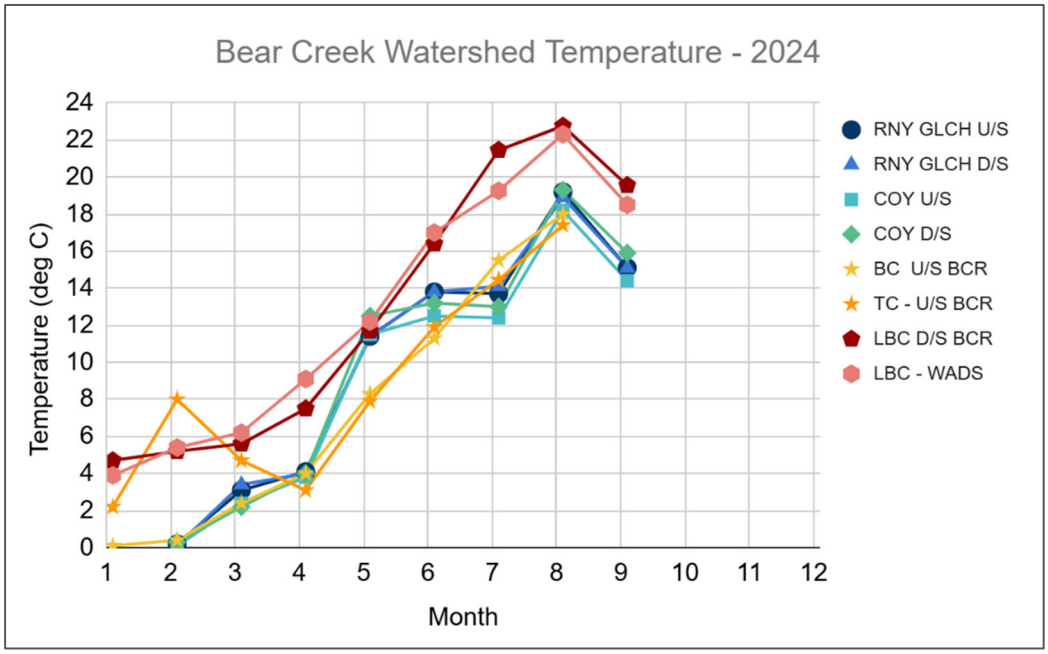


Figure 3. Temperature measured in 2024 in the Bear Creek Watershed.

pH

pH values for various monitoring sites across the Bear Creek Watershed in 2024 are depicted in Figure 4. Overall, pH levels at all sites remain within a relatively narrow range, mostly between 8.0 and 8.7, indicating slightly basic conditions throughout the year (Figure 3).

Most sites remain fairly stable, suggesting consistent buffering capacity and low acidification risk and the increase and decrease at some sites could reflect changes in biological activity or flow conditions.

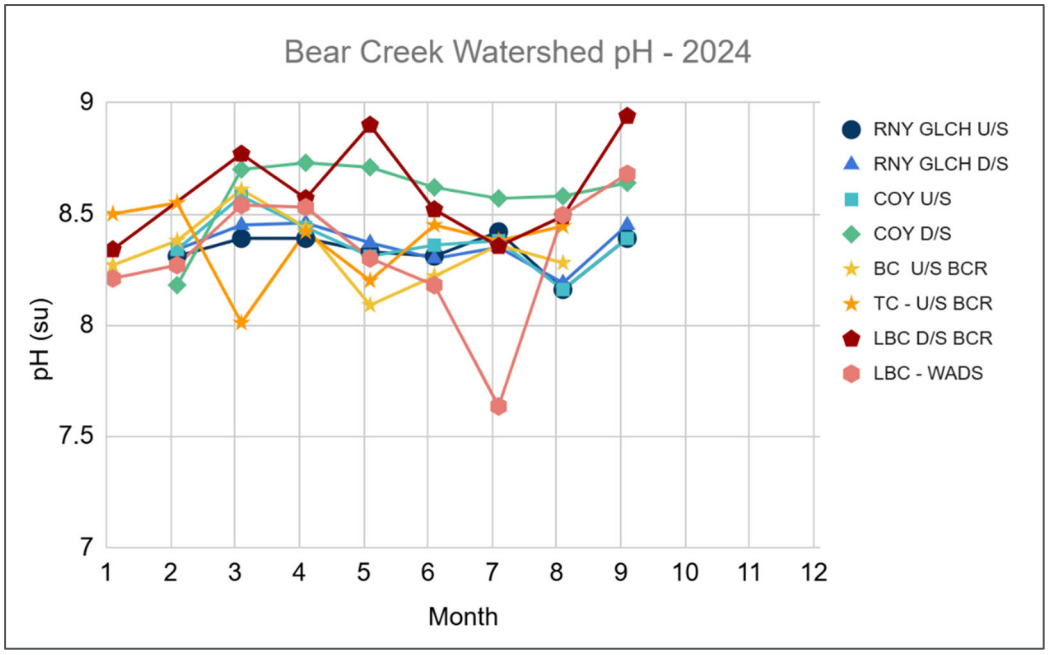


Figure 4. pH measured in 2024 in the Bear Creek Watershed.

Conductivity

Conductivity, an indicator of the concentration of dissolved ions in water, varies significantly across the watershed.

The Rooney Gulch sites (RNY GLCH U/S and D/S) sites consistently show the highest conductivity levels ranging from ~3,000 to over 5,000 µS/cm, suggesting a pollution source of elevated salinity or mineral content, likely influenced by upstream inputs or groundwater contributions (Figure 5). Although there are no stream conductivity standards for the Bear Creek watershed, the EPA considers levels above 1,500 µS/cm above average for most streams in the US.

In contrast, sites on Bear Creek and downstream of the Reservoir (LBC D/S BCR and LBC – WADS) maintain relatively low and stable conductivity below 600 µS/cm, indicating lower ion concentrations.

Turkey Creek (TC - U/S BCR) shows sharp variability, particularly a spike in July and August exceeding 2,000 µS/cm, which may indicate episodic inflows or runoff events. Overall, the data highlight spatial differences in water chemistry across the watershed.

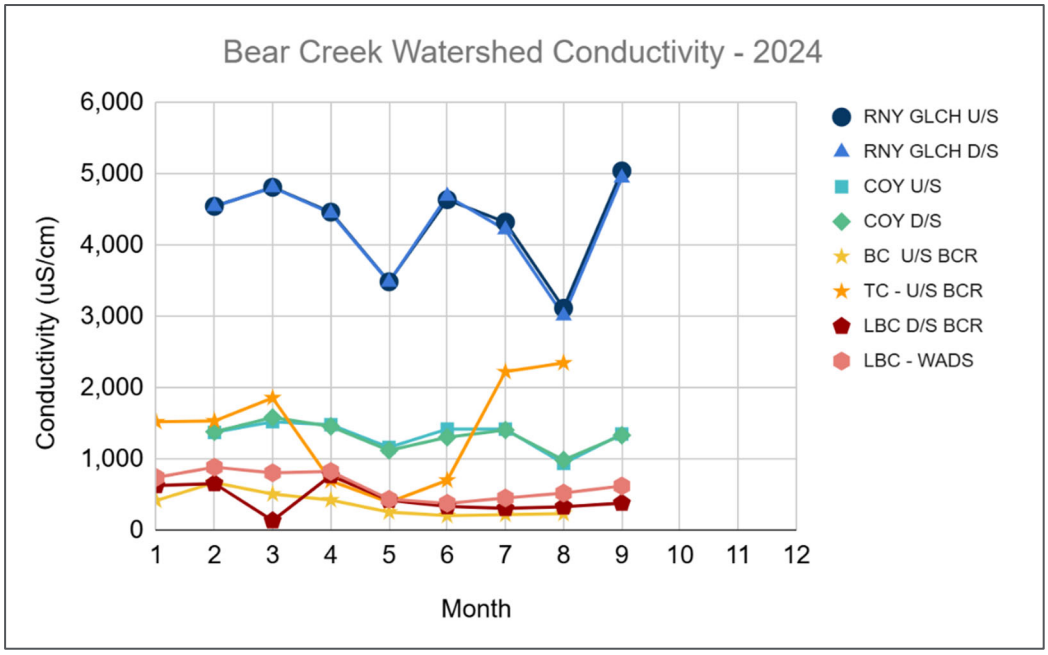


Figure 5. Conductivity measured in 2024 in Bear Creek Watershed.

Dissolved Oxygen

The Reg 38 DO standards for Bear Creek and Turkey Creek upstream of the Reservoir are classified as Cold Water Aquatic Life Class 1 and have a minimum threshold of 6.0 mg/L and a 30 day average of 7.0 mg/L. In 2024, dissolved oxygen (DO) concentrations across the Bear Creek Watershed exhibited typical seasonal trends, with higher levels during cooler months and declines observed in summer (Figure 6). Most sites maintained DO levels above 8 mg/L in winter and spring, although the sites on Rooney Gulch and Coyote Creek (RNY GLCH U/S, RNY GLCH D/S, and COY U/S) showed notable decreases in June and July, dropping to below 6.0 mg/L. Most sites remained in compliance with these standards, though mid-summer values at a few locations approached or briefly dipped near the 1-day minimum threshold, emphasizing the importance of continued monitoring during warm, low-flow periods.

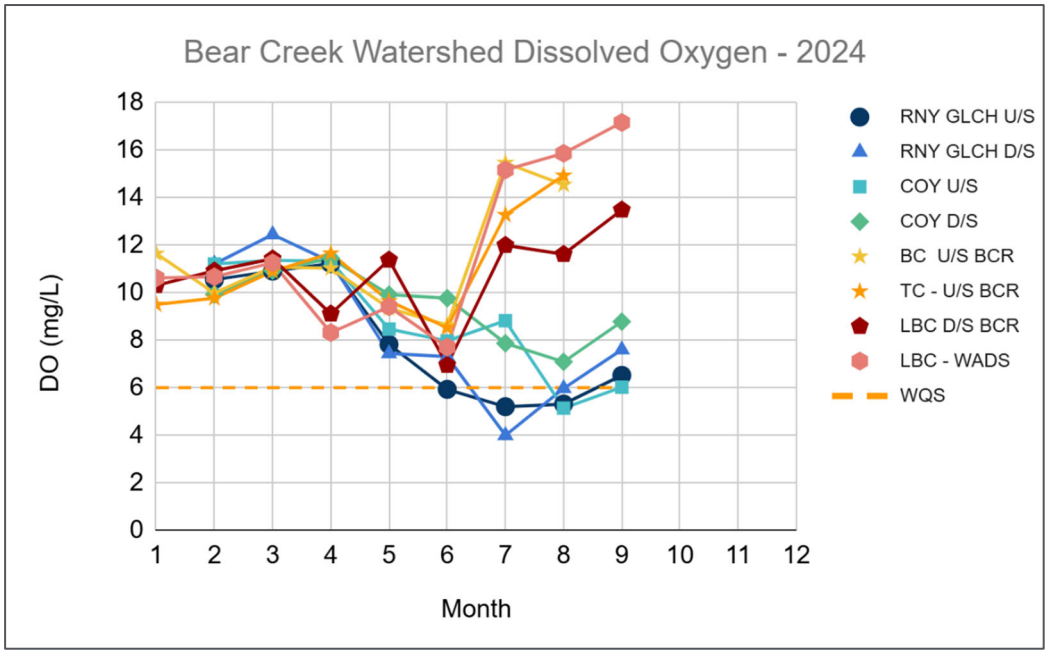


Figure 6. Dissolved oxygen measured in 2024 in Bear Creek Watershed.

5.3.2 Surface Water Concentrations

Nutrients are monitored at key tributary sites throughout the Bear Creek Watershed in 2024 to assess nutrient contributions to Bear Creek Reservoir. Watershed samples for phosphorus and nitrogen concentration analysis are collected monthly at the monitoring locations included in the current SAP. Although there is not a current water quality standard for instream phosphorus concentrations, the interim value established in 2012 is 110 ug/L.

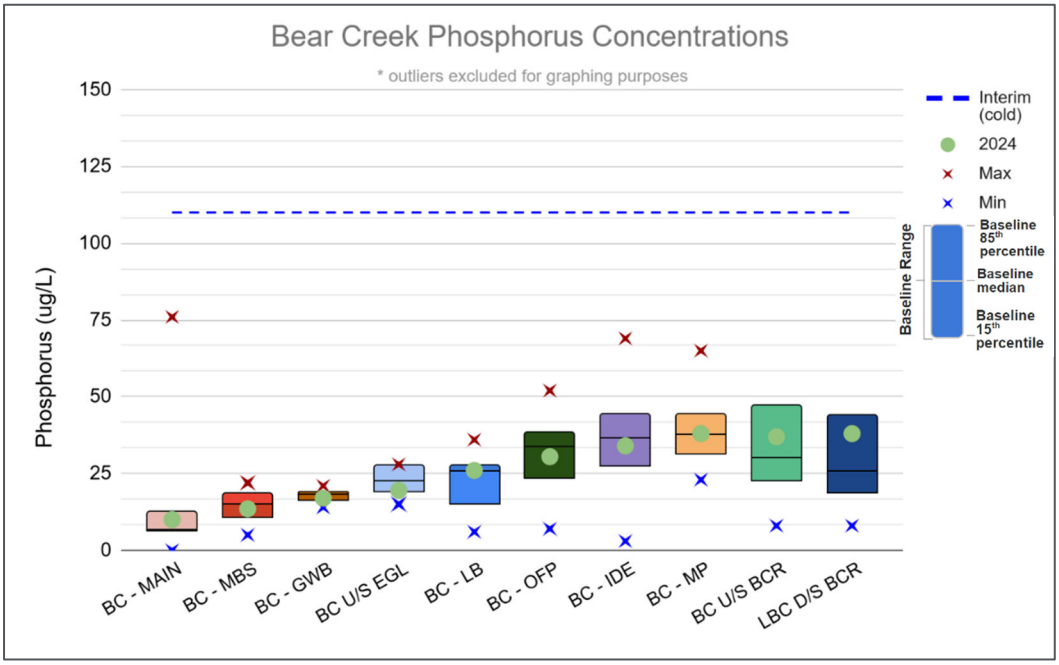


Figure 7. Bear Creek total phosphorus concentrations, historical baseline and 2024 median.

Bear Creek TP concentrations measured in 2024 at sites from upstream to downstream are shown in Figure 7. In 2024, median TP concentrations on Bear Creek were slightly higher than the historical median (2013-2024) at the mainstem below Summit Lake (BC-MAIN), and just above and below Bear Creek Reservoir (BCU/S BCR and LBC D/S BCR) (Figure 7.). The rest of the 2024 median concentrations were at or below the historical median and all fell within the 25th and 75th percentiles of the same time period.

In 2024, phosphorus concentrations remained relatively low at upstream sites such as Vance Creek (VNC CK) and Cemetery (CMTRY), consistent with historical patterns (Figure 8). Moderate concentrations were observed at Cub Creek (CUB) and North Turkey Creek near Flying J (NTC-FLYJ), while Troublesome Creek (TRB CK) exhibited some of the highest concentrations in the watershed, consistent with previous years. South Turkey Creek near Myers Ranch (STC-MYERS) also recorded elevated phosphorus levels in 2024, exceeding the 75th percentile of historical data, suggesting a potential area of concern. In contrast, concentrations at Turkey Creek just upstream of Bear Creek Reservoir (TC U/S BCR) remained near historical medians.

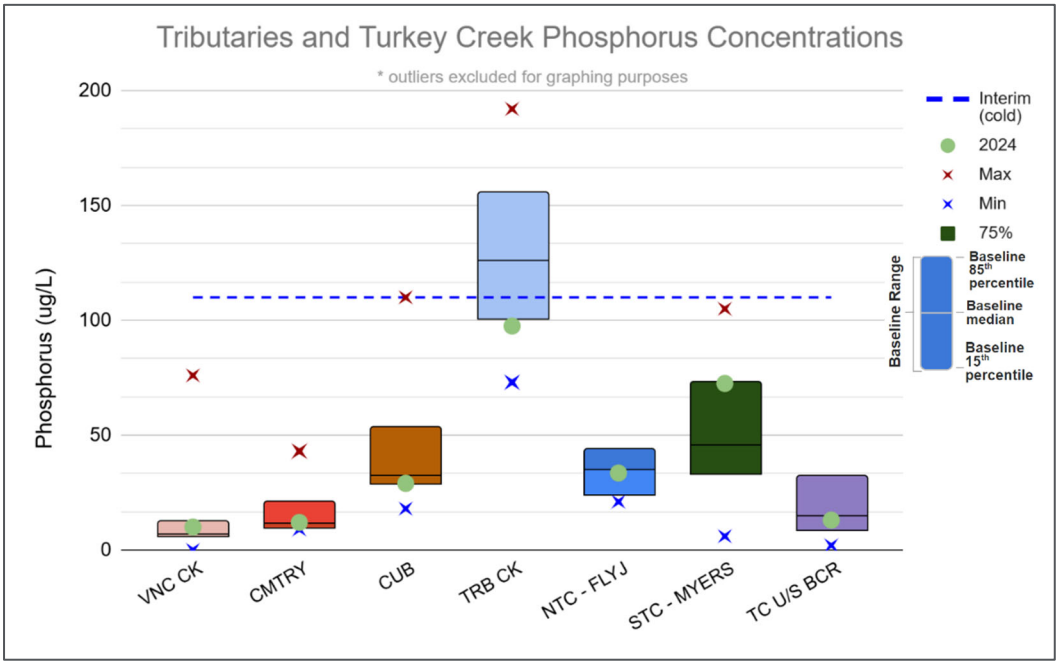


Figure 8. Phosphorus concentrations in other tributaries of the Bear Creek Watershed and Turkey Creek, historical baseline and 2024 median.

When evaluating 2024 median phosphorus concentrations at the locations where both upstream and downstream concentrations are monitored, all values were above the historical medians (Figure 9). Although the historical and 2024 median concentrations on Coyote Creek (COY CK) and Coyote Crossing (COY X) were slightly lower downstream the downstream concentrations.

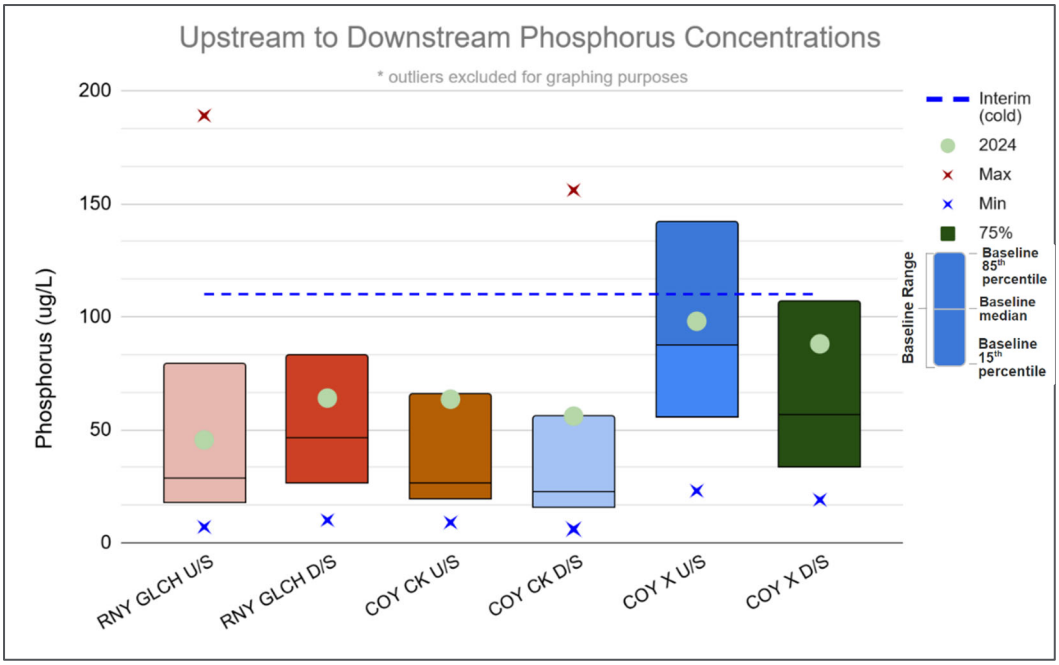


Figure 9. Upstream to downstream phosphorus concentrations, historical baseline and 2024 median.

6. Reservoir Monitoring

Bear Creek Reservoir is regulated under nutrient and aquatic life standards established by the WQCC to protect water quality and designated uses. The seasonal chl a standard is set at 12.2 µg/L, based on the seasonal mean from July through September with an allowable exceedance frequency of once in five years. This value was developed using a reservoir-specific translator derived through a two-step process: establishing a statistical relationship between phosphorus and chlorophyll based on summer average concentrations in the reservoir then applying a translator to account for natural variability, resulting in the exceedance threshold of 22.2 µg/L.

The epilimnion of a lake or reservoir is the mixed layer near the surface where the most phytoplankton algae reside because of its higher relative temperature and sunlight penetration for photosynthesis. The hypolimnion, or bottom layer, is cooler and denser and is where suspended materials settle to the bottom to decompose.

During bacterial decomposition, DO levels decline in the hypolimnion which lead to internal loading of phosphorus from the sediments. Sediment analysis had indicated that the concentrations of phosphorus in the sediments of Bear Creek Reservoir play a significant role in internal phosphorus loading. When the reservoir mixes, this phosphorus reaches the epilimnion where it can drive additional algae growth. Samples from Bear Creek Reservoir and Evergreen Lake are collected at both the top and bottom representing the epilimnion and hypolimnion respectively.

In addition to chl α and nutrient standards, Bear Creek Reservoir is subject to warm-water aquatic life criteria, which include thresholds for dissolved oxygen, pH, temperature, ammonia, and metals. These standards are designed to ensure the reservoir supports aquatic life and maintains long-term ecological and recreational value. The results from the reservoir monitoring program in 2024 are outlined in the sections below.

6.1 Chlorophyll α

Chlorophyll α (chl α) is an indicator of the prevalence of algae, and high levels of algae may impact beneficial uses. Chl α is also an enforceable water quality standard that the Division uses in its biennial assessment of water quality in the Bear Creek Reservoir.

The chl α concentrations at each of the three main reservoirs in the watershed Bear Creek Watershed (Bear Creek Reservoir, Big Soda Lake, and Evergreen Lake during each of the monitoring events in 2024 are Figure 10. Although the chl α concentrations in all Bear Creek Reservoir remained low through early August, the concentrations increased significantly in mid-August and remained high through the September monitoring events.

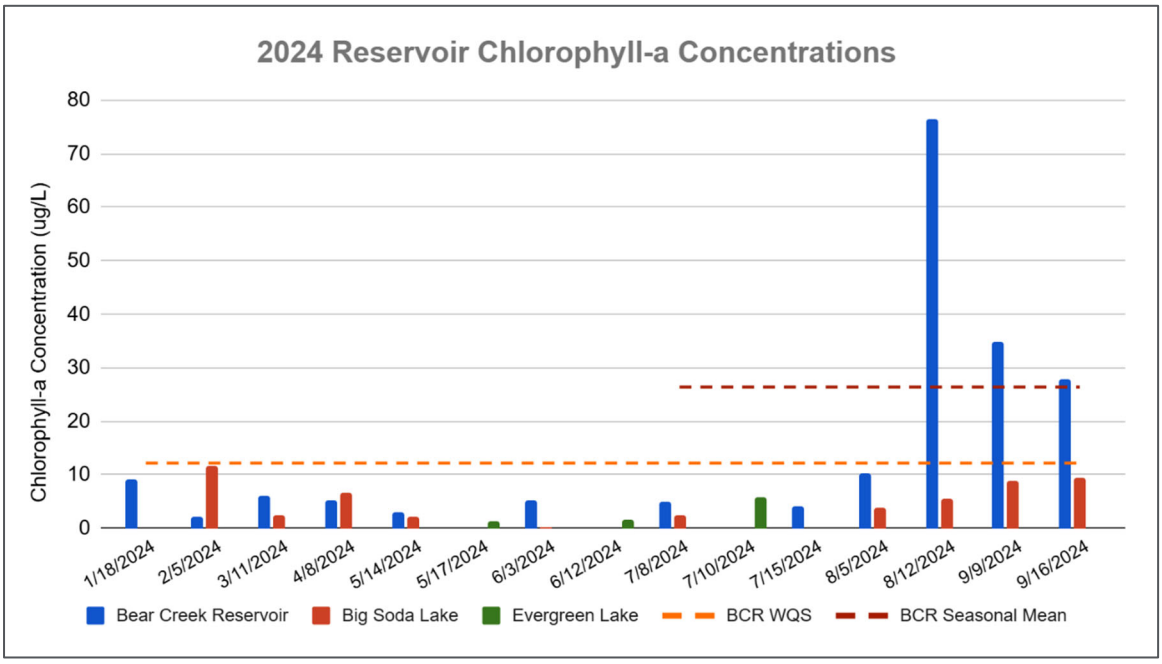


Figure 10. 2024 Chlorophyll-a concentrations in Bear Creek Reservoir, Big Soda Lake, Evergreen Lake during all monitoring events in 2024, with the WQS and BCR Seasonal mean for 2024.

Bear Creek Reservoir did not meet the seasonal chl α standard for 2024 and is not meeting the requirement of attainment 4 out of 5 years under Reg 38. The chl α seasonal (July through September) concentration was 24.6 ug/L, which exceeds the 12.2 ug/L standard (Figure 11). The

seasonal mean concentration is measured from just below the surface (photic zone), with an allowable exceedance frequency of once in five years.

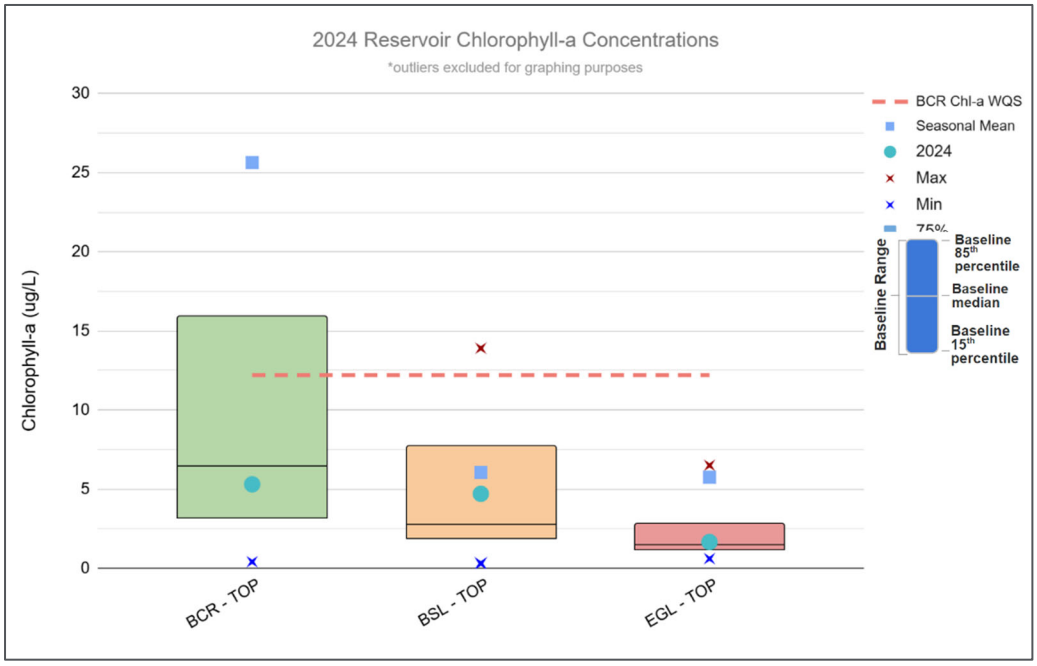


Figure 11. Chlorophyll-a concentrations in Bear Creek Reservoir, Big Soda Lake, and Evergreen Lake. Historical median 2013-2024, 25th and 75th percentiles, 2024 annual median, and 2024 seasonal average (July- Sept).

6.2 In-Situ Field Parameters

In 2024, Bear Creek Reservoir met the water quality criteria for temperature, pH, and dissolved oxygen (DO) as outlined in Regulation 38. These parameters are essential for supporting Cold Water Class 1 aquatic life, indicating favorable conditions for sustaining a healthy aquatic ecosystem.

6.2.1 Temperature

Bear Creek Reservoir attained the temperature standards established for the Cold 1 Aquatic Life classification as adopted in Re 38 of a daily maximum (DM) and maximum weekly average temperature (MWAT) of 23.3 °C (Figure 12).

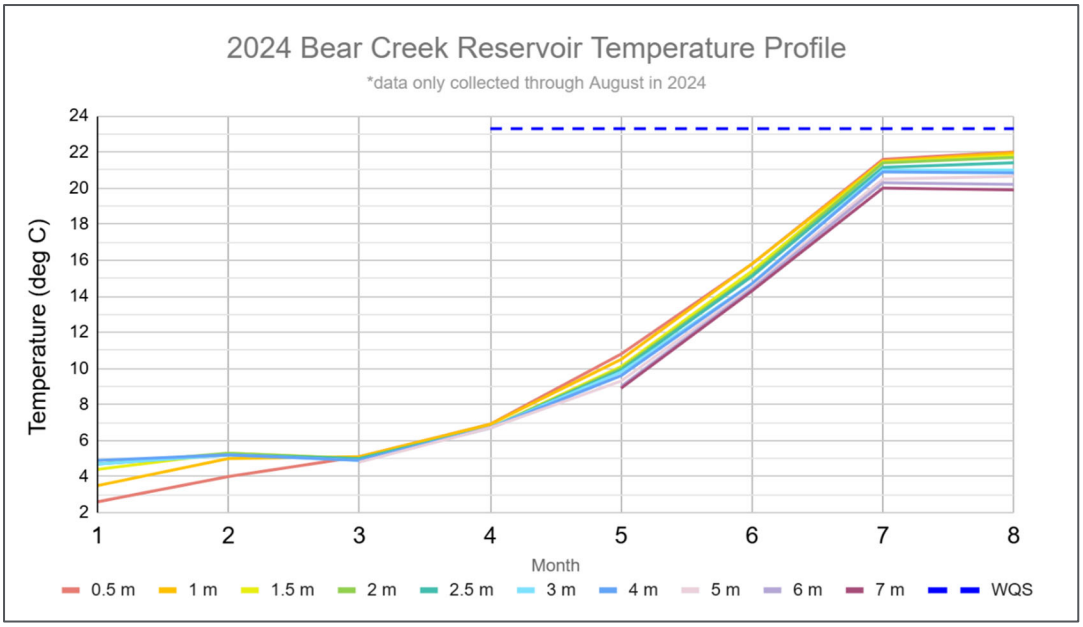


Figure 12. Bear Creek Reservoir temperature profile in 2024.

6.2.2 Dissolved Oxygen

The Cold 1 Aquatic Life Classification under Reg 38 specifies that the dissolved oxygen (DO) should remain above 6.0 mg/L and 7.0mg/L during spawning. The dissolved oxygen standard applies only to the upper and middle layers of lakes and reservoirs (the epilimnion and metalimnion). The lower layer (the hypolimnion) is naturally low in oxygen because bacteria use it up as they break down organic matter. Because of this natural process, the dissolved oxygen standard does not apply to the hypolimnion.

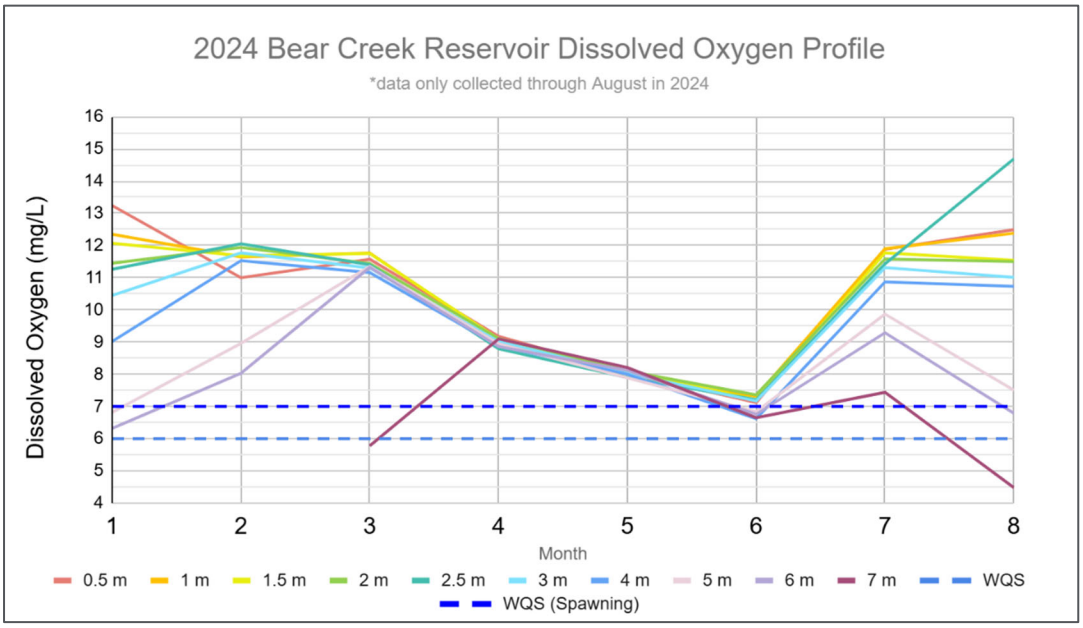


Figure 13. Bear Creek Reservoir dissolved oxygen profile (mg/L), 2024.

Bear Creek Reservoir attained the dissolved oxygen standard since DO concentrations were below these criteria but only at deeper locations in the reservoir which the standards do not apply (Figure 13).

6.2.3 pH

During WY 2024, the pH in Bear Creek Reservoir attained the pH standard. Reg 38 specifies that the minimum and maximum pH values should fall between 6.5 and 9.0, based on the annual 15th and 85th percentiles. Higher pH values were observed in August which is common and is usually correlated with higher productivity and elevated chlorophyll-α concentrations.

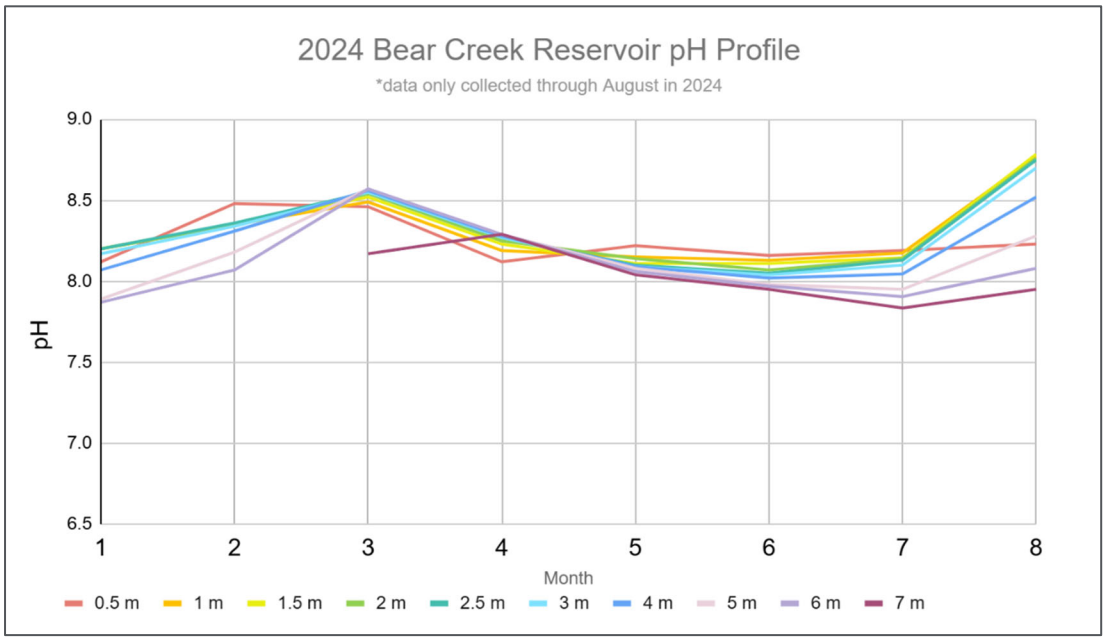


Figure 14. Bear Creek Reservoir pH profile, 2024.

6.3 Nutrients

Understanding reservoir nutrient dynamics play is key in understanding how nitrogen and phosphorus loading can lead to eutrophication, characterized by algal blooms, hypoxia, and degradation of aquatic habitat and recreational value. This section evaluates nutrient conditions within the reservoir, identifies key sources and trends, and assesses how nutrient concentrations align with applicable water quality standards or thresholds.

6.3.1 Phosphorus

TP concentrations are often elevated in the hypolimnion (lower layer of water in a stratified lake) from early spring through summer. Phosphorus increases in the hypolimnion can be caused by

internal loading or result from the decomposition of algal cells and other organic matter settling from higher levels in the water column. Inflows of cold runoff water, which have a higher density than warmer surface waters and sink to the bottom as they enter a lake, can also directly increase hypolimnetic nutrient concentrations, especially in reservoirs.

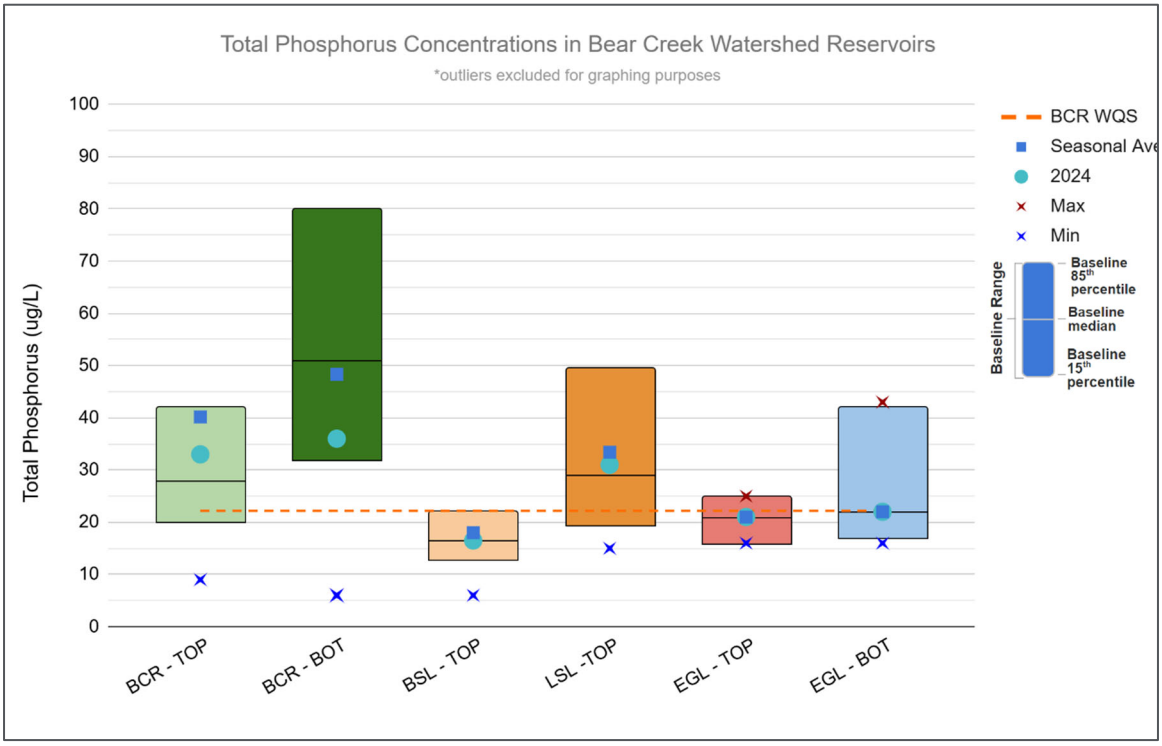


Figure 15. Total phosphorus concentrations in Bear Creek Watershed Reservoirs, 2014-2023 baseline median, 25th and 75th percentiles and 2024 median and seasonal mean.

The seasonal average concentration from the surface of Bear Creek Reservoir was 40 ug/L which is not in attainment of the total phosphorus standard of 22.2 ug/L established in Reg 85 (Figure 15. 2024 TP concentrations were similar to the historical median from 2014-2024 in Big Soda Lake, Little Soda Lake and Evergreen Reservoir at both the surface and just above the sediment water interface (Figure 15). However the concentrations of TP in both the 2024 median and seasonal mean were above the historical median at the surface (BCR - TOP) and below the historical median at the bottom (BCR – BOT). The 2024 median and seasonal mean TP concentrations from the bottom sites, which are often notably higher than the surface during periods of anoxia (and internal loading) were only slightly higher than the surface at Bear Creek Reservoir. There is no significant difference in the historical median, 2024 median and seasonal mean from the top or bottom samples in Evergreen Lake.

6.3.2 Nitrogen

Total nitrogen (TN) concentrations in three Bear Creek Watershed reservoirs in 2024 were monitored at similar frequencies and locations as phosphorus. Bear Creek Reservoir shows the

highest TN concentrations and the 2024 median concentrations were notably lower than the historical medians (Figure 16). Although TN levels were above the historical median and upper quartile in Evergreen Lake, tighter interquartile ranges and lower median concentrations are consistently observed.

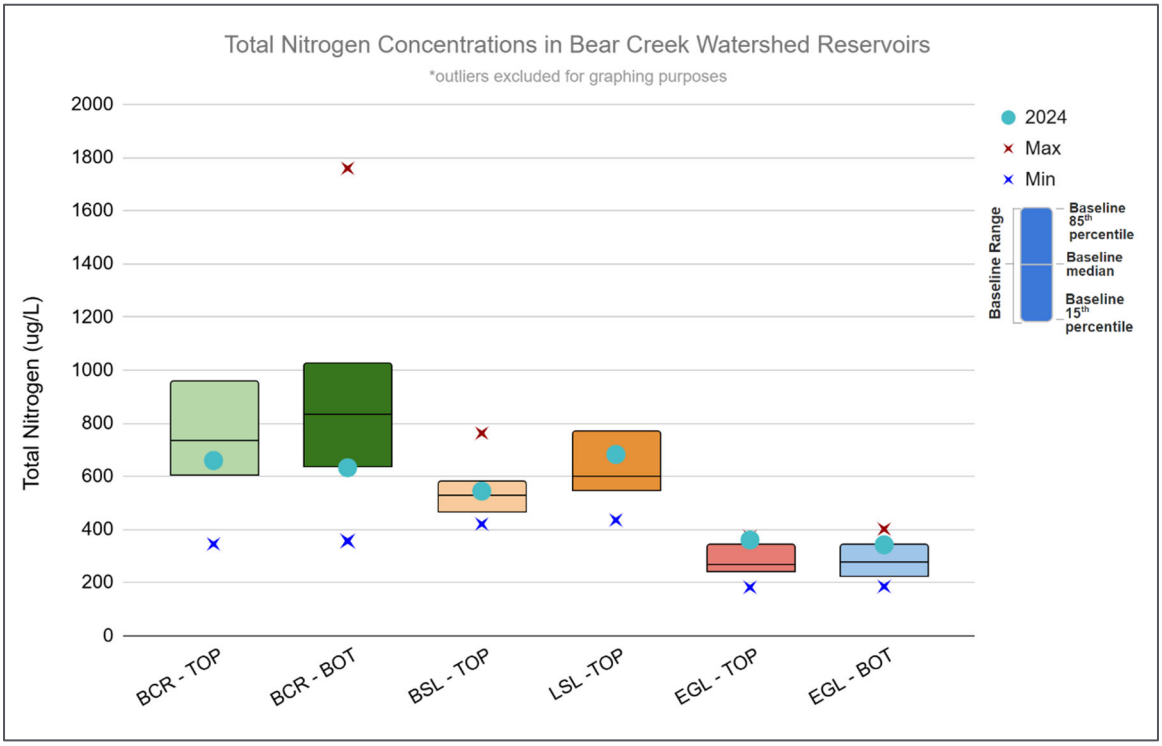


Figure 16. Total nitrogen concentrations in Bear Creek Watershed Reservoirs, 2014-2023 baseline median, 25th and 75th percentiles and 2024 median and seasonal mean.

Nitrogen and phosphorus are the nutrients that limit algal growth in natural waters. However, in nutrient-enriched lakes and reservoirs and during periods of nitrogen limitation, certain cyanobacteria populations have an advantage over other types of algae and can easily dominate populations and limit diversity. N:P ratios calculated during WY 2024 demonstrated that nitrogen was not limited although the ratios did decrease as the season progressed.

Although only total phosphorus and total nitrogen are included in the current monitoring program, soluble reactive phosphorus and inorganic forms of nitrogen are the most bioavailable form available for algae to drive chl α production.

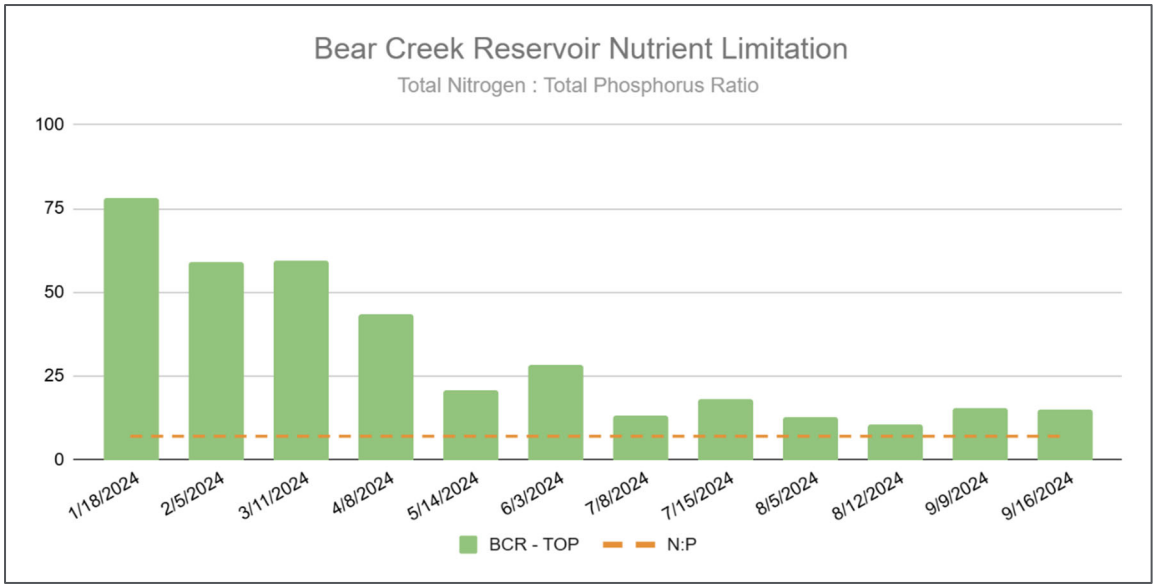


Figure 17. Total Nitrogen to Phosphorus Ratios in Bear Creek Reservoir, 2024.

6.4 Trophic State

The Trophic State is used to assess biological productivity by integrating key water quality indicators: TP, Secchi depth (a measure of water clarity), and chl α (a proxy for algal biomass). Eutrophic conditions indicate elevated nutrient levels and greater primary productivity, often resulting in increased risk of nuisance conditions such as algal blooms and surface scums. There are typically four trophic state categories: oligotrophic (low productivity), mesotrophic (moderate), eutrophic (high), and hypereutrophic (excessive).

In 2024, the trophic state for Bear Creek Reservoir indicates hyper-eutrophic for Secchi depth eutrophic for phosphorus and chlorophyll-a (Table 5).

Table 5. 2024 Trophic State Classification for Bear Creek Reservoir (May- September).

Trophic State	**Total P (mg/L)**	**Chlorophyll a (µg/L)***	**Secchi Depth (m)**
Oligotrophic	< 0.005	< 2.0	> 8
Mesotrophic	0.005 -0.030	2.0 - 6.0	4 – 8
Eutrophic	**0.030 - 0.100**	**6.0 - 40.0**	2 – 4
Hypereutrophic	> 0.100	> 40.0	**< 2**
Bear Creek Reservoir	0.037	19.9	1.2*

**Secchi values not available for Sept 2024.*

*** Table adapted from Carlson (1977) and commonly used trophic state classifications as published by EPA and state water quality agencies.*

6.5 Phytoplankton

Phytoplankton are photosynthetic organisms that are the primary producers in aquatic systems. They form the base of aquatic food chains and are grazed upon by zooplankton and herbivorous fish. A healthy lake should support a diverse assemblage of phytoplankton, in which many algal groups are represented. Phytoplankton groups measured include Bacillariophyta (diatoms), Chlorophyta (green algae), Chrysophyta, Cryptophyta, Cyanophyta (cyanobacteria), Dinophyta, and Euglenophyta. Cell counts (cells/mL) in this section are plotted on a logarithmic scale to show variation across several orders of magnitude.

6.5.1 Bear Creek Reservoir

The seasonal variation in phytoplankton community composition in Bear Creek Reservoir during 2024, based on cell counts (cells/mL) from March through mid-September is illustrated in Figure 18.

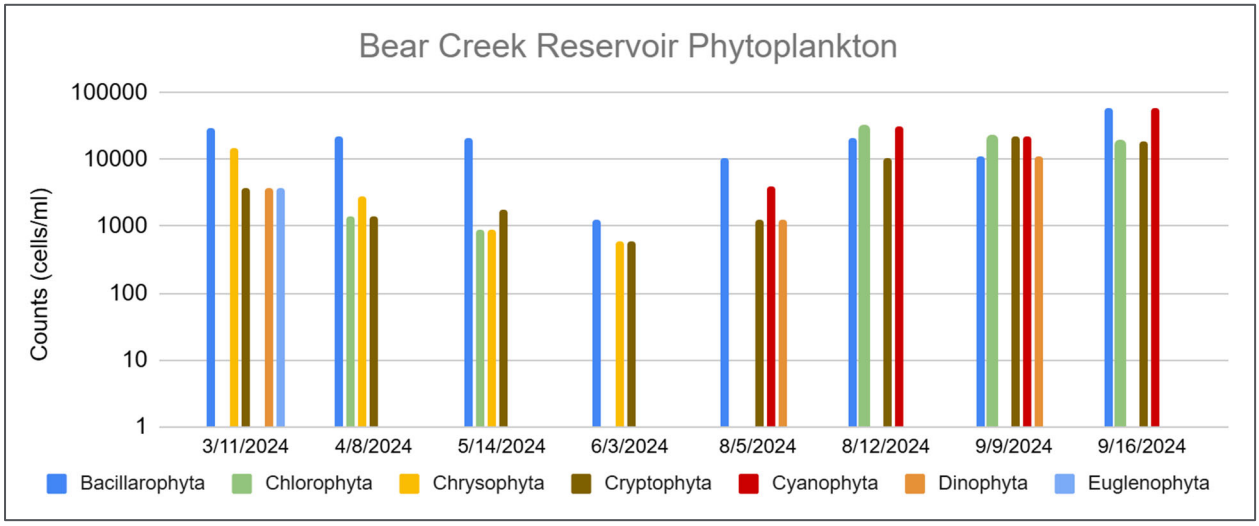


Figure 18. Phytoplankton Populations in Bear Creek Reservoir in 2024.

In early spring, Bacillariophyta dominated the community, with consistently high cell counts likely due to favorable light and nutrient conditions typical of the spring bloom period. Other groups such as Chlorophyta, Chrysophyta, and Euglenophyta were present but in lower abundances.

By mid-summer, community composition became more diverse. While Bacillariophyta declined, Cyanophyta (blue-green algae) increased substantially, exceeding 10,000 cells/mL in early August through September. This shift reflects warmer water temperatures and elevated nutrient availability during the growing season, conditions that often favor cyanobacterial growth and the potential for late-season bloom activity.

Although many cyanobacteria are nitrogen fixers (they can utilize nitrogen from the atmosphere) providing a competitive advantage, the phytoplankton data indicates both were present in 2024 in Bear Creek Reservoir. The common nuisance cyanobacteria *Microcystis aeruginosa* which is not a nitrogen fixer was present in addition to *Aphanizomemon flos-aquae* and *Anabeana flos-aquae* which are capable of utilizing atmospheric nitrogen for growth when it is limited in the water column.

The observed seasonal shifts in phytoplankton community structure are typical for a eutrophic reservoir and highlight the importance of continuous monitoring to detect trends that could influence water quality, such as harmful algal bloom formation.

6.5.2 Big Soda Lake

The phytoplankton community composition in Big Soda Lake demonstrated that early spring (March–April), was dominated by Euglenophyta and Chrysophyta and other groups, such as Chlorophyta and Cryptophyta, remained present at moderate levels (Figure 19). By mid-May, the community composition began to diversify, with Cyanophyta increasing late in the season, although they did not dominate the community which correlated with no observed bloom present in 2024.

These seasonal patterns suggest a typical succession of algal groups in a productive lake system, with spring diatom and euglenoid peaks transitioning to a more mixed community in summer. Continued monitoring will help assess long-term trends and potential ecological shifts in response to water quality or climate-related changes.

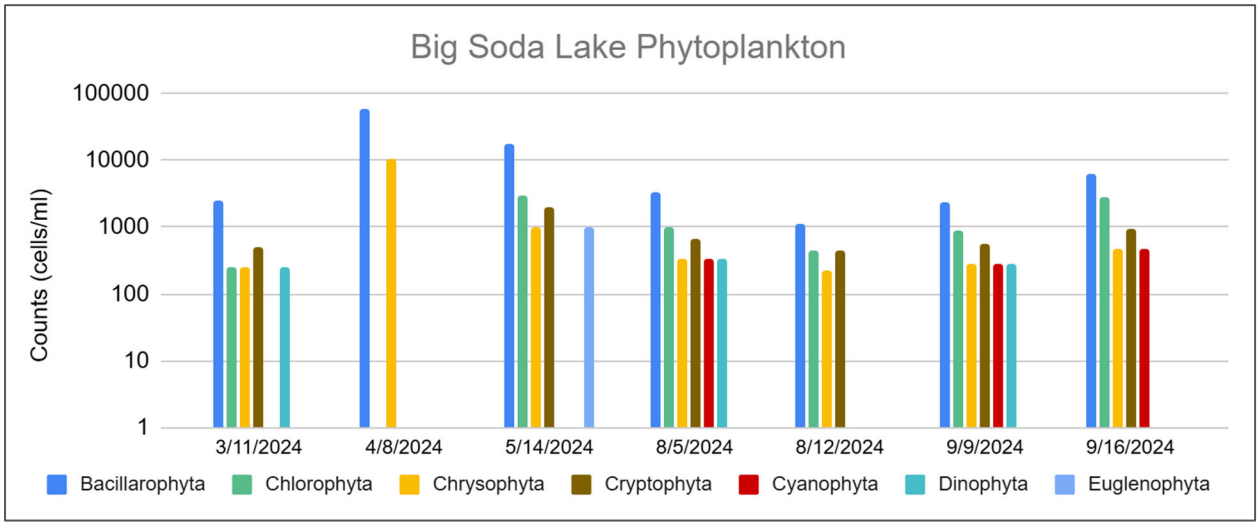


Figure 19. Phytoplankton Populations in Big Soda Lake in 2024.

6.5.3 Evergreen Lake

The phytoplankton community composition in Evergreen Lake in 2024 demonstrated that Bacillariophyta consistently dominated the community (Figure 20). Other groups such as Chlorophyta ,Chrysophyta, and Cryptophyta were present in lower but relatively stable concentrations across all dates. Notably, Dinophyta (dinoflagellates) appeared only in the September sample, indicating a possible seasonal shift or bloom later in the growing season. Overall, the data suggest a diverse but diatom-dominated assemblage with slight seasonal changes in community structure.

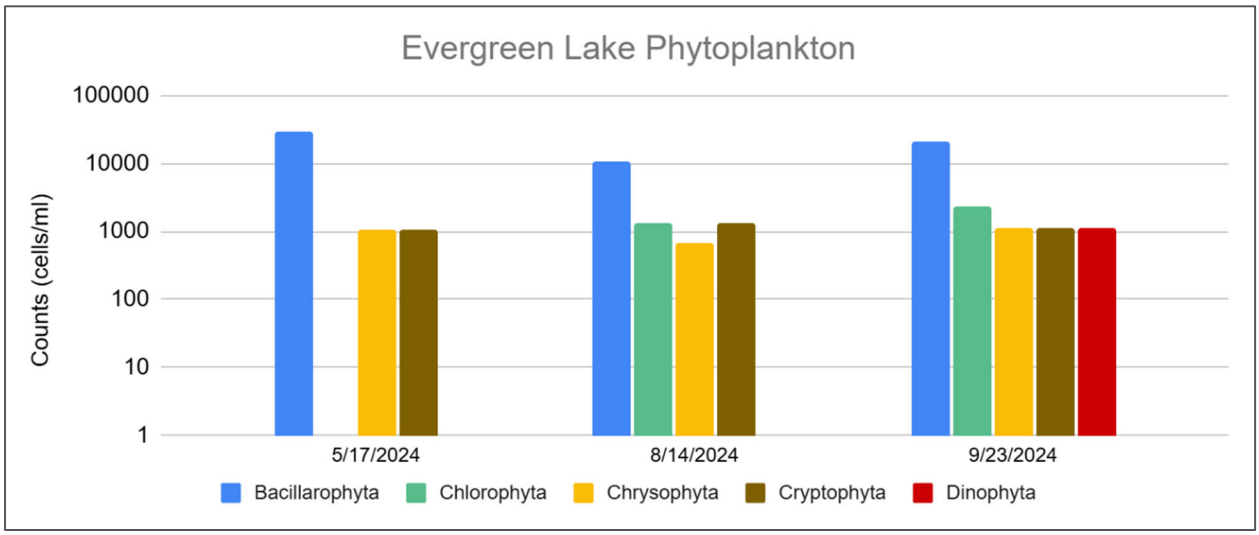


Figure 20. Phytoplankton Populations in Evergreen Lake in 2024.

7. Bear Creek Reservoir Water Balance and Nutrient Storage

Understanding the movement of water and associated nutrient loads into and out of Bear Creek Reservoir is essential for evaluating watershed health and informing management decisions. The water balance quantifies inflows from Bear Creek, Turkey Creek, direct precipitation, and outflows through reservoir releases. These flow volumes are paired with nutrient concentration data to calculate annual loading and estimate nutrient storage within the reservoir. The resulting nutrient balance provides insight into whether the reservoir is accumulating or exporting key nutrients, TP and TN, which play a critical role in reservoir productivity and algal growth. This analysis supports ongoing efforts to meet regulatory standards and manage eutrophication risk

7.1 Water Balance

Water balance calculations are essential for understanding how water moves into, out of, and is stored in Bear Creek Reservoir. This information and the water quality data is also used to calculate the annual nutrient storage (Section 8.3) The United States Army Corps of Engineers (USACE) monitors the reservoir elevation and releases through the outlet and provides estimated daily evaporation on an annual basis. A summary of all 2024 data provided by USACE is provided in Appendix D. The general water balance equation is:

Change in Storage = Inflows (Streams + Precipitation) – Outflows (Releases + Evaporation)

For Bear Creek Reservoir, the primary inflows include:

- Surface water from Bear Creek and Turkey Creek
- Direct precipitation on the reservoir surface

The main outflows include:

- Evaporation from the reservoir surface
- Controlled reservoir releases through the outlet structure

Surface water inflows were estimated using data from the USGS gaging station upstream of the reservoir on Turkey Creek. The inflow from Bear Creek was estimated by removing precipitation and the contribution from Turkey Creek from the inflows since flow measurements at Bear Creek are only available from April through September. Direct precipitation was calculated using recorded precipitation totals from the nearby weather station (see section 6.2) and applied over the estimated daily reservoir surface area. Evaporation was based on daily data provided by the USACE.

In WY 2024, reservoir releases were measured at the USGS outflow gage just downstream of the dam. Combined with evaporation losses and the change in reservoir volume (calculated from elevation-storage data), the water balance provides insight into hydrologic inputs and outputs for the year along with providing the basis for nutrient storage calculations.

This simplified approach focuses on measurable components and excludes adjusted or modeled ungauged flows. A full summary of inflow, outflow, and change in storage estimates for Bear Creek Reservoir in WY 2024 is included in Table 6.

Table 6. 2024 Bear Creek Reservoir Water Balance.

Water Source	Water Volume (AF)
Inflows*	
Bear Creek (BC U/S BCR)	19,969
Turkey Creek (TC U/S BCR)	6,284
Precipitation	163
Total Inflows	26,416
Outflows*	
Evaporation	426
Reservoir releases	26,237
Total Outflows	**26,663**
2024 Change in Storage*	-246

In 2024, total inflows to the reservoir were 26,416 acre-feet (AF), with Bear Creek contributing the majority at 75.6% (19,969 AF) followed by Turkey Creek at 23.8% (6,284 AF), and precipitation accounting for just 0.6% (163 AF). Total outflows slightly exceeded inflows at 26,663 acre-feet, comprised mainly of reservoir releases at 98.4% (26,237 AF) and evaporation losses at 1.6% (426 AF). This resulted in a small net decrease in reservoir storage of 246 acre-feet over the year.

7.2 Nutrient Loading

To estimate the annual nutrient balance of the reservoir, daily nutrient loads were calculated for each of the major inflows of Bear Creek and Turkey Creek along with the reservoir releases. The analysis takes the measured daily flow data at each location and interpolates the nutrient concentrations between sampling events to estimate daily total phosphorus (TP) and total nitrogen (TN) loads. These daily loads were then summed to determine the total annual load entering and leaving the reservoir. In addition to streamflow sources, nutrient contributions from direct precipitation to the reservoir surface were estimated using state standard values for TP and TN concentrations in precipitation, allowing for a more complete assessment of total nutrient inputs.

For the months when watershed data was not collected in 2024, the 2013-2023 year average concentration for each location was used (Table 10.)

Table 7. 2024 Monthly total phosphorus and total nitrogen concentrations in the Bear Creek Reservoir inflows from Bear Creek and Turkey Creek, and outflow downstream.

	Inflows				Outflow	
Site	Bear Creek		Turkey Creek		BCR Outlet	
Constituent (ug/L)	Total Phosphorus	Total Nitrogen	Total Phosphorus	Total Nitrogen	Total Phosphorus	Total Nitrogen
1/18/2024	47	1,539	5	1,243	19	1,235
2/5/2024	77	1,627	11	1,079	12	912
3/11/2024	29	1,017	5	1,173	13	843
4/8/2024	21	965	36	1,135	25	1,074
5/14/2024	46	726	47	839	30	841
6/3/2024	34	559	28	884	25	646
7/8/2024	47	621	28	1,289	53	454
7/15/2024	35	769	15	1,343	46	532
8/5/2024	30	712	37	1,461	84	529
8/12/2024	39	520	9	1,264	73	633
9/9/2024	32	837	10	1,195	48	676
9/16/2024	85	898	10	1,234	59	796
MIN	21	520	5	839	12	454
MAX	85	1,627	47	1,461	84	1,235
MEAN	44	899	20	1,178	41	764

Table 8. Average monthly TP and TN concentration for inflows and outflow, 2013-2023.

	Inflows				Outflow	
Site	Bear Creek		Turkey Creek		BCR Outlet	
Constituent (ug/L)	Total Phosphorus	Total Nitrogen	Total Phosphorus	Total Nitrogen	Total Phosphorus	Total Nitrogen
October	34	716	10	762	36	592
November	43	1,004	11	702	24	499
December	29	1,376	20	780	25	618

A study in 2017 found that median total phosphorus concentration in rain samples from Colorado was calculated to be 220 ug/L (Olson, et al. 2017). According to the National Atmospheric Deposition Program (NADP) states that nitrogen concentrations in precipitation ranges between ~0.5–1.5 mg/L. In order to calculate the nutrient loading from precipitation on the surface of the reservoir, concentrations of 220 mg/L of total phosphorus and 1.0mg/L total nitrogen were used (Table 9).

Table 9. TP and TN concentrations, calculate precipitation loading on Bear Creek Reservoir.

	Inflows	
Site	Precipitation	
Constituent (ug/L)	Total Phosphorus	Total Nitrogen
	220	1000

7.3 Nutrient Balance

The nutrient loading calculations are based on daily inflow volumes from each source combined with representative nutrient concentrations. The relative contribution of each source provides insight into the dominant pathways of nutrient delivery to the reservoir. The annual nutrient storage within the reservoir is estimated using a mass balance approach, accounting for inputs, outputs, and changes in internal loading or retention (**Error! Reference source not found.**Table 10).

Table 10. Total Phosphorus and Nitrogen mass balance in Bear Creek Reservoir, 2024.

	Water Source	Total Phosphorus Mass (pounds)	Total Nitrogen Mass (pounds)
Inflows	Bear Creek	2,039	42,187
	Turkey Creek	506	17,955
	Precipitation	98	444
	Total Inflows	6,761	145,699
Outflows	Reservoir Releases	-2,084	-55,450
	WY 2024 Storage	**4,677**	**29,663**

Bear Creek is the dominant source of phosphorus entering the reservoir (71%), followed by Turkey Creek (19%), with atmospheric deposition (precipitation) playing a small role (3.7%) (Figure 21). These relative percentages are comparable to historical ranges, taking into account that loading from precipitation was not previously included in the loading analysis.

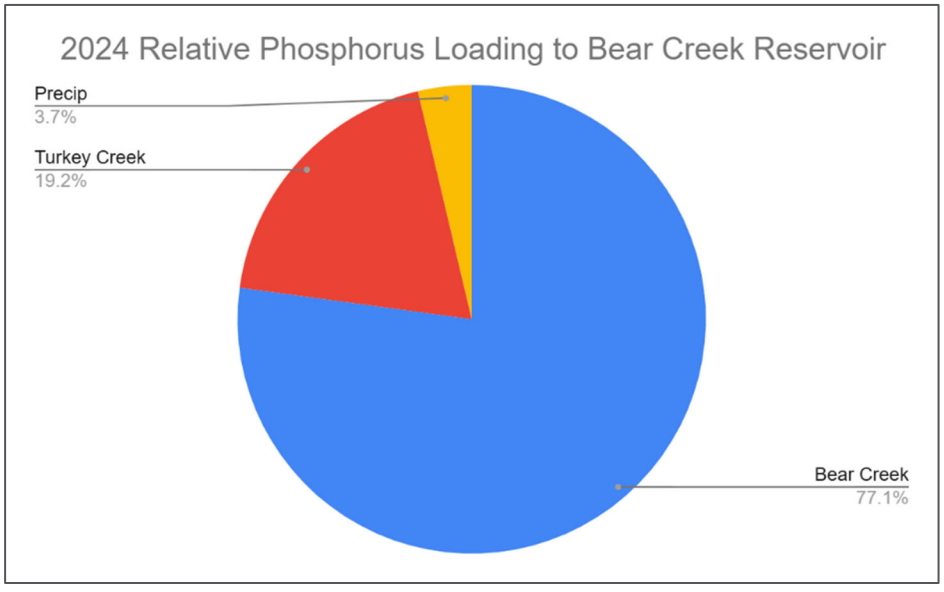


Figure 21. Relative Phosphorus Loading to Bear Creek Reservoir, 2024.

Similar to phosphorus, Bear Creek is the primary source of nitrogen loading to Bear Creek Reservoir as demonstrated in Figure 22. However, Turkey Creek plays a more significant role in nitrogen loading than it does in phosphorus loading. In 2024, precipitation contributed a negligible amount of nitrogen although a historical comparison has not been made.

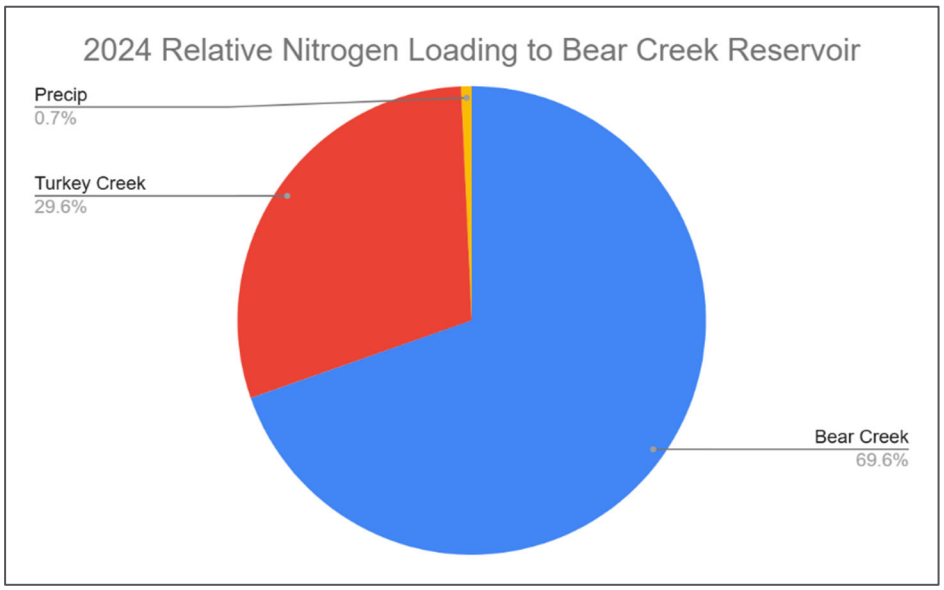


Figure 22. Relative Nitrogen Loading to Bear Creek Reservoir, 2024.

8. Special Studies

In 2024, BCWA continued several special studies to better understand the use of phosphorus inactivation watershed and opportunities to reduce pollutant loading to the Reservoir.

Special studies included continuing to monitor the phosphorus reduction technologies employed in Horseshoe Pond and the Wilmont drainage in 2021 and plans to provide additional information in a future annual report.

9. Future Planning

In January 2025, the CDPHE released a draft TMDL assessment for Bear Creek Reservoir. This assessment addresses impairments related to chlorophyll-a and total phosphorus levels in the reservoir. The draft was made available for public review on January 3, 2025, with a 60-day comment period ending on March 4, 2025.

The TMDL aims to identify the reservoir's capacity to assimilate these pollutants, pinpoint their sources, and allocate permissible pollutant loads among those sources. Following the public comment period, CDPHE will revise the TMDL as appropriate, issue a final notice for 30 days,

and then submit it to the Environmental Protection Agency (EPA) for approval. The TMDL will become effective upon EPA approval.

WWTF in the watershed have noted that this TMDL may significantly impact their new phosphorus discharge limits, both in terms of concentration and total pounds allowed.

In the next several years, the BCWA also plans to update the Watershed Plan.

References

Bear Creek Watershed Association. (2024, July 19). *2023 Annual Report*. http://www.bearcreekwatershed.org

Bear Creek Watershed Foundation. (2022, December). *BCWF pilot results: Wilmot drainage EutroSORB*. https://drive.google.com/file/d/1Pn6N7-2Q-Lei51TeqD6Y0ftmojvw3Wj8/view

Bear Creek Watershed Foundation. (2022, December). *BCWF pilot results: Horseshoe pond Inlet Drainage - EutroSORB*. https://drive.google.com/file/d/1Pn6N7-2Q-Lei51TeqD6Y0ftmojvw3Wj8/view

Carlson, R. E. (1977). A trophic state index for lakes. *Limnology and Oceanography*, 22(2), 361–369.

Dorsch, Lundt, Parman, Neilson, and Culbertson. Metro Water Recovery. (2024, May). *Water quality annual report 2023* (Jordan Parman, Ed.). https://www.metrowaterrecovery.com/wp-content/uploads/2024/05/MWR-Water-Quality-Annual-Report-2023_Jordan-Parman.pdf

Olson C. T. Dell, J. Brim. 2017. Nutrient Sources in Urban Areas - A Literature Review. Prepared for the City of Fort Collins.

United States Geological Survey. Bear Creek above Bear Creek Lake Near Morrison, CO, Station Id 06710605, January 2024 through December 2024.

United States Geological Survey. Turkey Creek above Bear Creek Lake Near Morrison, Station Id 06711040, January 2024 through December 2024.

United States Army Corps of Engineers, Bear Creek Reservoir Elevation, Inflows, Storage and Evaporation, personal communication with Kathryn Seefus, PE. Hydraulic Engineer, Water Control and Water Quality Section, Hydrologic Engineering Branch

Water Quality Control Commission, 2024. The Basic Standards and Methodologies for Surface Water. Regulation No. 31, 5-CCR-1002-31.

Water Quality Control Commission, 2022. South Platte Standards and Use Classifications, Regulation No. 38, 5-CCR-1002-38.

Water Quality Control Commission, 2017. Nutrient Control Regulation No. 85, 5-CCR-1002-85.

Olson C. T. Dell, J. Brim. 2017. Nutrient Sources in Urban Areas - A Literature Review. Prepared for the City of Fort Collins.

Appendices

Appendix A – 2024 Bear Creek Reservoir and Watershed Water Quality Data – Field Measurements and Laboratory Analysis

Appendix B – Full Monthly Summary of WLAs and Discharge Data for each WWTF in 2024

Appendix C – 2024 BCWA Sampling Plan

Appendix D – 2024 Bear Creek Reservoir Storage Data Provided by the USACE

Accessibility

The BCWA is committed providing accessible content to the public. If you need help accessing internal BCWA content, please email the Admin Coordinator, Diane Kielty at diane@bearcreekwatershed.org.

Appendix A

2024 Bear Creek Reservoir Water Quality - Field Measurements

			Parameter				
Date	Site	Site Abbrev.	Dissolved Oxygen (mg/L)	pH	Specific Conductance (uS/cm)	Temp (deg C)	Velocity (cfs)
1/18/2024	15a	BC U/S BCR	11.7	8.3	415	0.1	1.6
	16a	TC U/S BCR	9.5	8.5	1,520	2.2	
	45	LBC D/S BCR	10.3	8.3	626	4.7	
	90	LBC - WADS	10.6	8.2	739	3.9	
2/5/2024	15a	BC U/S BCR	10.0	8.4	668	0.4	
	16a	TC U/S BCR	9.8	8.6	1,532	8	
	45	LBC D/S BCR	10.9	0.4	655	5.2	14.1
	47a	COY CK U/S	11.2	8.3	1,373	0.1	1.4
	47b	COY CK D/S	9.9	8.2	1,381	0.3	1.1
	90	LBC - WADS	10.7	8.3	884	5.4	
	98a	RNY GLCH U/S	10.6	8.3	4,547	0.2	1.4
	98b	RNY GLCH D/S	11.2	8.3	4,546	0.1	1.4
3/11/2024	15a	BC U/S BCR	11.1	8.6	506	2.4	
	16a	TC U/S BCR	10.9	8.0	1,857	4.7	
	45	LBC D/S BCR	11.4	8.8	133	5.6	19.8
	47a	COY CK U/S	11.4	8.6	1,522	2.4	0.7
	47b	COY CK D/S	10.9	8.7	1,582	2.2	0.5
	90	LBC - WADS	11.3	8.5	805	6.2	27.1
	98a	RNY GLCH U/S	10.9	8.4	4,814	3.1	1.3
	98b	RNY GLCH D/S	12.5	8.5	4,811	3.4	0.8
4/8/2024	15a	BC U/S BCR	11.0	8.4	423	4	
	16a	TC U/S BCR	11.7	8.4	693	3.1	
	45	LBC D/S BCR	9.1	8.6	766	7.5	71.0
	47a	COY CK U/S	11.3	8.4	1,480	3.8	0.6
	47b	COY CK D/S	11.5	8.7	1,457	4	0.5
	90	LBC - WADS	8.3	8.5	824	9.1	
	98a	RNY GLCH U/S	11.2	8.4	4,465	4.1	0.2
	98b	RNY GLCH D/S	11.3	8.5	4,450	4	0.2
5/14/2024	15a	BC U/S BCR	9.4	8.1	253	8.3	
	16a	TC U/S BCR	9.7	8.2	390	7.9	
	45	LBC D/S BCR	11.4	8.9	421	11.7	190.0
	47a	COY CK U/S	8.5	8.3	1,162	11.5	0.3
	47b	COY CK D/S	9.9	8.7	1,119	12.5	0.3
	90	LBC - WADS	9.4	8.3	433	12.2	
	98a	RNY GLCH U/S	7.8	8.3	3,487	11.4	1.3
	98b	RNY GLCH D/S	7.4	8.4	3,484	11.4	1.2
6/3/2024	15a	BC U/S BCR	8.6	8.2	203	11.3	
	16a	TC U/S BCR	8.5	8.5	700	11.9	13.3
	45	LBC D/S BCR	7.0	8.5	333	16.4	
	47a	COY CK U/S	8.0	8.4	1,419	12.5	0.9
	47b	COY CK D/S	9.8	8.6	1,304	13.2	0.8
	90	LBC - WADS	7.7	8.2	377	17	
	98a	RNY GLCH U/S	5.9	8.3	4,639	13.8	0.7
	98b	RNY GLCH D/S	7.3	8.3	4,691	13.8	0.6
7/8/2024	15a	BC U/S BCR	8.2	8.4	210	13.6	
	16a	TC U/S BCR	7.2	8.4	2,121	13.3	
	45	LBC D/S BCR	7.0	8.7	306	22.5	16.2
	47a	COY CK U/S	8.8	8.4	1,418	12.4	0.4
	47b	COY CK D/S	7.9	8.6	1,405	13	0.4
	90	LBC - WADS	8.3	8.1	440	19.7	
	98a	RNY GLCH U/S	5.2	8.4	4,324	13.7	0.2
	98b	RNY GLCH D/S	4.0	8.4	4,220	14.1	0.2
7/15/2024	15a	BC U/S BCR	7.3	8.3	226	17.4	
	16a	TC U/S BCR	6.1	8.3	2,327	15.6	
	45	LBC D/S BCR	5.0	8.1	305	20.4	13.2
	90	LBC - WADS	6.8	7.2	462	18.8	
8/5/2024	15a	BC U/S BCR	7.5	8.3	256	19.3	
	16a	TC U/S BCR	7.7	8.4	2,434	18.3	12.9
	45	LBC D/S BCR	6.2	8.5	315	23.5	7.8
	47a	COY CK U/S	5.1	8.2	936	18.2	0.7
	47b	COY CK D/S	7.1	8.6	985	19.3	0.7
	90	LBC - WADS	8.2	8.6	557	23.5	11.2
	98a	RNY GLCH U/S	5.3	8.2	3,116	19.2	0.4
	98b	RNY GLCH D/S	6.0	8.2	3,010	18.9	0.3
8/12/2024	15a	BC U/S BCR	7.1	8.3	207	16.7	
	16a	TC U/S BCR	7.3	8.5	2,261	16.5	
	45	LBC D/S BCR	5.4	8.5	339	22	
	90	LBC - WADS	7.7	8.4	484	21.1	
9/9/2024	45	LBC D/S BCR	6.3	8.8	380	21.3	
	47a	COY CK U/S	6.0	8.4	1,349	14.4	1.4
	47b	COY CK D/S	8.8	8.6	1,332	15.9	1.3
	90	LBC - WADS	8.2	8.6	512	20.1	
	98a	RNY GLCH U/S	6.5	8.4	5,042	15.1	0.5
	98b	RNY GLCH D/S	7.6	8.5	4,947	15.1	0.3
9/16/2024	45	LBC D/S BCR	7.2	9.1	379	17.8	
	90	LBC - WADS	9.0	8.8	728	16.9	

Appendix A

2024 Bear Creek Reservoir Water Quality - Field Measurements

Parameter	Depth (m)	Units	Date									
			1/18/2024	2/5/2024	3/11/2024	4/8/2024	5/14/2024	6/3/2024	7/8/2024	7/15/2024	8/5/2024	8/12/2024
Secchi		*m*	1.1	2.6	1.1	0.65	0.45	1.45	1.5	1.8	1.1	0.9
Dissolved Oxygen	0.5	*mg/L*	13.2	11.0	11.6	9.2	8.1	7.1	5.6	6.3	7.1	5.4
Dissolved Oxygen	1	*mg/L*	12.4	11.6	11.8	9.0	7.9	7.3	5.5	6.4	7.0	5.4
Dissolved Oxygen	1.5	*mg/L*	12.1	11.7	11.8	9.1	8.1	7.2	5.4	6.4	6.6	4.9
Dissolved Oxygen	2	*mg/L*	11.5	11.9	11.4	9.1	8.1	7.4	5.4	6.2	6.4	5.1
Dissolved Oxygen	2.5	*mg/L*	11.3	12.1	11.4	8.8	7.9	7.2	5.4	6.1	6.7	8.0
Dissolved Oxygen	3	*mg/L*	10.5	11.8	11.3	9.0	8.0	7.2	5.4	6.0	6.7	4.3
Dissolved Oxygen	3.5	*mg/L*	9.0	11.5	11.2	8.9	8.0	6.6	5.3	5.6	5.8	5.0
Dissolved Oxygen	4	*mg/L*	8.3	9.9	11.7	8.8	8.1	7.0	5.3	4.8	5.8	4.7
Dissolved Oxygen	5	*mg/L*	6.8	9.0	11.4	9.0	7.9	6.8	5.0	4.9	3.4	4.1
Dissolved Oxygen	6	*mg/L*	6.3	8.0	11.3	8.9	8.1	6.8	4.9	4.4	3.1	3.7
Dissolved Oxygen	7	*mg/L*			5.8	9.1	8.2	6.7	3.9	3.5	1.5	3.0
Dissolved Oxygen	8	*mg/L*					8.2	6.7	3.6		9.0	
Dissolved Oxygen	9	*mg/L*					8.0	6.8	3.1		0.0	
Dissolved Oxygen	10	*mg/L*					7.8					
pH	0.5	*su*	8.1	8.5	8.5	8.1	8.2	8.2	8.1	8.3	8.1	8.4
pH	1	*su*	8.2	8.4	8.5	8.2	8.2	8.1	8.0	8.3	9.1	8.4
pH	1.5	*su*	8.2	8.4	8.5	8.2	8.1	8.1	8.0	8.3	9.2	8.4
pH	2	*su*	8.2	8.4	8.5	8.3	8.1	8.1	8.0	8.3	9.2	8.4
pH	2.5	*su*	8.2	8.4	8.6	8.3	8.1	8.1	8.0	8.3	9.2	8.3
pH	3	*su*	8.2	8.3	8.6	8.3	8.1	8.0	8.0	8.2	9.1	8.3
pH	3.5	*su*	8.1	8.3	8.6	8.3	8.1	8.0	8.0	8.1	8.8	8.2
pH	4	*su*	8.0	8.3	8.6	8.3	8.1	8.0	8.0	8.0	8.8	8.2
pH	5	*su*	7.9	8.2	8.6	8.3	8.1	8.0	7.9	8.0	8.4	8.2
pH	6	*su*	7.9	8.1	8.6	8.3	8.1	8.0	7.9	7.9	8.1	8.1
pH	7	*su*			8.2	8.3	8.0	8.0	7.9	7.8	8.0	8.0
pH	8	*su*					8.0	7.9	7.8		7.7	
pH	9	*su*					8.0	7.9	7.7		7.5	
pH	10	*su*					8.02					
Specific Conductance	0.5	*us/Cm*	605	514	703	768	389	321	300	302	316	339
Specific Conductance	1	*us/Cm*	602	550	702	768	399	320	299	302	316	338
Specific Conductance	1.5	*us/Cm*	594	568	702	767	399	318	299	303	316	338
Specific Conductance	2	*us/Cm*	511	613	701	767	400	320	299	302	316	338
Specific Conductance	2.5	*us/Cm*	623	616	701	767	401	321	299	302	316	337
Specific Conductance	3	*us/Cm*	640	635	701	767	401	317	299	300	316	337
Specific Conductance	3.5	*us/Cm*	657	670	701	766	401	317	299	298	319	337
Specific Conductance	4	*us/Cm*	668	705	701	767	401	318	299	301	319	335
Specific Conductance	5	*us/Cm*	692	718	701	766	403	318	298	299	318	336
Specific Conductance	6	*us/Cm*	697	733	706	766	411	317	297	301	316	333
Specific Conductance	7	*us/Cm*			987	766	410	317	295	301	308	335
Specific Conductance	8	*us/Cm*					411	323	293		307	
Specific Conductance	9	*us/Cm*					419	325	291		309	
Specific Conductance	10	*us/Cm*					422					
Temperature	0.5	*Deg C*	2.6	4	5.1	6.9	10.8	15.8	21	22.2	23	21
Temperature	1	*Deg C*	3.5	5	5.1	6.9	10.5	15.8	20.9	22.1	22.9	21
Temperature	1.5	*Deg C*	4	5.2	5	6.8	10.2	15.5	20.8	22.1	22.8	20.8
Temperature	2	*Deg C*	4.4	5.3	5	6.7	10.1	15.4	20.8	22.1	22.8	20.8
Temperature	2.5	*Deg C*	4.7	5.3	5	6.7	10.1	15.3	20.8	22	22.7	20.7
Temperature	3	*Deg C*	4.7	5.3	5	6.7	10	15.2	20.8	22	22.7	20.7
Temperature	3.5	*Deg C*	4.7	5.2	5	6.7	9.9	15.2	20.8	21.7	22.3	20.7
Temperature	4	*Deg C*	4.7	5.2	5	6.7	9.9	15.1	20.8	21.5	22.2	20.6
Temperature	5	*Deg C*	4.7	5.2	4.9	6.7	9.8	14.7	20.7	21.3	21.5	20.5
Temperature	6	*Deg C*	4.9	5.2	4.9	6.7	9.6	14.7	20.7	21.1	21.3	20.4
Temperature	7	*Deg C*			4.8	6.7	9.3	14.5	20.4	20.6	21	20.3
Temperature	8	*Deg C*					9	14.4	20.3		20.2	
Temperature	9	*Deg C*					8.9	14.3	20		19.9	
Temperature	10	*Deg C*					8.8					

Appendix A

2024 Big Soda Lake Water Quality - Field Measurements

Parameter	Depth (m)	Units	Date									
			2/5/2024	3/11/2024	4/8/2024	5/14/2024	6/3/2024	7/8/2024	8/5/2024	8/12/2024	9/9/2024	9/16/2024
Secchi		*m*	1.4	2	0.9	2.2	4.3	2.2	2.3	1.6	1.5	1.3
Dissolved Oxygen	0.5	*mg/L*	12.2	10.1	8.7	8.2	7.1	7.0	6.8	5.7	6.3	6.5
Dissolved Oxygen	1	*mg/L*	12.3	9.9	8.7	8.2	7.2	6.5	6.8	5.4	6.1	6.8
Dissolved Oxygen	1.5	*mg/L*	12.1	9.9	8.6	8.5	7.1	6.9	6.8	5.6	6.4	6.8
Dissolved Oxygen	2	*mg/L*	12.0	9.8	8.7	8.5	7.1	6.4	8.6	5.4	6.4	6.9
Dissolved Oxygen	2.5	*mg/L*	11.2	9.8	8.8	8.1	7.2	6.5	6.5	5.3	6.2	6.7
Dissolved Oxygen	3	*mg/L*		9.8	8.4	8.5	7.1	6.7	6.3	5.4	6.0	6.8
Dissolved Oxygen	3.5	*mg/L*		9.8	8.9	8.2	6.8	6.8	6.2	5.6	6.2	6.8
Dissolved Oxygen	4	*mg/L*		9.7	8.7	8.1	7.0	7.0	6.3	5.5	6.3	6.8
Dissolved Oxygen	5	*mg/L*		9.6	8.8	8.1	6.9	6.7	6.3	5.4	6.2	6.6
Dissolved Oxygen	6	*mg/L*		9.6	8.7	8.0	7.0	7.0	6.0	5.2	5.7	6.7
Dissolved Oxygen	7	*mg/L*		9.8	8.6	8.0	4.0	6.9	6.0	5.1	5.4	6.7
Dissolved Oxygen	8	*mg/L*		9.7	8.6	7.8	2.8	0.3	5.9	4.7	5.4	6.6
Dissolved Oxygen	9	*mg/L*		9.7	8.4	7.2	1.3	0.1	1.6	4.2	4.9	5.0
pH	0.5	*su*	9.0	8.7	8.7	8.7	8.3	8.8	8.7	8.5	8.1	8.8
pH	1	*su*	9.0	8.7	8.7	8.7	8.7	8.8	8.7	8.5	8.4	8.8
pH	1.5	*su*	9.0	8.7	8.7	8.7	8.7	8.8	8.7	8.5	8.5	8.8
pH	2	*su*	9.0	8.7	8.7	8.7	8.7	8.8	8.7	8.6	8.6	8.8
pH	2.5	*su*	9.0	8.7	8.7	8.7	8.7	8.8	8.7	8.6	8.7	8.8
pH	3	*su*		8.7	8.7	8.7	8.7	8.8	8.7	8.6	8.7	8.8
pH	3.5	*su*		8.7	8.7	8.7	8.7	8.8	8.7	8.5	8.7	8.8
pH	4	*su*		8.7	8.7	8.7	8.7	8.8	8.7	8.6	8.7	8.8
pH	5	*su*		8.7	8.7	8.7	8.7	8.8	8.7	8.6	8.7	8.8
pH	6	*su*		8.7	8.7	8.7	8.7	8.8	8.7	8.6	8.7	8.8
pH	7	*su*		8.7	8.7	8.7	8.5	8.8	8.6	8.6	8.7	8.8
pH	8	*su*		8.7	8.7	8.7	8.2	8.4	8.6	8.6	8.7	8.8
pH	9	*su*		8.7	8.7	8.6	8.1	8.0	8.1	8.5	8.6	8.7
Specific Conductance	0.5	*uS/cm*	788	785	792	788	802	822	838	837	843	846
Specific Conductance	1	*uS/cm*	791	785	793	788	802	822	835	837	843	845
Specific Conductance	1.5	*uS/cm*	792	785	796	789	801	822	837	837	843	845
Specific Conductance	2	*uS/cm*	803	785	795	788	801	822	836	837	843	845
Specific Conductance	2.5	*uS/cm*	812	785	794	788	802	822	835	837	843	845
Specific Conductance	3	*uS/cm*		785	794	787	801	822	836	837	843	845
Specific Conductance	3.5	*uS/cm*		785	795	787	802	822	836	837	843	845
Specific Conductance	4	*uS/cm*		785	795	788	802	822	836	837	843	845
Specific Conductance	5	*uS/cm*		785	795	788	801	822	835	837	843	845
Specific Conductance	6	*uS/cm*		785	794	788	801	822	836	837	844	844
Specific Conductance	7	*uS/cm*		785	794	788	803	822	836	838	844	845
Specific Conductance	8	*uS/cm*		785	794	789	802	822	836	838	845	845
Specific Conductance	9	*uS/cm*		785	795	790	805	826	837	838	845	845
Temperature	0.5	*Deg C*	3.7	5.2	7.8	13	17.3	21.2	21.8	20.8	19.7	18.18
Temperature	1	*Deg C*	3.8	5.1	7.7	12.5	17.3	21.2	21.9	20.8	19.7	18.9
Temperature	1.5	*Deg C*	3.8	5	7.5	12.1	17.2	21	21.9	20.8	19.6	18.8
Temperature	2	*Deg C*	3.8	5	7.4	11.8	17.2	21	21.8	20.7	19.4	18.8
Temperature	2.5	*Deg C*	3.8	5	7.3	11.7	17.1	20.9	21.7	20.7	19.4	18.7
Temperature	3	*Deg C*		5	7.3	11.6	17.1	20.9	21.5	20.7	19.4	18.7
Temperature	3.5	*Deg C*		5	7.3	11.6	17	20.9	21.5	20.7	19.4	18.7
Temperature	4	*Deg C*		5	7.3	11.5	16.9	20.9	21.4	20.7	19.4	18.6
Temperature	5	*Deg C*		5	7.3	11.5	16.6	20.8	21.3	20.6	19.3	18.6
Temperature	6	*Deg C*		5	7.3	11.5	16.4	20.8	21.2	20.6	19.3	18.6
Temperature	7	*Deg C*		5	7.3	11.4	14.6	20.8	21.2	20.6	19.2	8.5
Temperature	8	*Deg C*		5	7.3	11.3	13.7	20.1	21.2	20.6	19.1	18.5
Temperature	9	*Deg C*		5	7.2	11.3	13.5	18.6	20.6	20.5	19.1	18.5

Appendix A

2024 Evergreen Lake Water Quality - Field Measurements

Parameter	*Depth (m)*	*Units*	*Date*				
			5/17/2024	6/12/2024	7/10/2024	8/14/2024	9/23/2024
Secchi		*m*	1.2	1.15	2	1.15	0.9
Dissolved Oxygen	0.5	*mg/L*	7.98	7.84	7.56	6.5	7.12
Dissolved Oxygen	1	*mg/L*	8.21	7.39	7.44	6.4	7.1
Dissolved Oxygen	1.5	*mg/L*	8.17	7.91	7.44	6.37	6.63
Dissolved Oxygen	2	*mg/L*	8.15	7.83	7.24	6.39	6.72
Dissolved Oxygen	2.5	*mg/L*	8.07	7.63	7.16	5.94	7.36
Dissolved Oxygen	3	*mg/L*	8.32	7.33	7.01	5.99	6.91
Dissolved Oxygen	3.5	*mg/L*	8.1	7.51	7.15	5.95	7.02
Dissolved Oxygen	4	*mg/L*	7.86	7.43	6.72	5.74	7
Dissolved Oxygen	5	*mg/L*	7.84	7.02	7.08	5.81	6.96
Dissolved Oxygen	6	*mg/L*	7.35	3.31	5.66	5.54	6.63
pH	0.5	*su*	8.63	6.88	7.86	8.35	7.88
pH	1	*su*	8.25	7.03	7.57	7.84	7.88
pH	1.5	*su*	8.08	7.23	7.47	7.74	7.87
pH	2	*su*	8.02	7.26	7.46	7.7	7.88
pH	2.5	*su*	7.96	7.32	7.52	7.7	7.84
pH	3	*su*	7.92	7.35	7.54	7.73	7.82
pH	3.5	*su*	7.9	7.36	7.58	7.74	7.81
pH	4	*su*	7.85	7.38	7.61	7.75	7.79
pH	5	*su*	7.8	7.39	7.7	7.74	7.79
pH	6	*su*	7.77	7.18	7.48	7.72	7.78
Specific Conductance	0.5	*uS/cm*	92.6	61.9	63.4	71.8	79.9
Specific Conductance	1	*uS/cm*	92.6	61.2	62.3	71.2	79.3
Specific Conductance	1.5	*uS/cm*	90.6	60.2	62.1	71	79.2
Specific Conductance	2	*uS/cm*	91	60.1	62.2	71	79.4
Specific Conductance	2.5	*uS/cm*	93.7	60.3	62.1	70.7	79.4
Specific Conductance	3	*uS/cm*	95.8	60.8	62.2	70.9	79.4
Specific Conductance	3.5	*uS/cm*	97.4	61.6	62.1	71.1	79.3
Specific Conductance	4	*uS/cm*	106	61.6	62.1	71.5	79.3
Specific Conductance	5	*uS/cm*	112.6	63.1	61.9	72	79.3
Specific Conductance	6	*uS/cm*	113.9	82.7	61.7	73.5	79.3
Temperature	0.5	*Deg C*	11.1	15.8	16.9	18.6	14
Temperature	1	*Deg C*	10.5	14.1	16.4	18.2	13.8
Temperature	1.5	*Deg C*	9.7	13	16.2	17.3	13.8
Temperature	2	*Deg C*	8.9	12	16.1	17.1	13.8
Temperature	2.5	*Deg C*	8.4	11.7	15.9	17.1	13.8
Temperature	3	*Deg C*	8.2	11.6	15.9	17	13.7
Temperature	3.5	*Deg C*	7.7	11.5	15.9	17	13.7
Temperature	4	*Deg C*	6.9	11.4	15.8	16.9	13.7
Temperature	5	*Deg C*	6.1	10.9	15.4	16.8	13.7
Temperature	6	*Deg C*	5.9	9.7	14.8	16.5	13.7

Appendix A

2024 Watershed and Reg 85 Water Quality - Laboratory Analysis

Analyte	Units	Site	Site Abbrev.	Month											
				January	February	March	April	May	June	July	August	September	October	November*	December
E. coli	*MPN/100 mL*	45	LBC D/S BCR	2	0	2	2	30	2	0	2	2			
E. coli	*MPN/100 mL*	90	LBC - WADS	13	23	23	4	23	8	30	23	13			
Nitrate/Nitrite as N	*µg/L*	CONIFER SANITATION		1,043		1,344		656		1,080		1,472		1,135	
Nitrate/Nitrite as N	*µg/L*	EVERGREEN		4,746		6,598		6,510		4,512		7,461		6,397	
Nitrate/Nitrite as N	*µg/L*	FOREST HILLS		4,658		14,527		6,776		23,378		9,095		2,674	
Nitrate/Nitrite as N	*µg/L*	JCSD HIGH OUTDOOR LAB		9,922		29,218		17,722		20,264		19,631		27,926	
Nitrate/Nitrite as N	*µg/L*	JCSD HIGH SCHOOL		6,400		14,108		14,624		3,808		9,288		3,318	
Nitrate/Nitrite as N	*µg/L*	KITTREDGE		2,964		12,742		5,545		3,049		3,024		2,865	
Nitrate/Nitrite as N	*µg/L*	MORRISON		3,406		813		438		515		357		842	
Nitrate/Nitrite as N	*µg/L*	WEST JEFF		7,187		5,330		5,973		4,196		5,677		3,228	
Phosphorus, total	*µg/L*	5	BC - LB					29	25	18	27				
Phosphorus, total	*µg/L*	9	BC - OFP					42	20	27	34				
Phosphorus, total	*µg/L*	18	STC - MYERS					46	99	105	29				
Phosphorus, total	*µg/L*	19	NTC - FLYJ					45	22	310	21				
Phosphorus, total	*µg/L*	25	VNC CK					11	20	14	16				
Phosphorus, total	*µg/L*	26	CUB					29	29	18	110				
Phosphorus, total	*µg/L*	36	SML						8	25	7				
Phosphorus, total	*µg/L*	37	BC - MAIN						14	76	6				
Phosphorus, total	*µg/L*	45	LBC D/S BCR	19	12	13	25	30	25	53	84	59			
Phosphorus, total	*µg/L*	58	BC - MBS					17	22	5	10				
Phosphorus, total	*µg/L*	63	PLM - Out						85	197	790				
Phosphorus, total	*µg/L*	90	LBC - WADS	36	23	25	24	35	27	55	67	37			
Phosphorus, total	*µg/L*	101a	HRSH U/S						34	40		217			
Phosphorus, total	*µg/L*	101b	HRSH D/S						35	103		115			
Phosphorus, total	*µg/L*	102a	CMTRY					9	14	43		0			
Phosphorus, total	*µg/L*	13a	BC - IDE					31	24	69	37				
Phosphorus, total	*µg/L*	14a	BC - MP					43	31	33	45				
Phosphorus, total	*µg/L*	15a	BC U/S BCR	47	77	29	21	46	34	47	39	85			
Phosphorus, total	*µg/L*	16a	TC U/S BCR	5	11	5	36	47	28	28	37	0			
Phosphorus, total	*µg/L*	2a	BC - GWB					18	16	19	14				
Phosphorus, total	*µg/L*	32a	TRB CK					73	104	106	91				
Phosphorus, total	*µg/L*	3a	BC U/S EGL					20	19	15	26				
Phosphorus, total	*µg/L*	47a	COY CK U/S		61	26	19	44	66	369	117	113			
Phosphorus, total	*µg/L*	47b	COY CK D/S		62	22	16	37	57	114	109	55			
Phosphorus, total	*µg/L*	97a	COY X D/S		83	22	54	46	93	196	147	150			
Phosphorus, total	*µg/L*	97b	COY X U/S		78	23	37	273	76	278	118	157			
Phosphorus, total	*µg/L*	98a	RNY GLCH U/S		51	9	130	40	105	38	88	7			
Phosphorus, total	*µg/L*	98b	RNY GLCH D/S		45	14	20	27	83	611	536	161			
Phosphorus, total	*µg/L*	CONIFER SANITATION		7		47		0		19		23		10	
Phosphorus, total	*µg/L*	EVERGREEN		923		360		197		168		658		1,976	
Phosphorus, total	*µg/L*	FOREST HILLS		357		1,521		137		520		291		179	
Phosphorus, total	*µg/L*	JCSD HIGH OUTDOOR LAB		790		1,797		453		373		205		28	
Phosphorus, total	*µg/L*	JCSD HIGH SCHOOL		86		69		116		72		184		16	
Phosphorus, total	*µg/L*	KITTREDGE		411		365		402		802		426		204	
Phosphorus, total	*µg/L*	MORRISON		62		133		81		169		584		193	
Phosphorus, total	*µg/L*	WEST JEFF		126		258		144		127		138		201	
Total Ammonia as N	*µg/L*	CONIFER SANITATION		26		16		0		0		19		25	
Total Ammonia as N	*µg/L*	EVERGREEN		3,459		136		2,666		30		272		554	

Total Ammonia as N	µg/L	FOREST HILLS		161		1,495		104		935		142		601	
Total Ammonia as N	µg/L	JCSD HIGH OUTDOOR LAB		38		0		0		0		20		19	
Total Ammonia as N	µg/L	JCSD HIGH SCHOOL		0		0		0		0		54		3,380	
Total Ammonia as N	µg/L	KITTREDGE		9,024		670		306		3,923		645		569	
Total Ammonia as N	µg/L	MORRISON		153		704		128		259		286		115	
Total Ammonia as N	µg/L	WEST JEFF		764		1,201		297		95		219		1,335	
Total Nitrogen	µg/L	5	BC - LB					545	340	228	293				
Total Nitrogen	µg/L	9	BC - OFP					682	407	287	395				
Total Nitrogen	µg/L	18	STC - MYERS					582	777	881	456				
Total Nitrogen	µg/L	19	NTC - FLYJ					842	456	973	398				
Total Nitrogen	µg/L	25	VNC CK					215	215	167	163				
Total Nitrogen	µg/L	26	CUB					887	440	258	463				
Total Nitrogen	µg/L	36	SML						340	252	258				
Total Nitrogen	µg/L	37	BC - MAIN						503	273	361				
Total Nitrogen	µg/L	45	LBC D/S BCR	1,235	912	843	1,074	841	646	532	633	796			
Total Nitrogen	µg/L	58	BC - MBS					315	362	215	238				
Total Nitrogen	µg/L	63	PLM - Out						593	411	1,443				
Total Nitrogen	µg/L	90	LBC - WADS	1,379	1,087	1,031	1,068	846	684	649	809	948			
Total Nitrogen	µg/L	101a	HRSH U/S						1,247	1,011		1,224			
Total Nitrogen	µg/L	101b	HRSH D/S						1,261	1,383		2,080			
Total Nitrogen	µg/L	102a	CMTRY					496	208	384		270			
Total Nitrogen	µg/L	13a	BC - IDE					609	405	640	433				
Total Nitrogen	µg/L	14a	BC - MP					592	401	501	450				
Total Nitrogen	µg/L	15a	BC U/S BCR	1,539	1,627	1,017	965	726	559	769	712	898			
Total Nitrogen	µg/L	16a	TC U/S BCR	1,243	1,079	1,173	1,135	839	884	1,343	1,461	1,234			
Total Nitrogen	µg/L	2a	BC - GWB					292	306	205	194				
Total Nitrogen	µg/L	32a	TRB CK					1,927	1,805	1,414	2,430				
Total Nitrogen	µg/L	3a	BC U/S EGL					374	300	213	219				
Total Nitrogen	µg/L	47a	COY CK U/S		1,300	2,375	2,453	1,517	1,483	1,627	1,086	1,322			
Total Nitrogen	µg/L	47b	COY CK D/S		1,330	2,121	2,264	1,414	1,241	925	1,114	984			
Total Nitrogen	µg/L	97a	COY X D/S		1,312	451	673	769	599	636	892	858			
Total Nitrogen	µg/L	97b	COY X U/S		1,348	392	627	1,616	602	798	880	874			
Total Nitrogen	µg/L	98a	RNY GLCH U/S		2,305	1,386	3,886	3,424	3,657	802	2,218	2,658			
Total Nitrogen	µg/L	98b	RNY GLCH D/S		2,297	1,467	3,823	3,391	3,764	2,188	2,324	2,906			
Total Nitrogen	µg/L	CONIFER SANITATION		1,653		2,230		1,212		1,854		1,871		1,617	
Total Nitrogen	µg/L	EVERGREEN		10,569		7,201		10,118		5,445		8,585		8,312	
Total Nitrogen	µg/L	FOREST HILLS		7,334		18,970		6,456		21,188		11,723		4,045	
Total Nitrogen	µg/L	JCSD HIGH OUTDOOR LAB		7,537		29,544		19,412		28,205		19,312		36,667	
Total Nitrogen	µg/L	JCSD HIGH SCHOOL		7,923		16,057		16,576		4,329		10,002		7,010	
Total Nitrogen	µg/L	KITTREDGE		13,410		13,486		7,071		8,999		5,010		4,900	
Total Nitrogen	µg/L	MORRISON		5,303		2,616		1,444		1,621		1,362		1,534	
Total Nitrogen	µg/L	WEST JEFF		11,058		8,216		8,137		5,551		6,751		6,205	

*Only Reg 85 samples were collected in November.

Appendix A

2024 Reservoir Water Quality - Laboratory Analysis

Analyte	Units	Site Id	Site Abbrev.	Date													
				1/18/2024	2/5/2024	3/11/2024	4/8/2024	5/14/2024	5/17/2024	6/3/2024	6/12/2024	7/8/2024	7/10/2024	7/15/2024	8/5/2024	8/12/2024	9/9/2024	9/16/2024
Chlorophyll a	*mg/m3*	40a	BCR - TOP	9.3	2.1	6.2	5.3	2.9		5.3		4.9		4.25	10.3	76.35	34.8	27.85
Chlorophyll a	*mg/m3*	49a	BSL - TOP		11.8	2.4	6.7	2.3		0.3		2.6			3.8	5.6	9	9.3
Chlorophyll a	*mg/m3*	4a	EGL - TOP						1.4		1.7		5.75					
Phosphorus, total	*µg/L*	40a	BCR - TOP	16	19	16	27	42		20		43		26	39	47	42	44
Phosphorus, total	*µg/L*	40c	BCR - BOT	12	20	14	27	83		32		80		51	21	54	40	44
Phosphorus, total	*µg/L*	49a	BSL - TOP		12	14	16	10		0*		21			12	17	18	22
Phosphorus, total	*µg/L*	49b	LSL -TOP		18	225	59	29		24		51			44	21	18	33
Phosphorus, total	*µg/L*	4a	EGL - TOP						25		16		21					
Phosphorus, total	*µg/L*	4e	EGL - BOT						42		16		22					
Total Nitrogen	*µg/L*	40a	BCR - TOP	1,252	1,124	954	1,179	871		566		566		474	507	493	653	667
Total Nitrogen	*µg/L*	40c	BCR - BOT	972	1,003	977	1,127	854		678		582		521	357	444	584	588
Total Nitrogen	*µg/L*	49a	BSL - TOP		453	564	542	444		535		506			548	641	763	650
Total Nitrogen	*µg/L*	49b	LSL -TOP		566	748	603	526		712		993			806	654	779	650
Total Nitrogen	*µg/L*	4a	EGL - TOP						293		361		374					
Total Nitrogen	*µg/L*	4e	EGL - BOT						335		402		343					

*Total Phosphorus on 6/3/24 was not detected.

Appendix B
2024 WWTF Compliance Data

Drainage	WWTF	Jan lb/mo	Feb lb/mo	Mar lb/mo	Apr lb/mo	May lb/mo	Jun lb/mo	Jul lb/mo	Aug lb/mo	Sep lb/mo	Oct lb/mo	Nov lb/mo	Dec lb/mo	Sum lb/yr	WLA lb/yr	In Compliance	% Allocation Used
Bear Creek	Brook Forest Inn (Renamed Brookside Chateau LLC)[1]	0	0	0	0	0	0	0	0	0	0	0	0	0	5	Yes	0%
	Evergreen Metro District	89.04	65.94	34.72	40.41	44.03	18.55	12.11	57.12	45.58	29.33	102.79	39.32	578.94	1500	Yes	39%
	Forest Hills Metro District	NS[2]	6.17	5.6	1.22	4.98	9.38	2.69	0.09	16.35	5.09	1.29	0.42	53.28	80	Yes	67%
	Genesee Water and Sanitation	12.92	15.63	17.24	26.45	20.06	17.69	36.43	23.32	28.3	37.32	36.97	15.3	287.63	1015	Yes	28%
	Jerfferson County Schools - Mount Evans Outdoor Lab School	0.02	0.06	0.08	0.08	0.05	0.17	0.09	0.07	0.08	0.09	0.03	0.02	0.84	20	Yes	4%
	Kittredge Sanitation District	4.76	3.59	4.33	4.48	4.49	2.88	7.82	1.89	3.64	3.92	2.29	2.52	46.61	240	Yes	19%
	Town of Morrison	1.74	1.87	2.7	2.19	2.37	7.73	3.92	5.63	11.73	2.59	4.74	2.36	49.57	600	Yes	8%
	West Jefferson County Metro District	18.01	23.88	25.14	18.91	24.51	15.39	14.68	12.25	12.41	16.27	14.39	15.1	210.94	1500	Yes	14%
Turkey Creek	Aspen Park Metro District	0	0	0	0	1.488	0.306	0.285	0.194	0.11	0.465	0.075	0.314	3.237	40	Yes	8%
	Tiny Town[1]	0	0	0	0	0	0	0	0	0	0	0	0	0	5	Yes	0%
	Conifer Center Sanitation	0.21	0.22	0.19	0.20	0.24	0.19	0.28	0.24	0.38	0.20	0.20	0.19	2.73	40	Yes	7%
	Conifer Metro District	0.09	0.09	0.06	0.06	0.06	0.06	0.09	0.09	0.15	0.06	0.09	0.09	0.99	40	Yes	2%
	Geneva Glen Camp[1]	0	0	0	0	0	4.13	0	0	0	0	0	0	4.13	5	Yes	83%
	Jefferson County Schools - Conifer High School	3.12	2.44	0.00	0.23	2.31	0.00	1.54	0	1.61	1.76	1.01	1.35	15.36	110	Yes	14%
Reserve Pool[3]		--	--	--	--	--	--	--	--	--	--	--	--	--	55	--	--
													Totals	**1254.26**	**5255**	--	24%

[1]Brook Forest Inn and Tiny Town did not discharge in 2024 but remain permitted; Geneva Glen only discharged in June 2024

[2]Forest Hills Metro District failed to collect a sample in January of 2024

[3]The reserve pool in the Control Regulation is 2 pounds of total phosphorus, the 55 pounds listed by the BCWA includes pounds from closed WWTFs: Singing River Ranch (30), The Fort Restaurant (18), and Bear Creek Cabins (5)

Drainage	WWTF	Units	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Permit Limit	In Compliance?
Bear Creek	Brook Forest Inn (Renamed	mg/L	0	0	0	0	0	0	0	0	0	0	0	0	1.0	Yes
	Evergreen Metro District		0.88	0.70	0.28	0.30	0.35	0.19	0.13	0.56	0.48	0.29	0.99	0.38	1.0	Yes
	Forest Hills Metro District		NS[2]	**1.14**	0.84	0.2	0.82	**1.47**	0.35	0.33	**1.73**	0.53	0.33	0.09	1.0	**No**
	Genesee Water and Sanitation		0.25	0.33	0.34	0.46	0.33	0.34	0.66	0.41	0.52	0.68	0.74	0.29	1.0	Yes
	Jerfferson County Schools - Mount		0.06	0.1	0.12	0.11	0.06	0.17	0.08	0.14	0.13	0.016	0.048	0.07	1.0	Yes
	Kittredge Sanitation District		0.41	0.33	0.38	0.41	0.39	0.31	0.78	0.19	0.36	0.34	0.20	0.21	1.0	Yes
	Town of Morrison		0.07	0.08	0.11	0.08	0.08	0.30	0.14	0.21	0.50	0.11	0.20	0.13	1.0	Yes
	West Jefferson County Metro District		0.17	0.26	0.24	0.17	0.22	0.17	0.16	0.13	0.14	0.18	0.16	0.15	1.0	Yes
Turkey Creek	Aspen Park Metro District		<0.05	<0.05	<0.05	<0.05	0.43	0.08	0.07	0.07	0.04	0.15	0.03	0.1	0.5	Yes
	Tiny Town[1]		0	0	0	0	0	0	0	0	0	0	0	0	0.5	Yes
	Conifer Center Sanitation		0.05	0.07	0.05	0.05	0.05	0.05	0.06	0.05	0.1	0.05	0.05	0.05	0.5	Yes
	Conifer Metro District		0.05	0.07	0.05	0.05	0.05	0.05	0.06	0.05	0.1	0.05	0.05	0.05	0.5	Yes
	Geneva Glen Camp[1]		0	0	0	0	0	**7.18**	0	0	0	0	0	0	1.0	**No**
	Jefferson County Schools - Conifer		0.1	0.08	<0.05	0.06	0.06	<0.05	0.09	<0.05	0.04	0.05	0.03	0.07	1.0	Yes

[1]Brook Forest Inn and Tiny Town did not discharge in 2024 but remain permitted; Geneva Glen only discharged in June 2024

[2]Forest Hills Metro District failed to collect a sample in January of 2024

BCWA PROGRAM GUIDLELINES & OPERATIONS

Approved November 8, 2023

PGO43 - BCWA Surface Water Monitoring Program and Sample Analyses Plan
Version 2024.01

Table of Contents

List of Tables

List of Figures

Bear Creek Watershed Monitoring Program

Bear Creek Reservoir Control Regulation # 74

The Bear Creek Watershed (Figure 1) is a specific geographic area identified in the Bear Creek Watershed State Control Regulation (Regulation #74, 5 CCR 1002-74) (Control Regulation) identifying water quality management (BCWA Policy 13 – Vision, Mission & Targets). The watershed includes all tributary water flows that discharge into Bear Creek Reservoir and a small area below the dam as defined in *BCWA Policy 14 – Watershed Boundary*. Essentially, the watershed boundary extends from Mount Blue Sky and its associated Wilderness on the western end past the Town of Morrison on the eastern end. The two major tributaries are Bear Creek and Turkey Creek. The purpose of the Control Regulation is to attain site-specific water quality standards and classifications through control of total phosphorus and chlorophyll.

The Bear Creek Watershed Association (Association) oversees implementation of the Control Regulation. The Association is the local water quality agency responsible for monitoring and tracking water quality in the Bear Creek Watershed. The Association has conducted a generally continuous collection of surface quality data from 1990 for the Bear Creek Watershed and reservoir. Data collection includes specific chemical, physical and biological parameters. Data is collected monthly and bi-monthly at Bear Creek Reservoir and along Turkey Creek and Bear Creek. The Association meets water quality data sampling and analyses objectives established in the Bear Creek Reservoir Control Regulation # 74.

The Association provides watershed reporting as posted on the Association Website www.bearcreekwatershed.org, which serves to keep federal, state, and local governments and others informed on the state of the watershed. The Control Regulation defines specific reporting requirements, which helps the Association keep the Water Quality Control Commission and Water Quality Control Division staff updated on the progress of the Association in implementing the Control Regulation.

Figure 1 Bear Creek Watershed

The Association has established a series of management policies and strategies to guide the watershed monitoring programs (See PGO01for a complete list of program documents as incorporated into the Association Watershed Plan; and PGO02 for the Program Document Categories).

Monitoring requirements established by State Control Regulation #85 are designed to evaluate the effectiveness of and to determine the sources and load of nutrients at selected locations, and eventual implementation of appropriate and necessary source controls. The Bear Creek Association watershed monitoring plan includes monitoring elements for wastewater treatment facilities in the watershed, which allows these facilities to meet monitoring requirements in Regulation #85.

Nutrient Regulation #85

All wastewater treatment plants in the watershed are categorized as minor facilities. As such, upstream and downstream monitoring is exempt for the treatment works that surface discharge. All surface discharging wastewater treatment facilities must meet the effluent monitoring requirements of Regulation #85. Each facility has certification and reporting requirements defined in that regulation. The monitoring data collected for Regulation #85 is not part of the permit DMR reporting.

Implementation of Regulation #85 monitoring is a requirement of permitted surface water dischargers and is not a specific monitoring requirement of the Association. However, the Association board has determined that integrating the monitoring requirements from Regulation #85 into the Association watershed monitoring plan Regulation #74 could serve to improve water quality management in the watershed and have a shared funding benefit. A combined monitoring effort can meet state requirements, but, as importantly, it is an opportunity for the Association to develop a more comprehensive and holistic nutrient management plan that will protect and improve water quality throughout the watershed. Involvement of wastewater treatment facilities in this joint monitoring effort is strictly voluntary. See *BCWA Information Sheet 18 Reg 85 Shared Service Program* for shared service program details.

The Association completed the certification process for all wastewater treatment facilities in the watershed and maintains a copy of the certification in the association data record. However, the Association will only do the reporting requirement for those treatment facilities participating in the voluntary shared service monitoring program. All other non-participating treatment plants are expected to do their own reporting to the WQCD in accordance with the Regulation #85 reporting requirements. The wastewater treatment plants that have volunteered for this sampling effort are shown in Table 1. The Association will pick up collected effluent samples in coordination with these treatment plants. The Association contract laboratory will process these samples. The eight participating treatment plants will compensate the Association for the actual laboratory costs. Data collection will occur on the first or second week of every other month beginning in January.

Table 1 **Wastewater Treatment Plants Involved in a Coordinated Monitoring Plan**

Wastewater Treatment Works	Coordinated with Monthly Stream Samples	Not Participant
Bear Creek Drainage		
JCS Outdoor Lab	**x**	
Brookforest Inn		**x**
Evergreen Metro District	**x**	
West Jefferson County Metro District	**x**	
Kittredge Sanitation and Water District	**x**	
Genesee Water and Sanitation District		**x**
Forest Hills Metro District	**x**	
Morrison	**x**	
Turkey Creek Drainage		
Aspen Park Metro District		**x**
Conifer Metro District		**No Sample**
Conifer Sanitation Association	**x**	
JCS Conifer High School	**x**	
Tiny Town		**No Sample**
Geneva Glen		**No Sample**

Association Monitoring Program Types

The Bear Creek Watershed Association maintains five types of water quality and other monitoring efforts to characterize water and environmental quality within the Bear Creek Watershed*:*

P1- Routine water quality monitoring at Bear Creek Reservoir (multiple vertical stations), Turkey Creek inflow to reservoir, Bear Creek inflow to reservoir, reservoir discharge into lower Bear Creek, and the lower edge of the watershed near Wadsworth. The P1 sites are long-term reference monitoring sites consistent with the intent of the monitoring program outlined in the Bear Creek Reservoir Control Regulation #74.

P2- Supplemental sampling of tributaries, problem areas, restoration or other project specific sites (e.g., Coyote Gulch in cooperation with the City of Lakewood). These types of monitoring efforts can be either of limited duration, or long-term on a site-specific basis, and generally these programs monitor for specific parameters of interest to the project.

P3- Watershed surface water monitoring along Bear Creek and Turkey Creek drainages for site-specific characterizations (e.g., temperature trends, nutrient loading, flow studies). These are interim and long-term monitoring sites for watershed characterizations. Watershed monitoring stations include both long-term reference sites where multi-year data is desirable, and target sites that may provide only a couple years of data. The nutrient monitoring is on

a watershed basis that begins near Summit Lake and extends through Bear Creek Reservoir. The monitoring schedule for the watershed programs is maintained by the Association manager and are available on request.

P4- Supplemental environmental characterizations of Bear Creek watershed including, but not limited to macroinvertebrates, flow analysis, habitat characterizations, fishery evaluations, system productivity, or other environmental factors that potentially affect fisheries or watershed health.

P5- Wastewater treatment facility nutrient sampling consistent with Regulation #85. The wastewater treatment plants in the watershed are listed in Table 2.

Table 2 WWTF in Bear Creek Watershed

Wastewater Treatment Plants	Facility Type	Design Capacity MGD	2024 Effluent Monitoring
JCS Outdoor Lab	Minor	0.0075	Yes
Brookforest Inn (Not active)	Minor	0.009	No
Evergreen Metro District	Minor	0.99	Yes
West Jefferson County Metro District	Minor	0.7	Yes
Kittredge Sanitation and Water District	Minor	0.125	Yes
Genesee Water and Sanitation District	Minor	0.8	?
Forest Hills Metro District	Minor	0.05	Yes
Morrison	Minor	0.35	Yes
Aspen Park Metro District	Minor	0.025	Yes
Conifer Metro District	Minor	0.043	Yes
Conifer Sanitation Association	Outfall	0.019	Yes, CMD
JCS Conifer High School	Minor	0.052	Yes
Tiny Town	Minor	0.005	No
Geneva Glen	Minor	0.0105	Yes

Mapped Watershed Features

The BCWA uses Google Earth to track monitoring sites and watershed features of interest. The mapping codes and station types are shown in Table 3. A Google Earth *Myplaces* file is available to the membership for use with Google Earth.

Table 3 BCWA Google Earth Station Types

Code	Station Type
P1	Routine CR Monitoring stations
P1 BCR	BCR Stations
P1 S	Stream Sites for mass balance
P2	Supplemental Water Quality Characterizations in Bear Creek Watershed
P2 Air	BCR Aeration Sites
P2 Coyote	Coyote Gulch Nutrient Reduction
P2 Fen	Summit Fen Study
P2 Gen	Genesee Reservoir
P2 K/S	Kerr and Swede Gulch Special Study
P2 MV	Mount Vernon Creek
P2 Sed	Bear Creek Reservoir Sediment Study
P2 Soda	Soda Lakes
P2 Summit	Summit Plume Study
P2 Temp	Stream Temperature Only Probe
P2 Trib	Special tributary Nutrient loads
P2 Trouble	Troublesome Gulch
P2 TSS	Total Suspended Sediment Sites
P2 Flow	Stream Flow Measurement Sites
P2 Copper	Segment 1e Copper Study
P3	Watershed Monitoring Program Active sites
P3 EGL	Evergreen lake
P3 WS	Watershed
P3 Old	Stream Site Not Active

P4	Supplemental Studies, Education Sites or Informational Features
P4 Ed	Educational site
P4 Fish	CDFW Fishery Surveys
P4 Gage	Gaging Stations
P4 Horse	Horse Stables or Operations
P4 Macro	Macroinvertebrates
P4 Other Group	Other Outside Agency Monitoring Stations
P4 Sign	BCWA Signs
P4 Segments	Mainstem segment brake points
P4 WS	Watershed Features
P4 Weather	Watershed Weather Stations
P5	WWTF
P5 Outfall	WWTF Outfalls

2024 Water Quality Monitoring Program & Quality Assurance Project Plan

The following monitoring plan sections details the 2024 reservoir and watershed monitoring programs as approved by the BCWA Board. This monitoring plan remains consistent with the quality assurance goals of the previously adopted Association QAPP (Bear Creek Watershed Association, 2006). However, this monitoring plan is the working version. The monitoring program version 2024.01 is adapted from the last version of the 2023.01 monitoring plan.

Watershed Field Monitoring Personnel

The Association contracts field monitoring, sampling coordination, and data management with RNC Consulting LLC:

Russell N Clayshulte, RNC Consulting LLC
1529 S Telluride St
Aurora, CO 80017
Cell (303) 638-4931
rclayshulte@earthlink.net

BCWA Field Methods

RNC Consulting LLC conducts field sampling in cooperation with Evergreen Metropolitan District staff and the City of Lakewood, and occasionally other members. All water quality samples for laboratory analyses are delivered by RNC Consulting LLC to GEI Consultants, Inc. / Chadwick Ecological Division within 2 hours of final sample collection. Field data sheets are scanned and converted into PDF files for electronic storage. Field data is transferred into master spreadsheets, which contain all annualized data collected for the Association, including temperature logger data.

The BCWA has adopted a set of indices forms, field methods and habitat summaries, which are listed and maintained in the PGO1 Master Index List as part of the Association's Watershed Plan (Table 4).

Table 4 BCWA Indices & Methods

	BCWA Indices & Methods
FI01	BCWA Habitat Indices Form
FI02	BCWA Physical Stream Indices Form
ME01	Embeddedness Field Estimation Method
ME02	Gravelometer Pebble Count Method
ME03	Field Flow Estimation Method
ME04	Macroinvertebrate Field Sample Method
ME05	Periphyton Field Estimation Method
ME06	Water Clarity Estimation Method
ME07	Habitat Indices Site BCW
ME08	Erosion Pin Method (Not Currently Used)
ME09	2015 Habitat Indices Summary
ME10	Tributary Assessment Procedure
ME11	Temperature Probes
ME12	Macro Labels

Watershed Field Monitoring Notes and Methods

Treatment facilities listed in Table 2 may provide effluent data collected at their respective WWTP's, including analytical results; and /or assistance with special monitoring.

The Interval frequency for temperature dataloggers is every half-hour (48 per day). The dataloggers located in the stream will be field downloaded as needed.

Manual pH, Temperature, DO, Specific Conductivity, Total Nitrogen, Nitrate-nitrogen, Total Ammonia, Total Inorganic Nitrogen and Total Phosphorus data collected at selected temperature datalogger locations. Manual monitoring is performed in the morning to early afternoon, beginning at approximately 08:00 and ending at approximately 15:00. Monthly monitoring provides a check on integrity of dataloggers.

WWTP effluent data collected as part of the typical plant process control performed daily. Effluent pH/Temperature/DO recorded and ammonia sampling performed in accordance with the requirements of each WWTP discharge permit. Total ammonia analyzed for WWTP effluents by the method allowing for the lowest detection limit.

USGS flow measurement obtained at gages above Evergreen Lake, above the Town of Morrison, below Morrison within Bear Creek Lake Park, Turkey Creek and at the Lower bear Creek Sheridan gage.

Daily weather data (High/low temperature, precipitation) from the NWS station at the EMD WWTP obtained annually.

Calibrations of portable equipment documented prior to each use and Certificates of Calibration for all equipment obtained. NIST certifications and Certifications of Compliance are originally obtained for each temperature datalogger used in the study.

GPS points maintained for all new sampling and monitoring locations.

RNC Consulting LLC works with the City of Lakewood to monitor dissolved oxygen in water column in Bear Creek Reservoir and Big Soda Lake. In BCR the aeration system can be adjusted to o maintain DO standards, while minimizing aeration operations. This may require additional vertical probe sampling in the July to October period to monitor DO levels in the water column at site 40.

RNC Consulting LLC maintains photographic points for critical segments and conditions, and documents dewatering of Bear Creek Segment 1b below both the Arnett-Harriman and Ward ditches.

All collected data is maintained in an annual master spreadsheet, which is posted at the completion of the annual monitoring program on the Association Website.

Contract Laboratory and Laboratory Methods

The contract laboratory used by the Association for all laboratory analysis is GEI Consultants, Inc. / Chadwick Ecological Division.
Drew Kekkonen Laboratory Manager
GEI Consultants, Inc.
Ecological Division
4601 DTC Boulevard, Suite 900
Denver, CO 80237

Macroinvertebrate Analysis

GEI Consultants analyses samples by the BCWA for benthic macroinvertebrates. Samples collected by the Association follow the *BCWA M04 Macroinvertebrate Field Sample Method*. Data for samples are reported as number of organisms per square meter. Percent of total is also reported. The species are counted consistent with the CDPHE EDAS import columns for taxa and species. This data is converted into MMI scores using the EDAS protocols (EDAS CO Master Version - Distributable to 3rd Parties and *A Stepwise Guide to Generating MMI Scores Using Colorado-EDAS*). Table 5 shows the Macroinvertebrate QA performance from the GEI Laboratory.

Table 5 Macroinvertebrate QA Performance

# of Samples for QA	Extractions		Initial Identifications	
	Sample %	Acceptable %	Sample %	Acceptable %
1	98.1	95	99.3	95

Laboratory Methods

The GEI Laboratory methods and limits are summarized as follows:

- Analyte Methods are shown in Table 6.
- General Preservation: preserved with H2SO4 to pH <2.0
- Storage: refrigerated at 4ºC until analyzed
- Number of Replicates/Analyte: 2 for all nutrients
- QA/QC Analyses: 3 standards at beginning & end of analyses, & at 5 replicate increments, for all nutrients
- Example of a Matrix Spike by analyte report is shown in Table 7.
- Table 8 reports the minimum detection limits used by GEI.
- Table 9 shows the New GEI Lachat Method for Nutrients.
- Nutrient Analysis
  - Preservation: preserved with H_2SO_4 to pH <2.0
  - Storage: refrigerated at 4ºC until analyzed
  - Number of Replicates/Analyte: 2 for all nutrients
  - QA/QC Analyses: 3 standards at beginning & end of analyses, & at 5 replicate Increments, for all nutrients
- Total Suspended Solids Analysis
  - Storage: refrigerated at 4ºC until filtered
  - Filtration: filtered through a pre-baked Gelman A/E 1.0 µm glass fiber filter
- Chlorophyll a Analysis
  - Filtration: filtered through a pre-baked Gelman A/E 1.0 µm glass fiber filter
  - Storage: filter stored frozen at -20°C, kept in the dark and in desiccator
- E. coli Analysis
  - All testing would follow the Hach colilert method for E. coli adapted from Standard Methods (9223 B) for the Examination of Water and Wastewater (APHA et al, 1998).
  - Sample containers supplied by GEI.

Table 6 Analyte Methods

Analyte	Method	Filtered (0.45 µm filter)	Preservation (H2SO4 to pH <2.0)	Allowable Hold Time (unpreserved samples) *
Total Phosphorus	QuickChem 10-115-01-4-B, with manual digestion	No	Yes	48 hours prior to digestion; 7 days prior to analysis
Total Dissolved Phosphorus	QuickChem 10-115-01-4-B, with manual digestion	Yes	Yes	48 hours prior to digestion; 7 days prior to analysis
Total Nitrogen	QuickChem 10-107-04-4-B, with manual digestion	No	Yes	48 hours prior to digestion; 7 days prior to analysis
Nitrate + Nitrite	QuickChem 10-107-04-1-C	Yes	No	48 hours
Ammonia	QuickChem 10-107-06-2-A	Yes	Yes	24 hours
Total Suspended Solids	Standard Methods 2540 D	Yes		7 days before filtration, indefinitely after drying
Chlorophyll *a*	Hot Ethanol Extraction	Yes		28 days
E. coli	Hach colilert method (9223 B)	No	No	24 hours
Copper	EPA 200.8	Yes	No	48 hours
Hardness	Standard methods 2340 C	No	No	48 hours

*all preserved samples have an allowable holding time of 28 days

Table 7 Example of Matrix Spikes by Analyte Reported to Association.

Analyte	Average % Recovery	Number of Samples Spiked	Within Target Range
TP	106	1	Yes
TDP	103	1	Yes
TN	102	1	Yes
NOx	98	1	Yes
NH3	93	1	Yes
Target recovery range is 80-120% recovery.			

Table 8 Minimum Detection Limits

Analyte	Method	MDL	PQL (ug/l)
Total Phosphorus	QuickChem 10-115-01-4-B, with manual digestion	2 ug/l	8
Total Dissolved Phosphorus	QuickChem 10-115-01-4-B, with manual digestion	2 ug/l	8
Total Nitrogen	QuickChem 10-107-04-4-B, with manual digestion	6 ug/l	42
Nitrate+Nitrite	QuickChem 10-107-04-1-C	2 ug/l	8
Total Ammonia	QuickChem 10-107-06-3-A	5 ug/l	35
Total Suspended Solids	Standard Methods 2540 D	4 mg/l	
Chlorophyll *a*	Hot Ethanol Extraction	0.1 ug/l	
Hardness	Standard Methods 2340 C	2 mg/l	

The GEI Consultants, Inc. (GEI) Laboratory uses a Lachat instrument and accompanying methods used for low-level nutrient analyses. All nutrient samples are analyzed using GEI's Lachat methods (Table 8). All methods are either EPA-accepted, EPA-equivalent or have been approved by the state of Colorado for use in GEI lab. All methods are acceptable under Regulation 85 (Nutrients Management Control Regulation). GEI will continue to follow the same rigorous QA/QC procedures they have always followed under our previous methodology.

Table 9 Lachat Method for Nutrients

Analyte	Old GEI Method	New GEI Method	MDL ug/l	PQL ug/l
NH3	QC 10-107-06-3-D	QC 10-107-06-2-A	5	35
NOx	QC 10-107-04-1-B	QC 10-107-04-1-B	2	14
NO2	QC 10-107-04-1-B	QC 10-107-04-1-B	2	14
TN/TDN	SM 4500-N B (mod)	QC 10-107-04-4-B	6	42
OP	QC 10-115-01-1-T	QC 10-115-01-1-T	2	14
TP/TDP	QC 10-115-01-4-U	QC 10-115-01-4-B	2	14

Laboratory QA/QC Protocols for Nutrient Analyses

Equipment calibrations performed each time new standards are prepared (minimum of once per week). If the r-value of the standard curve is less than 0.999, the instrument is recalibrated, or standards are remade. Replicates run on each sample are analyzed and the percent difference must be within 10% if the resultant concentration is above the minimum detection limit. If results of analyses of replicate samples are not within 10% of one another, samples are placed in a clean test tube and reanalyzed.

During analysis, check standards are analyzed between every 5 samples (or 10 replicates). The check standards consist of one high range standard, one mid-range standard, and the zero (blank). Check standards analyzed before and after each group of samples must be within 10% of the theoretical value. If standards are outside of this range, samples and standards are placed in clean test tubes and reanalyzed to try to determine the source of the problem. Sample values are not accepted until the problem has been resolved and all check standards pass the QC criteria. One matrix spike is run for every 10 samples analyzed. The percent recovery for matrix spikes must be ± 20%.

After sample analyses a final QC check performed to determine if all parameters measured agree. Final analyses for each sample are compared to ensure that concentrations of total phosphorus ≥ total dissolved phosphorus ≥ orthophosphate and that the concentration of total nitrogen ≥ total dissolved nitrogen ≥ nitrate/nitrite and ammonia. If parameters do not agree, samples are reanalyzed.

Chain of Custody

The Association provides the laboratory with a chain-of-custody form with the transfer of samples that identifies each sample, parameters required for sample, date and time of collection, sample personnel and where data is reported. At transfer a staff member from the laboratory signs and dates the chain-of-custody and makes a copy for RNC Consulting LLC. The laboratory uses Table 10 as part of their chain-of-custody.

Table 10 Laboratory Chain-of-Custody

QA Requirement	Yes	No	Note
Chain of Custody received complete			
Samples received within holding times			
Samples at correct temperature (1-8ºC)			
QA/QC Standards within acceptable 10% difference			
Duplicate samples within acceptable 10% difference			

QA Requirement	Yes	No	Note
All matrix spikes within target range of 80-120% recovery			

Data Management

RNC Consulting LLC is responsible for all Association water quality and environmental data management, including QA/QC of data. Large quantities of varied data are collected during the annual monitoring program: Monthly stream monitoring and sampling, laboratory results, thirty-minute temperature measurements from dataloggers, wastewater treatment plant effluent process, control, and permit monitoring data, weather statistics and stream flows comprise raw data. All data are stored on an office computer, using Microsoft Office 365 software. Most of the data resides in and analyses occur in Excel spreadsheet format. RNC Consulting LLC maintains all monitoring data for all Association monitoring programs. Data is kept on a computer with back-up to an external cloud-drive. Additionally, some back-up data sets of recent data are kept on flash drives. The Association incorporates data into a data report, after the study. Electronic data files are made available after the Association Board has approved the study report. Sampling and Monitoring Plan summaries are provided to the BCWA at meetings, which are open to the public.

Watershed Sampling Dates 2024

The 2024 monitoring schedule, which maybe periodically updated or changed as required by the field monitoring personnel, is maintained by the Association Manager. Changes to the monitoring schedule are sent to the Association through electronic notifications.

Water Quality Monitoring Parameters in 2024

Table 11 lists the 2024 water quality monitoring parameters by monitoring program.

Table 11 Monitoring Parameters

Watershed and Special Stream WQ Studies	
Field Chemistry/ Physical	**Laboratory Analyses**
Temperature (discrete field probe)	Total Nitrogen (GEI)
Temperature (continuous data loggers, 1/2-2m)	Total Phosphorus (GEI)
Dissolved Oxygen, YSI Probe	E. coli, sites 45 and 90 (GEI)
Specific Conductivity, YSI Probe	Total Suspended Sediments, if needed Spring Runoff
pH, YSI Probe	
Manual Flow/ gage readings	
Water Clarity - Staining	
Periphyton Coverage	
Wastewater Treatment Facilities Regulation 85 Requirements	
Field Data	**Laboratory Analyses (GEI)**
Daily average effluent discharge	Total Nitrogen
Temperature (continuous data loggers, Effluent)	Nitrate/Nitrite as N, dissolved
	Total Ammonia
	Total Inorganic Nitrogen (Calculation = NO2+NO3+NH4)
	Total Phosphorus
Monitoring Site Survey - Annual Select Sites	
Macroinvertebrates - 10 sites	Habitat Indices
Pebble Counts	Physical Stream Indices
Embeddedness	
BCR, EGL, Big Soda Sediment Survey - Annual Limited Sites	
Sediment TP: BCR composite of 3 sites, EGL composite of 3 sites, Big Soda 1 site	
Reservoirs (BCR, Big Soda and Evergreen)	
Field Data	**Laboratory Analyses**
Temperature (field probe, 1/2-m intervals in central pool)	Total Nitrogen (-1/2m and +1m) (GEI)
Temperature (continuous data loggers, 1/2-2m)	Total Phosphorus (-1/2m and +1m) (GEI)
Dissolved Oxygen (field probe, 1/2-m intervals in central pool thru 4m, then 1m interval)	Chlorophyll a (-1/2m only) (GEI)
Specific Conductivity (field probe, 1/2-m intervals in central pool thru 4m, then 1m interval)	BCR Phytoplankton (June, July, August, September, October) EGL (June, July, August, September, October) (GEI)
pH (field probe, 1/2-m intervals in central pool thru 4m, then 1m interval)	Zooplankton - annual, species present (GEI), if needed
Total Depth	
Secchi Reading	

2024 Monitoring Stations and Frequency of Sampling

Table 12 lists the 2024 monitoring stations, type of monitoring, reference sites and frequency of sampling by stream segments.

Table 12 2024 Monitoring Stations

Site ID	Watershed Sample Program Site Location by Stream Segment	2024			Reference Site
		Data Logger	Manual Flows	Chemistry	
Segment 1a					
Site 58	Bear Creek Below Mt. Blue Sky Wilderness	x	x	x	R
Site 2a	Golden Willow Bridge	x	x	x	R
Site 3a	Above Evergreen Lake at CDOW Site	x	USGS gauge	x	
Segment 1b					
Site 15a	Bear Creek within Bear Creek Park	x	USGS gauge	x	R
Segment 1c					
Site 40a/ 40c	Bear Creek Reservoir, Profile; Chemistry -1m,+1m	x		x	R
Site 41	BCR, Outlet	Field Profile			
site 42	BCR South Dam	Field Profile			
Segment 1d					
Site 4a/4e	Evergreen Lake, profile; Chemistry -1m, +1	x		X	R
Segment 1e					
Site 5a	CDOW downtown Little Bear site	x	x	x	R
Site 9	O'Fallon Park, west end at CDOW Site	x	x	x	
Site 13a	Below Idledale, Shady Lane CDOW site	x	x	x	
Site 14a	Morrison Park east end at gaging station	x	USGS gauge	x	R
Segment 2					
Site 45	Lower Bear Creek, below reservoir trace/ weir	x	DNR	x	R
Site 90	Lower Bear Creek Wadsworth	x	(Sheridan)	x	R
Segment 3					
Site 25	Vance Creek	x	x	x	R
Site 101 a/b	Wilmot Drainage		x	x	
Site 102 a	Cemetery Drainage		x	x	
Segment 4a					
Site 47 a/b	Upper Coyote Gulch		x	x	
Site 97 a/b	Coyote Crossing		x	x	
Site 98 a/b	Rooney Gulch		x	x	
Site 100 a/b	Horseshoe Drainage		x	x	
Segment 5					
Site 26	Cub Creek, Mouth	x	x	x	R
Site 32	Troublesome Mouth		x	x	R
Segment 6a					
Site 16a	Turkey Creek within Bear Creek Park	x	x	x	R
Site 18	South Turkey Creek Myers Ranch	x	x	x	
Segment 6b					
Site 19	North Turkey Creek Flying J Ranch Bridge	x	x	x	R
Segments 7 and 8					
Site 36	Summit Lake (Segment 8)		x	x	R
Site 63	Plume Outlet		x	x	
Site 37	Bear Creek Mainstem (Segment 7)		x	x	R
Segment 10, 11, and 12 (Lake/ Pond Segments)					
Site 49a/b	Big Soda (Segment 11)	x		x	R

Wastewater Treatment Facility Regulation #85 Monitoring

The Bear Creek Association watershed monitoring plan includes monitoring elements for wastewater treatment facilities in the watershed, which allows these facilities to meet monitoring requirements in Regulation #85. The monitoring data collected for Regulation #85 is not part of the permit DMR reporting.

The wastewater treatment effluent parameters used to meet Regulation #85 requirements are shown in Table 13. The PQLs and MDLs are lower than those required in Regulation #85 and are shown in Table 14. These MDLs and PQLs are used for all Association nutrient data processed by the Associations contract laboratory.

Table 13 Regulation 85 Parameters

Wastewater Treatment Facilities	
Field Data	**Laboratory Analyses**
Daily average effluent discharge	Total Nitrogen
Temperature (Selected plants continuous data loggers, Effluent)	Nitrate+Nitrite-Nitrogen
	Ammonia-Nitrogen
	Total Inorganic Nitrogen (Calculation = NO2+NO3+NH4)
	Total Phosphorus

Table 14 MDLs and PQLs used for Association Sample Parameters

Analyte	Old GEI Method	GEI Method	MDL (ug/l)	PQL (ug/l)
NH3	QC 10-107-06-3-D	QC 10-107-06-2-A	5	35
NOx	QC 10-107-04-1-B	QC 10-107-04-1-B	2	14
NO2	QC 10-107-04-1-B	QC 10-107-04-1-B	2	14
TN/TDN	SM 4500-N B (mod)	QC 10-107-04-4-B	6	42
OP	QC 10-115-01-1-T	QC 10-115-01-1-T	2	14
TP/TDP	QC 10-115-01-4-U	QC 10-115-01-4-B	2	14

The monitoring frequency is to have 6-monthly samples for treatment plants per year. The State is interested in winter numbers and evenly spaced effluent data. The sample months for Regulation #85 sampling are January, March, May, July, September, November. Data collection will occur on the first or second week of every other month beginning in January 2022.

The Association stream flow monitoring program and analysis plan is enough to meet the intent of Regulation #85 and allow the Association to mass-balance nutrients in the watershed.

Small treatment plant effluent samples can be grab samples, if defined as such in permit. If a larger plant is required by permit to do composites, then the sample used for Regulation #85 should be a composite that matches permit requirements. Sampling for nutrients is required in the effluent before it is discharged into the receiving water body at the location where monitoring is performed to satisfy other CDPS permit requirements (as per regulation). Total phosphorus data collected under Regulation #85 for small treatment plants may be used to meet Regulation #74 requirements. The nutrient data collected under Regulation #85 are not required to be reported by the permittee in their respective NPDES DMR reporting system; however, the collected data can be submitted as part of the DMRs. Each plant is responsible for getting the daily average effluent discharge and reporting this information to the Association on a monthly basis.

The Association will provide sample bottles, if requested, to the treatment plants for sample collection that are participating in the cost share program. The treatment plant operators must collect necessary effluent samples. The Association cannot take the samples at the plants.

Treatment Tech, who operates smaller treatment works, is opting out of the Association shared monitoring program. The Association will not be responsible for the annual submittal and data transfer to the state for those treatment facilities not participating in a joint monitoring program.

A certification letter is available for each treatment plant. The Association bundled the available certifications, noting the facility is covered by a watershed monitoring program. The Association maintains a copy of the plant

certifications to link with the monitoring plan. The nutrient data collected under the regulation #85 regulations are not required to be reported by the permittee in their respective NPDES DMR reporting system; however, the collected data can be submitted as part of the DMRs. See Table 15 for certification status.

Table 15 Certifications Available for WWTF under Regulation #85

Wastewater Treatment Plants	Permit Number	LRP Certification	Effluent Sample Type	Copy of Certification	Latitude/ Longitude
Bear Creek Drainage					
JCS Outdoor Lab	CO-0032514	Kim Brogan	grab	Yes 2016	To be determined
Brookforest Inn	CO-0030261	Robert Clodfelter	grab	Yes	39.579394/ 105.380764
Evergreen Metro District	CO-0031429	Dave Lighthart	Composite12-hour	Yes	39.38' 16.19/105.18' 56.07
West Jefferson County Metro District	CO-0020915	Dave Lighthart	Composite12-hour	Yes	39.39' 46.05/105.20' 06.62
Kittredge Sanitation And water District	CO-0023841	Dave Lighthart	Composite12-hour	Yes	39.39' 27.75/105.17' 15.04
Genesee Water and Sanitation District	CO-0022951	Chris Brownell	Composite 24-hour	Yes	39.40' 34/ 105.16' 26
Forest Hills Metro District	CO-0037044	Bruce McCreary	Composite12-hour	Yes	39.42' 09/ 105.15' 07
Morrison	CO-0041432	John McEncroe	Composite12-hour	Yes	39.39' 10.89/ 10510' 39.99
Turkey Creek Drainage					
Aspen Park Metro District	CO-0631016	Robert Clodfelter	Composite12-hour	Yes	39.32' 38/ 105.17' 25
Conifer Metro District	CO-047295	Bryan McCarty	Groundwater	Yes	Not Sampled
Conifer Sanitation Association	COX-0047392	Becky Hammer	Grab	Yes	39.31' 49/ 105.18' 16
JCS Conifer High School	CO-047988	Kim Brogan	Composite12-hour	Yes	95.523470/ 105.306350
Tiny Town	CO-0036129	Robert Clodfelter	grab	Yes	39.36' 22/105.13' 38
Geneva Glen	CO-0044652	Ken Atchison	Groundwater	Not Needed	Not Sampled

P1 - Routine Monitoring Program

The routine monitoring program (P1) focuses on Turkey Creek drainage and Bear Creek drainage inputs and discharge from Bear Creek Reservoir (Figure 2) into lower Bear Creek with a central pool characterization of the reservoir near the dam (Site 40). In Figure 3, the outlet structure is near site 41 with Bear Creek inflow near site 44 and Turkey Creek inflow near site 43. The reservoir chemistry and biological characterization occur at site 40. Vertical probe samples at ½ and 1-meter intervals measured at sites 40, 41, and 42 beginning at -1/2-m. Temperature Logger profile of Bear Creek Reservoir at Site 40 with buoy placement and probes attached at ice-off (April-December, first week): ½ m, 1m, 1 ½m, and 2m. Field probe measurements year-round at site 40 with profile interval of ½ m, 1m, 1 ½m, 2m, 2 ½m, 3m, 3 ½ m, 4m, 5m, 6m, 7m, 8m, 9m, 10m, and 11m. Similar profile pattern used at other reservoir sites. The current monitoring program optimizes data generation to evaluate reservoir inflow loading, tropic state changes within the reservoir, and reservoir outflow; while minimizing monitoring cost.

Field Sampling Management: Russell Clayshulte, Association Manager; Field Assistance from Lakewood staff.

2024 Routine P1 sampling Sites

The six 2024 P1 routine watershed-monitoring stations, including the Bear Creek Reservoir station, are:

1. Mainstem of Turkey Creek prior to discharge into Bear Creek Reservoir, within Bear Creek Park, adjacent to the City of Lakewood Maintenance Yard.

2. Mainstem of Bear Creek prior to discharge into Bear Creek Reservoir, within Bear Creek Park, adjacent to the bridge at the western edge of the park.

3. Tail-water discharge from Bear Creek Reservoir (Site 45) in the concrete channel that defines lower Bear Creek.

4. Bear Creek Reservoir, center of main pool and supplemental vertical profile stations 40, 41, and 42.

5. Big Soda Reservoir off swimming beach.

6. Bear Creek Site 90 above Wadsworth.

Figure 2 2024 P1 Bear Creek Reservoir Monitoring Sites

Figure 3 P1 Reservoir Monitoring Stations; Site 40 is the Nutrient P1 station

P1 Sampling Parameters BCR

Table 16 Bear Creek Reservoir and Big Soda Sampling Parameters

Parameter (units)	Reservoir Sites	Reservoir Outflow, Site 45
Physical/Field		
Flow/ Discharge (cu m/s)	Manual and Staff gage	Manual and Staff gage
Specific Conductance (umhos/cm)	BCR Profiles at sites 40, 41, 42. Big Soda site 49a	X
Secchi (meters)	Sites 40, 41, 42, 49a	
Total Depth (m)	Sites 40, 41, 42, 49a	
Dissolved Oxygen (mg/l)	Profiles at sites 40, 41, 42, 49a	X
Temperature (C)	Profiles at sites 40, 41, 42, 49a Data Logger at BCR site 40	X
Total Suspended Sediments (mg/l)	Seasonal Only Spring	X
pH (standard unit)	Profiles at sites 40, 41, 42, 49a	X
Biological (Site 40 only)		
Chlorophyll a (ug/l)	X (-1m)	
Zooplankton (August)	Vertical Tow	
Phytoplankton (June, July, August, September, October)	Composite top 1-meter water	
Nutrients (Reservoir Site 40 only)		
Total Nitrogen (ug/l)	X (top, lower)	X
Total Phosphorus (ug/l)	X (top, lower)	X
Bottom Sediments BCR (As Needed)		
Total Phosphorus (mg/kg)	Composite 3 sites	
% Organics (TOC)	Composite 3 sites	

P1 Stream Sampling Parameters

Table 17 Monitoring Parameters for Sites 15a, 16a, 45, 90, 97a/b, 98a/b, and 100a/b

Watershed and Special Stream WQ Studies	
Field Chemistry/ Physical	**Laboratory Analyses**
Temperature (discrete field probe)	Total Nitrogen
Temperature (continuous data loggers, 1/2-2m)	Total Phosphorus
Dissolved Oxygen, YSI Probe	E. coli, select sites
Specific Conductivity, YSI Probe	Total Suspended Sediments, select sites Spring Runoff
pH, YSI Probe	
Manual Flow/ gage readings	
Water Clarity - Staining	
Periphyton Coverage	
Monitoring Site Survey - Annual Select Sites	
Macroinvertebrates	Habitat Indices
Pebble Counts	Physical Stream Indices
Embeddedness	

P1 Sampling Frequency

P1 sites sampled monthly in January, February, March, April, May, June, October, November, and December. Growing season samples taken twice in July, August, and September.

P2 - Supplemental Water Quality Characterizations in Bear Creek Watershed

Addressing WQ Concerns on Tributary Drainages

2024 special assessment of potential tributary load areas, as directed by Board.

- Conduct ground surveys to identify potential "hot" spots, map
- Conduct multiple field probe measurements at intervals to see if any discernible filed data is event. Only collect TP/TN pair if a suspected area is found, will need linked flow data to calculate nutrient loads. After spring rainy period.

Coyote Gulch, Coyote Crossing, and Rooney Gulch

The Association coordinates with the City of Lakewood a sampling program on Coyote Gulch, Coyote Crossing, and Rooney Gulch within Bear Creek Park. The monitoring on Coyote Gulch is done at two sampling sites: above the restoration project, and at the discharge into the reservoir (Figure 4). New sampling sites at Coyote Crossing and Coyote Gulch were established in 2020. Generally, the sampling protocols will match the Coyote Gulch program. For Coyote Gulch, the Association collects the chemistry data for total phosphorus and nitrate-nitrogen. The Association takes monthly flow measurements to determine nutrient loading. The Association also collects data for temperature, pH, specific conductance and Dissolved Oxygen. Data results are incorporated into the Association monthly and annual data summaries. The Association has pre-construction and post-construction loading data. This monitoring project has established a total phosphorus trade credit for use of the Association.

Figure 4 Coyote Gulch Sample Sites

Coyote Crossing discharges directly into Bear Creek Reservoir at the boat launch parking lot. This historically was an intermittent drainage receives flows from Green Mountain. In the last 3-5 years, this discharge tended to flow year-round with very low winter flows. The new development on Green Mountain has definitely resulted in increased flows. The new monitoring site 97a is located at the road crossing bridge near the parking lot. The site is monitored for background Total Nitrogen and Total Phosphorus. It appears some of the flow comes from a leak in the Ward Ditch near Morrison Road. This drainage has produced amphibian and bird kills in Bear Creek Reservoir in the past. The increased development on Green Mountain is likely to make this a year-year loading source to the reservoir. There are some opportunities for mitigation above the maximum pool level within the park. After investigating a monitoring site 97b near Morrison Road, it is not necessary to start an upstream monitoring station at this time.

Figure 5 Coyote Crossing Sample Site

Rooney Gulch discharge is carried through a culvert under Morrison Road and discharges into Bear Creek near the park entrance. This historically was an intermittent drainage receiving flow from the large Rooney Valley area (2,740 acres). In the last 1-2 years, this discharge tended to flow more frequently, and within the last year there is flow most of the year, even in this drier year. There is a substantial new development and land clearing operation just north of Morrison Road in Rooney Valley. There is evidence of increased silty deposition within the stream channel in the park. There has also been increased large flow events. The new monitoring site 98a is located in the park below the culvert (difficult access). The specific conductance was exceptionally high at this site (4,583 uS). It is highly likely that this site will receive year-round flow in the coming years and will be a significant loading point to Bear Creek Reservoir. The site is monitored for background Total Nitrogen and Total Phosphorus. An investigation will be made north of Morrison Road to determine if a better upstream monitoring site is available to the Association.

Figure 6 Rooney Gulch Sample Site

Bear Creek Reservoir Sediment Study

Obtain grab samples of bottom sediments at multiple sites after shut-down of aeration system. May include discrete dredge samples from each of three reservoir zones; Central pool, Turkey Creek inlet and Bear Creek inlet using three fixed transects (Figure 7). Bottom samples obtained with a petite Ponar sampler. This sampler takes a grab of the top 5-6 cm of the mud bottom. One dredge drop made at each site resulting in about 0.5 liters of bottom mud, then all collected samples are composited and a single sample is prepared for lab analysis. The locations in Figure 7 are estimates. Determine total phosphorus.

Figure 7 Reservoir Sediment Sites

Summit Lake and Plume

Bear Creek Watershed Association established two sampling stations at Summit Lake and upper Bear Creek, Mt Evans Wilderness, Clear Creek County Colorado. The Association selected sampling Site 36 (Summit Lake at outfall) and Upper Bear Creek Site 37 to monitor assumed high quality "background" conditions. However, monitoring data shows atypical water quality results. The station data suggests there is a pollution source causing elevated nutrient loads, low pH conditions and reduced dissolved oxygen. Association observations suggests the pollution plume originates from the old toilet vaults area in the Summit Lake parking area and this pollution plume affects data results from sites 36 and 37.

In June 2012, the Association began a special study effort to document the extent and magnitude of the potential pollution plume. The Association walked the area to identify potential problem areas. The Association concluded that the source area was in the vicinity of the parking lot. The Association originally assumed the problem was related to the past waste disposal practice of using pit privies. There are many wetland or bog ponds that occur between the parking lot and upper Bear Creek. The Association noted that some of these ponds in a drainage fall-line had much more algal productivity than those ponds nearer Summit Lake and well downstream from the parking lot. This suggested that the pollution plume was surfacing in-part in some of the ponds.

E. Coli Special Monitoring

BCWA Fact Sheet 39 E. coli identifies standards for waters in the Bear Creek Watershed and lists those stream segments on the Colorado 303(d) list of impaired waters. An alternative BCWA management program that doesn't require the adoption of a formal regulatory total maximum daily load for E. coli in these listed segments or other waterbodies in the watershed with suspected bacterial contamination contains the following management strategies and approaches.

Waterway Source Tracking

Fecal coliform & *E. coli* bacteria found in streams in the watershed originate in human, pet, livestock, and wildlife waste. Irrigation, stormwater runoff, snowmelt and flood water, failed on-site wastewater treatment systems (OWTS) leach fields, broken/leaking sewer lines contaminated with fecal matter pose higher risks. *E. coli* does not occur naturally in soil and vegetation but can survive for periods in moist soil or on vegetation. It only enters water from fecal contamination.

1. Routine bacterial monitoring at long-term reference sites can be used to detect presence of E. coli over established standards (in lower watershed two-sites below BCR and near Wadsworth on Bear Creek). Routine sites include comprehensive water quality monitoring as defined in the BCWA annual water quality sample plan using established quality assurance protocols.

2. Systematic bacterial monitoring when E. coli is detected can be used to trace upstream potential sources of contamination. A targeted monitoring process can identify and isolate likely problem areas. If a problem area is identified, targeted management solutions for that site can be applied through established watershed partners and land-use decision makers.

3. Predict potential pathways from land uses (e.g., map pastures, large animal grazing or corral operations, parks and open space, dog parks, locate OWTS by sub-drainages, maps of sewer mains, erosional problem areas and high use human recreational areas

4. Establish a water watch program for citizens and businesses that includes education & trained data collection.

5. Apply adaptive management to monitoring program. Provide an annual technical memorandum on E. coli management in the watershed.

Stream Flow Data

Manual Site-Specific Measurements

Manual flow measurements are performed at watershed locations through the program period. The Association uses three methods to obtain flow data:

1. Manual stream flow is measured using an OTT MF Pro to measure average water velocity in a stream cross-section. Depth and velocity readings are taken at 2-foot increments in the cross-section. Velocity readings are taken at the mid-water column level. Flow is calculated for each sub-section of the cross-section (Q=V x A) and the subsection flows are added to estimate the stream flow. The manual measures have been checked against the flow measurements taken at both USGS gages and the manual flows are generally within 5% of the USGS estimates.

2. The Association has an OTT MF Pro flow meter. When the sensor is placed in flowing water, a magnetic field around the sensor creates a voltage proportional to the flow velocity. This voltage amplitude, which represents the rate of water flow around the sensor, is detected by electrodes in the sensor and processed by the sensor

microprocessor. The processed signal is digitally transmitted through the sensor cable to the portable meter and the information is shown on the meter display. The system includes a portable meter, sensor with cable and a depth probe. Velocity is calculated in user defined cross-sections that allows for a more accurate estimate of stream or conduit flow than the flow probe. The Mean-section method divides the cross-section into individual flow segments. Pairs of adjacent verticals are the limits of the segments. The two edges of the cross-section are given values of 0 for the velocity and depth. The total flow is the sum of the partial flows of all segments.

USGS, Colorado Department of Water Resources and Urban Drainage Gaging Station Stream Flows

Flow data summarizes the flow gages located on Bear Creek. There are five locations in the watershed that produce flow data and include above Evergreen Lake, above Morrison, Bear Creek Park (partial year), Turkey Creek and below the dam in the outflow trace. A USGS stream gage (USGS 06710385) maintains a location above Evergreen Lake, near the CDOW fish survey site. The gage location is adjacent to the Denver Mountain Parks golf course (Keys on the Green) parking lot. The second gaging station is located below the temperature datalogger location ID MORR10, above the town of Morrison, just west of the Highway 8 Bridge over Bear Creek. This station (BCMORCO 06710500) is maintained by the Colorado Division of Water Resources. Weekly stream flow graphs were printed from both stations and filed for record. Monthly average daily flows from gages exported to a spreadsheet for comparison with historical data. Although flow records began at this location in 1899, the most complete data record exists from 1919 through 2023 for the Morrison gage. A 25-year record recorded in annual data reports.

P3 - Watershed Monitoring Programs

The Bear Creek Watershed Association conducts watershed scale monitoring programs. These P3 monitoring programs focus on characterizing water quality of surface waters in the Turkey Creek and Bear Creek drainages of the watershed. The monitoring year is divided into a warm-season period with more intense sampling and a cold-season period, designed to provide minimal winter and spring data. This data report summarizes temperature and water quality monitoring data, sampling results obtained from in-stream locations, and data from five-wastewater treatment plant (WWTP) effluents. The complete Cold-season and Warm-season water quality data set is an electronic data summary report and spreadsheet.

P3 Field Parameter Probe Measurements

Monthly measurements are performed in the morning and early afternoon. Measurements are recorded with an YSI Professional hand-held meter. The meter utilizes a multi-probe sensor, capable of measuring pH, Temperature, Dissolved Oxygen and Specific Conductance simultaneously. Measurements are logged, retained in the on-board computer, and then manually downloaded. Typically, the logged data is manually downloaded by viewing each file and transcribing data onto monthly Logsheets. The data is entered into a spreadsheet. Prior to the program, the meter is calibrated by certified technicians. Prior to each monitoring event, the meter is calibrated for each parameter, using a purchased calibration solution for specific conductance and purchased pH buffers (two-point calibration, 7.0 and 10.0). Fresh batteries installed in the meter at the start of the program and batteries replaced when the observed battery charge reached 50%. Flow measurements are performed coincidentally with monthly sampling and monitoring. A Global Water flow probe Model FP101 is used and values obtained are combined with stream width and depth measurements to calculate estimated streamflow.

P3 Evergreen Lake Monitoring

Evergreen Lake has a temperature data logger string near the dam structure with temperature logger profile at ice-off (April-May) through November 1: ½ m, 1m, 1 ½m, and 2m. Profile data is collected in May to October for Temperature, DO, specific conductance, and pH at 0m, -1m, -2m, -3m, and -4m. Chemical analyses include chlorophyll a, Total Nitrogen, and Total Phosphorus. Water is sampled at -1m and +1m in water column. Phytoplankton is sampled at -½ m. A total depth and Secchi reading are collected. Chlorophyll is sampled at only -1m. Association may collect data consistent with protection of a major drinking water supply system.

P3 Temperature Datalogger Monitoring Locations

Programmable temperature dataloggers measure and record watershed stream temperatures every thirty minutes. The loggers used in the Program are Onset Computer Corporation brand, Temp Pro v2 (U22) programmable dataloggers. Every other year all model dataloggers are returned to Onset for a NIST (National Institute of Standards and Technology) one-point certification and a ‘tune-up’. The one-point certification is performed against calibration standards at 20°C. The ‘tune-up’ consists of a new battery and quality control testing, assuring the dataloggers meets manufacturer’s operating specifications. The Association maintains a fact sheet with temperature monitoring protocols, as included in the Association annual report.

The dataloggers are programmed for measurements every thirty minutes at an office computer equipped with the Onset software. At this frequency, the memory capacity is approximately 905 days for the U22 (Water Temp Pro) series logger. The Association employs newer models with delayed-start capabilities. Logsheets are utilized to record the exact time of deployment and retrieval of all units, so that erroneous measurements (measurements recorded out of water) can be omitted during the data evaluation process.

The U22 series loggers are utilized in all watershed stream locations. These loggers are downloaded to a shuttle device. Occasionally, the download process occurred precisely at the measurement instance and a measurement is lost. There are no watertight cases required for the U22 model loggers. The date and deployment time for all loggers is noted on a Logsheet. After downloading the last logger in the Watershed, the laptop and shuttles are transported to the desktop computer with the Onset software at the EMD Administration office. The logger data is transferred from the laptop and from the shuttles to the desktop. The shuttles are connected to the computer via a download cable, and data on the shuttles are individually downloaded into separate program files.

30-minute datalogger temperature measurements are exported from the Onset Computer software into Excel spreadsheets. Each download of temperature data is treated as a file in the Onset software. Once the Onset file formats is exported and saved as separate Excel files, the Excel spreadsheets for each location is combined into one Excel spreadsheet with multiple worksheets. Therefore, each Excel file contains multiple worksheets, one for each separate download of data, and a summary worksheet. The master dataset spreadsheet contains separate worksheets for each Site in the watershed, displaying all temperature datalogger values and statistical analysis, as well as sampling and monitoring data and statistics.

The date and time recorded on the Launch/Retrieval Logsheet is used to eliminate erroneous temperature measurements prior to data analysis. The majority of these erroneous measurements are eliminated by utilizing the shuttle devices to field-download data. Occasionally, the field download process occurs exactly at the time of a measurement, and an erroneous value is recorded or missed. These are also removed from the raw data prior to analysis. Once in a spreadsheet format, the data is evaluated against the underlying standard Weekly Average Temperature (WAT) criteria, against the underlying standard Daily Maximum Temperature (DM) criteria and against the Maximum Weekly Average Temperature (MWAT) criteria. Percentages of compliance are calculated. Weekly Average Temperatures are determined by calculating the mean temperature of seven consecutive days of data beginning with either April or May or the first day of data collection. Any lack of data collection resulting in a data gap of one day or more, requires that the seven-day period begin anew. Maximum Weekly Average Temperatures are determined by evaluating the calculated Weekly Average Temperatures.

Daily Maximum values are obtained by calculating the average temperature of a two-hour period beginning with the first temperature recorded, and determining the maximum value from each day. Again, any lack of data collection resulting in a data gap more than two hours, requires that the two-hour calculation period begin anew. In most cases, there are four measurements in a two-hour period.

Limited Seasonal Temperature Datalogger Monitoring Locations

Continuous temperature measurements taken by loggers every half-hour, May 15-Oct 15 (ice dependent)

Site 58	Bear Creek below the Mt. Blue Sky Wilderness
Site 37	Below Summit Lake
Site 25	Vance Creek
Site 2a	Golden Willow on Upper Bear Creek
Site 3a	Above Evergreen Lake at Keys-on-the-Green, CDOW Site
Site 4	Evergreen Lake, at dam (1/2m, then at 1-meter intervals)
Site 5	Above EMD WWTP, CDOW Downtown Site
Site 9	O'Fallon Park (west end, CDOW Site)
Site 13a	Below Idledale (at Idledale at Shady Lane, CDOW Site)
Site 14a	Morrison Park (west end of town, CDOW Site)
Site 19	North Turkey Creek Flying J Ranch
Site 18	South Turkey Creek below APMD

Seasonal Temperature Datalogger Monitoring Locations

Continuous temperature measurements taken by loggers every half-hour, Apr 15-Dec 1 (ice dependent)

Site 16a	Turkey Creek within Bear Creek Park (Lakewood)
Site 15a	Bear Creek Segment 1b east of Gaging Station in Bear Creek Park
Site 40	Bear Creek Reservoir (1/2m-2m)
Site 49	Big Soda (1/2m-2m)
Site 45	Below Bear Creek Reservoir
Site 90	Bear Creek at Wadsworth

P-4 Colorado Division of Parks &Wildlife Fishery Sites, Macroinvertebrates

Weather (local)

A National Weather Service Cooperative Reporting Station Number 052790 is maintained at the EMD WWTP. Daily high and low air temperatures and precipitation are recorded and transmitted monthly to the National Weather Service. Weather data was tabulated and correlated with Bear Creek stream flows (obtained at the USGS gage above Evergreen Lake) for the Program. Weather data collected during the program period was compared to the available historical weather records, obtained at the NWS High Plains Climate Center.

Fishery Surveys

The Colorado Division of Wildlife (CDOPW) has monitored fish populations in the watershed from 1988 through 2022. Prior to 2005, there were five monitoring sites. In 2010, there were ten survey sites (Table 18). In 2011, Bear Track site 38 was included in survey. All of the CDOPW survey sites incorporated in the Association monitoring network. No fish surveys were done in 2012 due to the low flow conditions. No fish surveys were done in 2013 due to flood conditions. Fishery survey completed in 2014-2017 and 2019-2022. No survey in September 2018 due to low flow concerns.

Table 18 Colorado Division of Parks and Wildlife Fish Survey Sites

Stream Segment	CDOPW Fishery Reference Sites
Segment 3	Vance Creek (one-time)
Segment 1a	Keys on the Green, Golden Willow Bridge, Site 58
Segment 1e	Little Bear, Bear Creek Cabins, O'Fallon Park, Lair O' the Bear, Idledale, Morrison Park
Segment 7	Bear Tracks (one-time)

These reference sites have coordinated chemistry, biological, physical data collection. This mixed data analysis establishes reference conditions for four stream segments in the watershed. The CDOPW surveys fish populations in September. The survey determines young of the year and adult size classes, species present, total biomass of fish by species and total pounds per acre by species. The Association assists the CDOPW with fish sampling. The CDOPW provides raw and processed data to the Association for the annual data report.

BCWA Macroinvertebrate and Habitat Sampling

See *BCWA ME04 Macroinvertebrate Field Sample Method* for field collection protocols. The reference sites in Table 12 sampled for macroinvertebrates, physical habitat (modified Rapid Bioassessment Protocol) and streambed characterization (modified Wolman Pebble Count). The WQCD's procedure on physical habitat is a visual assessment of the quality of the instream and riparian habitat that influences the structure and function of the aquatic community in a stream. Parameters are ranked as optimal, suboptimal, marginal, or poor based on a 4-point scale, with 4 being the best possible (optimal) conditions and one representing the worst (poor) conditions.

Macroinvertebrate samples have been historically collected at 7 CDOPW fish survey sites along Bear Creek: Morrison Park, Idledale, Lair o' the Bear Park, O' Fallon Park, Bear Creek Cabins, Main Street Evergreen (across from the Little Bear), above Evergreen Lake upstream of the USGS gaging station, Golden Willow Bridge site 2a and site 58. The WQCD previously assisted with data analyses and interpretation. The sampling, data analyses and interpretation is now an Association function. The macroinvertebrate sampling is done by the Association in August with analyze done by GEI. Sample collection done by the state timed-kick net methodology protocol (Benthic Macroinvertebrate Sampling Protocols, Water Quality Control Division, Standard Operation Procedure, WQCDSOP-001, May 2010).

Table 19 shows the Association sample locations for macroinvertebrates, physical habitat (modified Rapid Bioassessment Protocol) and streambed characterization (modified Wolman Pebble Count). Due to stream bed alterations from the September 2013 flooding event, the Association did new physical habitat and streambed characterization in September 2015; additional surveys completed in 2016-2021.

Table 19 BCWA Macroinvertebrate Stations

Primary Target Sites	Secondary Target Sites
Golden Willow Bridge site 2a	Idledale
Dedisse Park near Keys on the Green	Site 58
Little Bear in downtown Evergreen	O' Fallon Park
Bear Creek Cabins	Wadsworth
Lair o' the Bear Park	Site 45
Morrison (gage)	Site 90
BCLP	Turkey Creek

Appendix D

2024 Bear Creek Reservoir - United States Army Corps of Engineers Storage Data

Date	Elevation	Storage	Flow-In	Flow-Out	Flow-Evap
	(ft)	(ac-ft)	(cfs)	(cfs)	(cfs)
1/1/2024	5,558.08	1760	15	17	0.06
1/2/2024	5,558.01	1753	14	17	0.09
1/3/2024	5,558.02	1754	13	13	0.14
1/4/2024	5,558.18	1770	16	7	0.11
1/5/2024	5,558.31	1784	15	8	0.13
1/6/2024	5,558.41	1794	13	8	0.25
1/7/2024	5,558.48	1801	12	8	0.3
1/8/2024	5,558.59	1813	14	8	0.41
1/9/2024	5,558.67	1821	12	8	0.21
1/10/2024	5,558.80	1834	14	7	0.38
1/11/2024	5,558.92	1847	14	7	0.32
1/12/2024	5,558.94	1849	8	7	0.44
1/13/2024	5,558.94	1849	8	7	0.37
1/14/2024	5,558.97	1852	8	7	0.28
1/15/2024	5,559.03	1858	11	7	0.49
1/16/2024	5,559.11	1867	13	9	0.25
1/17/2024	5,559.14	1870	17	15	0.12
1/18/2024	5,559.08	1864	17	20	0.21
1/19/2024	5,559.00	1856	16	20	0.19
1/20/2024	5,558.93	1848	16	19	0.06
1/21/2024	5,558.86	1841	15	19	0.06
1/22/2024	5,558.81	1836	16	19	0.02
1/23/2024	5,558.76	1830	16	19	0.05
1/24/2024	5,558.71	1825	16	19	0.04
1/25/2024	5,558.65	1819	15	18	0.05
1/26/2024	5,558.58	1812	14	17	0.06
1/27/2024	5,558.49	1802	13	18	0.11
1/28/2024	5,558.42	1795	14	18	0.08
1/29/2024	5,558.37	1790	15	18	0.04
1/30/2024	5,558.34	1787	16	17	0.04
1/31/2024	5,558.30	1783	15	17	0.01
2/1/2024	5,558.25	1778	15	17	0.02
2/2/2024	5,558.23	1776	16	17	0.02
2/3/2024	5,558.45	1798	28	17	0.07
2/4/2024	5,558.51	1804	20	17	0.14
2/5/2024	5,558.56	1810	21	17	0.12
2/6/2024	5,558.63	1817	21	17	0.13
2/7/2024	5,558.72	1826	22	17	0.25
2/8/2024	5,558.76	1830	20	17	0.21
2/9/2024	5,558.75	1829	17	17	0.18
2/10/2024	5,558.83	1837	23	19	0.28
2/11/2024	5,558.80	1834	18	20	0.19
2/12/2024	5,558.79	1833	19	19	0.13
2/13/2024	5,558.81	1836	21	20	0.21
2/14/2024	5,558.78	1832	18	19	0.23

2/15/2024	5,558.75	1829	18	19	0.11
2/16/2024	5,558.76	1830	20	19	0.24
2/17/2024	5,558.73	1827	18	19	0.24
2/18/2024	5,558.70	1824	17	19	0.14
2/19/2024	5,558.69	1823	20	20	0.16
2/20/2024	5,558.70	1824	19	19	0.17
2/21/2024	5,558.80	1835	25	19	0.24
2/22/2024	5,558.88	1843	24	20	0.18
2/23/2024	5,558.88	1843	20	20	0.31
2/24/2024	5,558.88	1843	19	19	0.31
2/25/2024	5,558.96	1851	23	19	0.52
2/26/2024	5,559.02	1858	23	19	0.36
2/27/2024	5,559.11	1867	25	20	0.46
2/28/2024	5,559.05	1861	17	20	0.19
2/29/2024	5,559.08	1864	22	20	0.1
3/1/2024	5,559.12	1868	22	20	0.08
3/2/2024	5,559.18	1875	23	20	0.29
3/3/2024	5,559.24	1881	23	20	0.25
3/4/2024	5,559.22	1879	19	20	0.21
3/5/2024	5,559.18	1874	18	20	0.17
3/6/2024	5,559.12	1868	17	20	0.13
3/7/2024	5,559.19	1875	24	20	0.12
3/8/2024	5,559.19	1875	19	20	0.24
3/9/2024	5,559.10	1866	15	20	0.12
3/10/2024	5,559.06	1862	18	20	0.12
3/11/2024	5,559.06	1862	20	20	0.18
3/12/2024	5,559.06	1862	20	20	0.16
3/13/2024	5,559.17	1873	25	20	0.16
3/14/2024	5,559.51	1909	39	20	0.32
3/15/2024	5,559.60	1918	31	26	0.25
3/16/2024	5,559.61	1920	39	38	0.23
3/17/2024	5,559.69	1928	42	38	0.23
3/18/2024	5,559.75	1934	42	38	0.28
3/19/2024	5,559.87	1947	45	39	0.27
3/20/2024	5,560.04	1965	48	39	0.28
3/21/2024	5,560.26	1989	52	39	0.32
3/22/2024	5,559.37	1894	61	109	0.44
3/23/2024	5,558.82	1837	66	95	0.28
3/24/2024	5,558.84	1839	71	70	0.51
3/25/2024	5,558.79	1833	71	73	0.62
3/26/2024	5,558.71	1825	55	59	0.34
3/27/2024	5,558.69	1823	55	55	0.4
3/28/2024	5,558.60	1814	46	50	0.39
3/29/2024	5,558.59	1813	41	41	0.31
3/30/2024	5,558.61	1815	39	38	0.32
3/31/2024	5,558.73	1827	57	51	0.2
4/1/2024	5,558.83	1838	71	65	0.38

4/2/2024	5,558.76	1830	66	69	0.43
4/3/2024	5,558.77	1831	63	62	0.29
4/4/2024	5,558.80	1834	71	69	0.46
4/5/2024	5,558.88	1843	80	75	0.69
4/6/2024	5,558.91	1846	87	85	0.95
4/7/2024	5,558.78	1832	64	70	1.02
4/8/2024	5,558.74	1828	66	68	0.51
4/9/2024	5,558.74	1828	61	60	0.45
4/10/2024	5,558.77	1831	67	65	0.51
4/11/2024	5,558.77	1831	65	65	0.5
4/12/2024	5,558.82	1837	69	66	0.44
4/13/2024	5,558.90	1845	84	79	0.4
4/14/2024	5,558.98	1854	93	88	0.73
4/15/2024	5,559.04	1860	100	96	1.02
4/16/2024	5,559.00	1856	96	97	0.75
4/17/2024	5,558.99	1854	94	94	0.51
4/18/2024	5,559.00	1856	95	94	0.58
4/19/2024	5,558.90	1845	84	89	0.5
4/20/2024	5,558.86	1841	82	83	0.49
4/21/2024	5,558.84	1839	76	76	0.47
4/22/2024	5,558.87	1842	80	78	0.53
4/23/2024	5,558.88	1843	81	80	0.58
4/24/2024	5,558.92	1847	87	84	0.53
4/25/2024	5,559.00	1855	94	89	0.51
4/26/2024	5,559.06	1862	102	98	0.59
4/27/2024	5,559.67	1926	190	158	0.55
4/28/2024	5,559.47	1905	164	174	0.56
4/29/2024	5,559.44	1902	171	172	0.58
4/30/2024	5,559.39	1897	163	165	0.69
5/1/2024	5,559.42	1900	159	157	1.06
5/2/2024	5,559.39	1896	160	161	0.79
5/3/2024	5,559.32	1889	148	151	1.09
5/4/2024	5,559.29	1886	140	141	0.95
5/5/2024	5,559.27	1884	138	138	1.02
5/6/2024	5,559.21	1878	131	133	1.61
5/7/2024	5,559.15	1871	122	124	1.16
5/8/2024	5,559.06	1862	109	113	0.98
5/9/2024	5,559.03	1859	99	100	0.69
5/10/2024	5,559.08	1864	106	103	0.44
5/11/2024	5,559.03	1859	101	103	0.5
5/12/2024	5,560.03	1964	212	158	0.46
5/13/2024	5,559.64	1923	213	233	0.49
5/14/2024	5,559.60	1918	192	194	0.54
5/15/2024	5,559.59	1917	191	190	0.66
5/16/2024	5,559.65	1924	207	203	0.77
5/17/2024	5,559.54	1912	188	193	0.78
5/18/2024	5,559.49	1907	177	179	0.85

5/19/2024	5,559.43	1900	167	170	0.7
5/20/2024	5,559.42	1900	164	163	0.78
5/21/2024	5,559.43	1901	164	163	0.84
5/22/2024	5,559.30	1887	149	155	0.97
5/23/2024	5,559.23	1880	135	137	1.04
5/24/2024	5,559.20	1876	129	130	1.07
5/25/2024	5,559.16	1872	123	124	0.78
5/26/2024	5,559.10	1866	115	117	1.02
5/27/2024	5,559.06	1862	106	107	0.76
5/28/2024	5,559.03	1859	101	103	0.75
5/29/2024	5,559.00	1856	96	97	0.64
5/30/2024	5,558.98	1854	95	95	0.81
5/31/2024	5,559.00	1855	96	94	0.68
6/1/2024	5,558.98	1853	94	95	0.71
6/2/2024	5,558.95	1850	92	93	0.85
6/3/2024	5,558.90	1845	88	89	0.79
6/4/2024	5,558.89	1844	86	85	1.09
6/5/2024	5,558.84	1838	81	83	0.96
6/6/2024	5,558.84	1839	80	79	0.94
6/7/2024	5,558.86	1841	83	81	0.75
6/8/2024	5,558.95	1850	91	86	0.7
6/9/2024	5,558.89	1844	88	90	0.88
6/10/2024	5,558.97	1852	98	93	0.91
6/11/2024	5,558.91	1846	91	93	0.91
6/12/2024	5,558.81	1836	77	81	0.75
6/13/2024	5,558.76	1830	67	69	0.92
6/14/2024	5,558.72	1826	61	62	1.01
6/15/2024	5,558.74	1828	67	65	0.95
6/16/2024	5,558.72	1826	59	59	1.06
6/17/2024	5,558.71	1825	58	57	1.2
6/18/2024	5,558.65	1819	51	52	1.69
6/19/2024	5,558.65	1819	49	48	1.43
6/20/2024	5,558.61	1815	46	47	1.08
6/21/2024	5,558.62	1816	46	45	0.8
6/22/2024	5,558.59	1813	43	43	0.96
6/23/2024	5,558.56	1810	40	41	0.74
6/24/2024	5,558.54	1808	38	38	1.03
6/25/2024	5,558.49	1802	32	34	0.9
6/26/2024	5,558.49	1802	29	28	1.09
6/27/2024	5,558.49	1802	32	31	1.03
6/28/2024	5,558.47	1800	28	28	1.24
6/29/2024	5,558.44	1797	27	27	1.31
6/30/2024	5,558.46	1799	30	28	1.23
7/1/2024	5,558.50	1803	34	31	1.05
7/2/2024	5,558.44	1797	26	29	0.98
7/3/2024	5,558.40	1793	25	26	1.42
7/4/2024	5,558.36	1789	21	21	1.28

7/5/2024	5,558.36	1789	23	22	1.5
7/6/2024	5,558.33	1786	20	20	1.39
7/7/2024	5,558.31	1784	18	18	1.31
7/8/2024	5,558.35	1788	21	18	1.05
7/9/2024	5,558.31	1784	17	18	1.28
7/10/2024	5,558.28	1781	15	15	0.85
7/11/2024	5,558.26	1779	15	15	0.85
7/12/2024	5,558.21	1773	13	15	0.89
7/13/2024	5,558.13	1765	12	15	1.29
7/14/2024	5,558.06	1758	13	15	1.26
7/15/2024	5,558.00	1752	13	15	1.22
7/16/2024	5,557.96	1748	15	15	1.1
7/17/2024	5,557.94	1746	15	15	1.11
7/18/2024	5,558.03	1755	21	15	1.22
7/19/2024	5,558.01	1753	16	15	1.05
7/20/2024	5,558.03	1755	18	16	1.26
7/21/2024	5,558.14	1766	23	16	1.18
7/22/2024	5,558.38	1791	30	16	1.17
7/23/2024	5,558.45	1798	21	16	1.03
7/24/2024	5,558.38	1791	16	19	1.01
7/25/2024	5,558.16	1768	13	23	1.66
7/26/2024	5,558.04	1756	15	20	1.23
7/27/2024	5,558.12	1764	21	17	0.99
7/28/2024	5,558.12	1764	18	17	1.04
7/29/2024	5,558.03	1755	13	17	1.12
7/30/2024	5,557.89	1741	11	16	1.25
7/31/2024	5,557.75	1727	10	16	1.04
8/1/2024	5,557.57	1709	8	16	1.04
8/2/2024	5,557.45	1696	8	13	0.96
8/3/2024	5,557.38	1690	9	11	1.19
8/4/2024	5,557.33	1685	9	11	1
8/5/2024	5,557.30	1682	10	10	1.03
8/6/2024	5,557.38	1690	15	10	1.09
8/7/2024	5,557.44	1695	14	10	1.14
8/8/2024	5,557.54	1705	16	10	0.88
8/9/2024	5,557.96	1748	34	11	0.85
8/10/2024	5,558.20	1772	28	14	1.2
8/11/2024	5,558.32	1785	21	14	1.08
8/12/2024	5,558.32	1785	15	14	0.8
8/13/2024	5,558.32	1785	16	15	0.84
8/14/2024	5,558.53	1807	27	15	0.89
8/15/2024	5,558.45	1798	15	19	0.76
8/16/2024	5,558.19	1771	12	24	1.25
8/17/2024	5,557.91	1743	11	24	0.88
8/18/2024	5,557.64	1715	11	25	0.92
8/19/2024	5,557.48	1699	17	25	0.9
8/20/2024	5,557.36	1688	21	25	1.12

8/21/2024	5,557.14	1666	16	25	1.24
8/22/2024	5,557.05	1657	14	18	1.14
8/23/2024	5,557.10	1662	14	11	0.83
8/24/2024	5,557.16	1668	14	10	1.17
8/25/2024	5,557.19	1671	12	9	1.31
8/26/2024	5,557.29	1681	14	8	0.83
8/27/2024	5,557.37	1689	14	8	1.42
8/28/2024	5,557.31	1683	9	11	1.04
8/29/2024	5,557.15	1667	8	15	1.01
8/30/2024	5,557.03	1655	7	12	1.21
8/31/2024	5,557.03	1655	7	5	1.19
9/1/2024	5,557.03	1655	7	5	1.27
9/2/2024	5,557.03	1655	7	5	1.37
9/3/2024	5,557.03	1655	6	5	0.83
9/4/2024	5,557.08	1660	9	5	0.84
9/5/2024	5,557.78	1730	41	5	0.76
9/6/2024	5,557.96	1748	19	9	0.83
9/7/2024	5,557.86	1738	10	14	0.95
9/8/2024	5,557.73	1725	9	14	0.92
9/9/2024	5,557.60	1711	8	14	0.8
9/10/2024	5,557.45	1696	8	14	0.87
9/11/2024	5,557.28	1680	7	15	1.06
9/12/2024	5,557.08	1660	7	15	1.28
9/13/2024	5,556.97	1649	7	12	0.84
9/14/2024	5,556.97	1649	6	6	0.76
9/15/2024	5,556.97	1649	6	6	0.66
9/16/2024	5,556.97	1649	7	6	0.96
9/17/2024	5,556.96	1648	7	6	1.26
9/18/2024	5,556.95	1647	6	6	0.98
9/19/2024	5,556.94	1646	6	6	1.07
9/20/2024	5,556.92	1644	6	6	0.51
9/21/2024	5,556.91	1643	6	6	0.94
9/22/2024	5,557.23	1675	22	5	0.57
9/23/2024	5,557.35	1687	17	10	0.55
9/24/2024	5,557.16	1668	12	21	0.63
9/25/2024	5,556.91	1643	9	21	0.68
9/26/2024	5,556.62	1615	2	16	0.52
9/27/2024	5,556.56	1609	3	5	0.53
9/28/2024	5,556.50	1603	3	5	0.75
9/29/2024	5,556.45	1598	3	5	0.75
9/30/2024	5,556.37	1590	2	5	0.84
10/1/2024	5556.29	1582	2	5	0.69
10/2/2024	5556.26	1579	5	5	1
10/3/2024	5556.22	1576	4	5	1
10/4/2024	5556.20	1574	5	5	1
10/5/2024	5556.18	1572	5	5	1
10/6/2024	5556.16	1570	5	5	1

10/7/2024	5556.16	1570	6	6	1
10/8/2024	5556.12	1566	4	5	1
10/9/2024	5556.19	1573	9	5	0
10/10/2024	5556.38	1591	15	6	0
10/11/2024	5556.60	1613	17	6	1
10/12/2024	5556.71	1623	11	6	1
10/13/2024	5556.72	1624	7	6	1
10/14/2024	5556.74	1626	7	6	0
10/15/2024	5556.88	1640	13	5	1
10/16/2024	5557.09	1661	18	6	1
10/17/2024	5557.22	1674	15	7	1
10/18/2024	5557.11	1663	6	11	1
10/19/2024	5557.07	1659	9	11	0
10/20/2024	5557.03	1655	9	11	1
10/21/2024	5556.99	1651	9	11	1
10/22/2024	5556.91	1643	7	11	0
10/23/2024	5556.82	1634	7	11	0
10/24/2024	5556.72	1624	6	11	1
10/25/2024	5556.63	1615	7	11	1
10/26/2024	5556.55	1608	8	11	0
10/27/2024	5556.51	1604	10	11	0
10/28/2024	5556.41	1594	7	11	0
10/29/2024	5556.31	1584	6	11	1
10/30/2024	5556.23	1576	7	11	0
10/31/2024	5556.15	1569	8	11	1
11/1/2024	5556.07	1561	5	9	1
11/2/2024	5556.06	1560	5	5	0
11/3/2024	5556.06	1560	6	5	0
11/4/2024	5556.23	1576	14	5	1
11/5/2024	5556.34	1587	11	5	0
11/6/2024	5556.47	1600	12	5	1
11/7/2024	5556.51	1604	7	5	0
11/8/2024	5556.57	1610	10	7	0
11/9/2024	5556.64	1616	13	10	0
11/10/2024	5556.66	1618	11	10	0
11/11/2024	5556.65	1617	10	10	0
11/12/2024	5556.62	1614	9	10	0
11/13/2024	5556.59	1611	9	10	0
11/14/2024	5556.51	1604	7	10	0
11/15/2024	5556.41	1594	6	10	0
11/16/2024	5556.29	1582	4	10	0
11/17/2024	5556.21	1575	6	10	0
11/18/2024	5556.15	1569	7	10	0
11/19/2024	5556.02	1556	4	10	1
11/20/2024	5555.88	1542	3	10	0
11/21/2024	5555.77	1532	5	10	0
11/22/2024	5555.75	1530	7	8	0

11/23/2024	5555.85	1539	10	5	0
11/24/2024	5555.94	1548	10	5	0
11/25/2024	5556.00	1554	8	5	0
11/26/2024	5556.07	1561	9	5	0
11/27/2024	5556.13	1567	11	8	0
11/28/2024	5556.06	1560	8	11	0
11/29/2024	5555.93	1547	4	11	0
11/30/2024	5555.79	1534	4	11	0
12/1/2024	5555.68	1523	5	11	0
12/2/2024	5555.65	1520	6	8	0
12/3/2024	5555.7	1520	4.00	4.00	0.070
12/4/2024	5555.71	1526	7	4	0.08
12/5/2024	5555.77	1532	7	4	0.08
12/6/2024	5555.81	1535	5	4	0.06
12/7/2024	5555.81	1535	4	4	0.08
12/8/2024	5555.81	1535	4	4	0.08
12/9/2024	5555.84	1539	5	4	0.18
12/10/2024	5555.9	1544	7	4	0.35
12/11/2024	5555.95	1549	6	4	0.18
12/12/2024	5555.99	1553	6	4	0.14
12/13/2024	5556.04	1558	6	4	0.28
12/14/2024	5556.11	1565	8	4	0.15
12/15/2024	5556.18	1571	8	4	0.15
12/16/2024	5556.25	1578	8	4	0.13
12/17/2024	5556.37	1590	10	4	0.14
12/18/2024	5556.36	1589	9	10	0.11
12/19/2024	5556.3	1583	13	16	0.18
12/20/2024	5556.28	1581	16	16	0.09
12/21/2024	5556.28	1581	16	16	0.07
12/22/2024	5556.28	1581	16	16	0.07
12/23/2024	5556.28	1581	16	16	0.03
12/24/2024	5556.29	1582	17	16	0.08
12/25/2024	5556.37	1590	21	16	0.05
12/26/2024	5556.44	1597	22	19	0.08
12/27/2024	5556.31	1584	16	22	0.13
12/28/2024	5556.17	1571	15	21	0.11
12/29/2024	5556.04	1558	15	21	0.1
12/30/2024	5555.88	1542	13	21	0.45
12/31/2024	5555.63	1518	9	21	0.19