

Upper Yampa River (Bear River Sub-Basin) Watershed and Stagecoach Reservoir 2025 Water Quality Monitoring Report



Prepared for

Upper Yampa Water Conservancy District
Steamboat Springs, CO

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2025 Water Quality Monitoring Report

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Introduction

The Upper Yampa Water Conservancy District and its stakeholders are committed to understanding nutrient sources in the Bear River sub-basin of the Upper Yampa watershed and the conditions contributing to potentially harmful cyanobacteria blooms (HCBs) in Stagecoach Reservoir. The monitoring program in the Upper Yampa River (Bear River sub-basin) and Stagecoach Reservoir was developed to build on the historical data set to provide a deeper understanding of the complex interactions of human and environmental factors potentially driving these blooms.

I. Monitoring Program

Historically monitoring in the Bear River sub basin of the Upper Yampa River and Stagecoach Reservoir has taken place at various frequencies and key locations. Recently, additional concerns over the potential factors and conditions contributing to the HCBs in Stagecoach Reservoir has highlighted the need for a comprehensive monitoring program. In order to maintain consistency and reliability the Upper Yampa Water Conservancy District developed the UPPER YAMPA WATERSHED - BEAR RIVER SUB BASIN AND STAGECOACH RESERVOIR - SAMPLING AND ANALYSIS PLAN (SAP). The current sampling procedures began in spring 2024 and have continued on an annual basis through 2025.

ACZ Laboratory was used to analyze concentrations of nutrients, general chemistry and biological oxygen demand (BOD). See details in SAP. Values are reported that are flagged by the lab as between the minimum detection limit (MDL) and the practical quantitation limit (PQL). Values below the MDL are reported as $\frac{1}{2}$ MDL since zero values would skew the analysis.

A. Monitoring Locations

The monitoring locations are provided in **Figure 1** and represent various sites upstream and downstream of potential nutrient sources on the Yampa River as well as multiple tributaries in the watershed that feed directly into Stagecoach Reservoir. The locations were chosen at or near current or historical monitoring for consistency and potential comparison with other water quality data that has been collected in the past or is included in the current monitoring program.

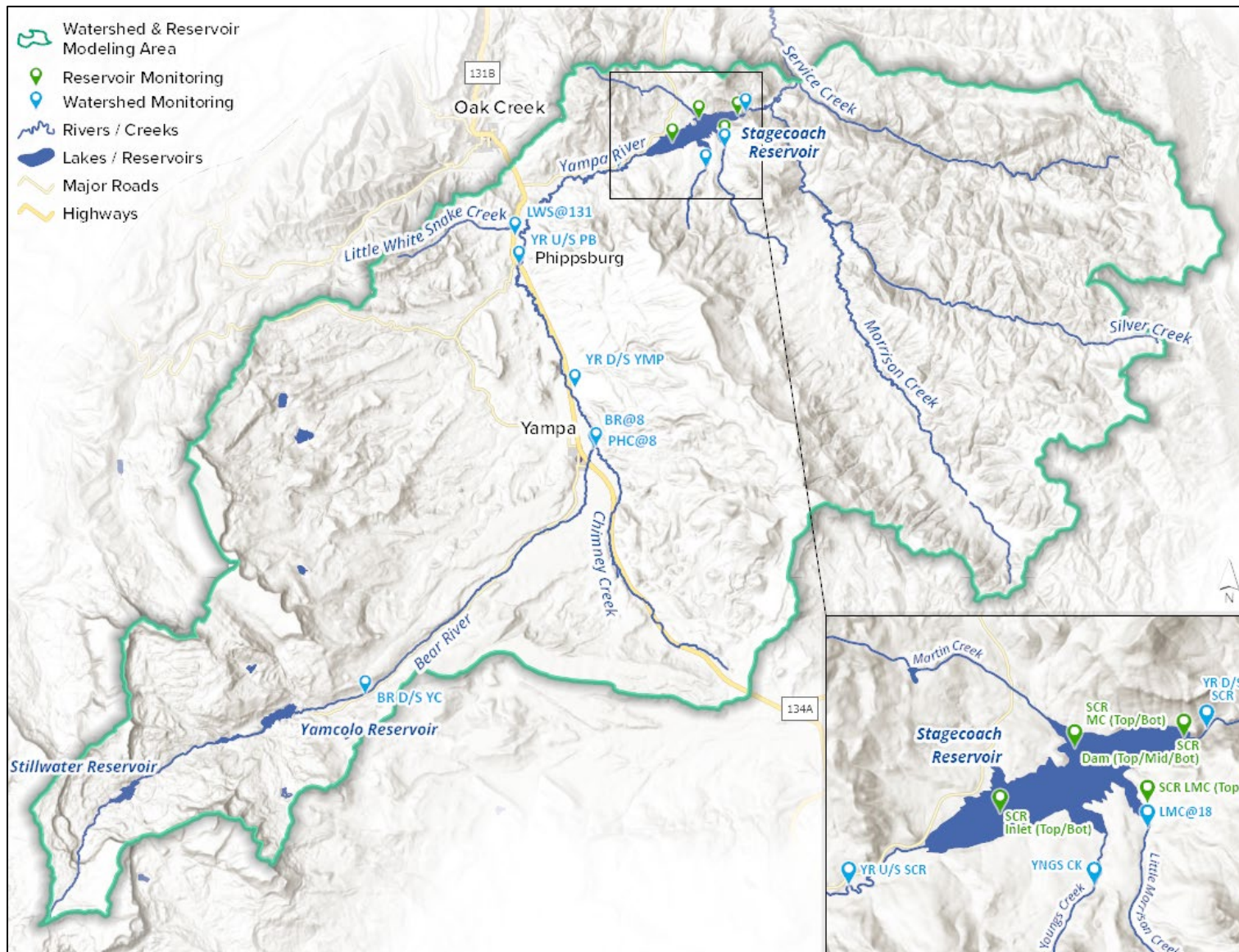


Figure 1. Overview map of the monitoring locations for the Bear River Watershed and Stagecoach Reservoir.

Table 1. Bear River Watershed Monitoring Locations and Historical Monitoring Location Equivalent

#	Represents	Abbreviation	Lat	Long	Historical Monitoring Location Equivalent
1	Bear River baseline	BR D/S YCR	40° 03'41.35"N	107°00'43.32"W	BEAR RIVER D/S YAMCOLO RESERVOIR [12817]
2	Bear River near confluence w/ Yampa	BR@8	40° 9'25.60"N	106°54'3.50"W	BEAR R. @ RD. 8 [21COL001-12898]
3	Phillips Creek baseline	PHC@8	40° 9'28.80"N	106°54'0.00"W	CHIMNEY CK @ RD. 8 [21COL001-12899]
4	Yampa River below Yampa	YR D/S YMP	40°10'47.91"N	106°54'50.17"W	YAMPA R. BLW YAMPA @ CR21 [12815]
5	Yampa above Phippsburg	YR U/S PB	40°13'35.37"N	106°56'25.26"W	YAMPA R. ABV. PHIPPSBURG [21COL001_WQX-12814]
6	Little White Snake	LWS@131	40°14'27.29"N	106°56'33.39"W	LITTLE WHITE SNAKE @ HWY 131
7	Little Morrison Creek	LMC @SCR	40°16'22.37"N	106°50'20.69"W	LITTLE MORRISON CREEK NEAR STAGECOACH, CO. [401634106502200]
8	Youngs Creek	YNGS CK	40°15'53.8"N	106°50'54.1"W	YOUNGS CREEK [1006}
9	All tributaries and mainstem above Stagecoach Reservoir (SCR)	YR U/S SCR	40°15'51.34"N	106°53'30.39"W	YAMPA RIVER ABOVE STAGECOACH RESERVOIR, CO [09237450]
10	Stagecoach Reservoir outlet	YR D/S SCR	40°17'11.56"N	106°49'44.60"W	YAMPA RIVER BELOW STAGECOACH RESERVOIR, CO
11	Stagecoach Reservoir Inlet	SCR Inlet	40°16'28.07"N	106°51'55.00"W	STAGECOACH RESERVOIR NR INLET, NR OAK CREEK, CO.
12	Martin Creek Cove of SCR	SCR MC	40° 17'00.69"N	106°51'08.32"W	STAGECOACH RESERVOIR NR MARTIN CR NR OAK CREEK, CO
13	Little Morrison Creek Cove of SCR	SCR LMC	40° 16'34.36"N	106°50'21.94"W	
14	SCR Dam/Deepest Portion of SCR	SCR Dam	40° 17'06.96"N	106°49'57.93"W	STAGECOACH RESERVOIR AT DAM, COLORADO

II. Water Quality Standards

Incorporating the reference to relevant water quality standards is integral to an effective monitoring program. The 5ug/L chlorophyll- α standard was implemented in April 2023 for all direct-use water supply lakes and the upcoming nitrogen and phosphorus lake standards are set to be implemented in the next 5 years for all Class 1/2 Cold Water Biota and those classified for recreational use as in Stagecoach Reservoir.

The EPA's 303(d) list is a compilation of impaired water bodies in the United States. These are waters that don't meet water quality standards set by the Clean Water Act and require the development of Total Maximum Daily Loads (TMDLs) to control pollution and restore water quality. Table 1. Listed the stream segments in the Bear River Sub Basin of the Upper Yampa Watershed that are listed as impaired for parameters included in the current monitoring program.

Table 2. Impaired waters in Bear River sub-basin of the Upper Yampa Watershed for parameters included in the current monitoring program.

Segment	Segment Portion	Description	Affected Use	Analyte	EPA Category	Cycle First Listed
COUCYA02	2a-A	Mainstem of the Yampa River from the confluence of the Bear River and Phillips Creek to Stagecoach Reservoir.	Aquatic Life Use	Temperature	303d List	2016
COUCYA02	02a-B	Mainstem of the Yampa River from Stagecoach Reservoir to above confluence with Oak Creek.	Aquatic Life Use	Temperature	303d List	Aquatic Life Use
COUCYA04	04-A	Mainstem of Little White Snake Creek from the source to the confluence with the Yampa River.	Aquatic Life Use	Dissolved Oxygen	M&E List	null
COUCYA04	04-A	Mainstem of Little White Snake Creek from the source to the confluence with the Yampa River.	Aquatic Life Use	Macroinvertebrates	303d List	2024
COUCYA02	02a-B	Mainstem of the Yampa River from Stagecoach Reservoir to above confluence with Oak Creek.	Aquatic Life Use	Macroinvertebrates	303d List	2024
COUCYA02	2a-A	Mainstem of the Yampa River from the confluence of the Bear River and Phillips Creek to Stagecoach Reservoir.	Aquatic Life Use	Temperature	303d List	2022
COUCYA02	02a-B	Mainstem of the Yampa River from Stagecoach Reservoir to above confluence with Oak Creek.	Water Supply Use	Arsenic, Total	303d List	2020

III. Monitoring Analyte Descriptions

The monitoring program evaluates several water quality parameters to help determine if the Reservoir meets standards designed to protect aquatic life and recreation. The parameters also play a critical role in defining the Reservoir's trophic state - a measure of its overall health that reflects interactions between chemical and biological components within the aquatic ecosystem. While additional water quality standards exist for parameters like metals and fecal indicator bacteria, these are not included in the scope of the annual monitoring program.

All analyses performed adhere to approved methods outlined by the U.S. Environmental Protection Agency (EPA) or Standard Methods for the Examination of Water and Wastewater, as detailed in the project's Sampling and Analysis Plan/Quality Assurance Project Plan (SAP/QAPP). Colorado Code of Regulations (CCR), Water Quality Control Commission's (WQCC) Regulation # 33 (Reg 33) outlines the stream classifications and water quality standards for the Yampa River Basin for cold water aquatic life and recreational use. Stagecoach Reservoir is also classified as a direct use water supply (DUWS) under WQCC Regulation # 31 which details the basic standards and methodologies for surface water.

A summary of the key parameters and metrics analyzed in this report, as well as applicable water quality standards, are provided below.

pH

pH is a measure of how acidic or basic water is, expressed on a scale from 0 to 14. On this scale, a pH of 7 is neutral, values below 7 are acidic, and values above 7 are basic (or alkaline). Reg 33 specifies that the acceptable pH range for the reservoir is 6.5 to 9.0 to ensure the protection of aquatic life.

pH is measured on a logarithmic scale, meaning each 1-unit change corresponds to a tenfold difference in hydrogen ion concentration. For example, water with a pH of 6 is 10 times more acidic than water with a pH of 7 and 100 times more acidic than water with a pH of 8. For context, the pH of normal rainwater, unaffected by pollutants, is approximately 5.6 due to the natural presence of carbon dioxide, which forms carbonic acid when dissolved in water.

Oxidation Reduction Potential

Oxidation-reduction potential (ORP) measures a water body's capacity for redox reactions, which influence contaminant degradation and nutrient cycling. It quantifies electron exchange during oxidation-reduction reactions and is reported in millivolts (mV). ORP is measured alongside dissolved oxygen to provide additional water quality insights. High ORP values indicate an oxidizing environment, often linked to higher dissolved oxygen and organic matter breakdown. Low or negative ORP values signal a reducing environment, typically found in oxygen-depleted waters and sediments, where microbial decomposition dominates.

Conductivity

Conductivity (specific conductance) is the ability of water to conduct an electrical current and is based on the dissolved inorganic solids (positive and negative ions) present. Conductivity is a useful general measure of water quality since values increase with salinity and can be an indicator of dissolved solids that can be considered "pollutants" in the water. The geology of the area, water source, and watershed affect conductivity. Conductivity values of 50-1500 $\mu\text{S}/\text{cm}$ are typical for surface water. Conductivity also varies in direct proportion with temperature with higher temperature increasing the conductivity. Thus, to allow direct comparison of samples collected at different temperatures, conductivity is typically corrected to 25 $^{\circ}\text{C}$ and reported as specific conductance ($\mu\text{mhos}/\text{cm}$ @ 25 $^{\circ}\text{C}$). For the sake of simplicity, specific conductance is referred to as "conductivity" in this report.

Dissolved Oxygen

Dissolved oxygen (DO) is the oxygen available to aquatic organisms, entering water through diffusion and photosynthesis. Turbulent waters, like rivers, typically have higher DO due to aeration, while stagnant waters, such as lakes, have lower levels. DO saturation decreases as temperature rises, influencing mixing

patterns and aquatic life. High sediment loads can reduce DO by increasing turbidity, limiting photosynthesis, and accelerating oxygen-consuming decomposition.

Reg 33 specifies a minimum DO standard of 6.0 mg/L to protect cold-water fish species and a 7.0 mg/L minimum during spawning (February – March). If DO concentrations fall below this level in one area or depth of the reservoir, adequate refuges must exist at other depths or locations where DO concentrations are above 5.0 mg/L to ensure the survival of aquatic life.

Temperature

Water temperature affects the DO concentration of the water, the rate of photosynthesis, rates of chemical reactions, metabolic rates of aquatic organisms, and the sensitivity of organisms to toxins, parasites, and disease. All aquatic organisms are dependent on certain temperature ranges for optimal health. If temperatures are outside of this optimal range for a prolonged period, the organisms become stressed and can die. Water temperature generally increases with turbidity; as the particles absorb heat, the DO levels are reduced. Temperature is primarily controlled by climatic conditions but can also be impacted by human activities.

Secchi Depth

The Secchi depth of a waterbody is a way to quantify turbidity or water clarity. It is measured with an 8" black and white disk which is slowly lowered into the water column and the depth at which it is no longer visible becomes the Secchi depth. The measurement is based on both light absorption and the amount of light scattered by particles in the water column. The Secchi depth is higher when there is greater clarity or fewer particles in the water and is usually a representation of productivity of the water. Secchi depths of less than 6.6 feet (2.0 meters) have traditionally been considered undesirable for recreational uses in natural lakes; however, lower clarity is usually tolerated in reservoirs.

Photic Zone

The Photic Zone of an aquatic resource is calculated as the depth at which light can penetrate or the depth of the water column where phytoplankton could complete photosynthesis based on light availability. Samples in Stagecoach Reservoir are collected as a composite from what represents the common photic zone based on conditions, typically from 0-3 m. See Secchi Depth above.

Chlorophyll α

Chlorophyll is the pigment found in plants that provides a green color and helps absorb energy during photosynthesis. Chlorophyll α is the primary form found in algae and concentrations are an excellent indicator of water quality based on the presence and density of photosynthesizing phytoplankton responsible for algal blooms in a water body.

Cyanobacteria, commonly called blue-green algae, produce chlorophyll α (chl α), but can also produce toxins that are dangerous to other animals, including humans. Excess algae and cyanobacteria result in elevated chlorophyll α production and can result in undesirable conditions such as green water, floating mats, and even scums. When these blooms die and start to decay, they can produce bad odors and can reduce dissolved oxygen concentrations which can stress fish and lead to nutrient cycling from the reservoir sediments.

In surface water, lower chl α concentrations often (0-6 $\mu\text{g/L}$) correspond to oligotrophic or mesotrophic (low to medium nutrient concentrations) conditions, where higher concentrations indicate nutrient rich, or

eutrophic (6-40 µg/L) conditions, or a hypereutrophic state with very nutrient enriched conditions (>40 µg/L).

Stagecoach Reservoir's chlorophyll α levels are established by Regulation 31 which sets the seasonal (March -November) standard of 5 µg/L. Maintaining chlorophyll α levels around or below this threshold is important to the overall health of Stagecoach Reservoir and helps to maintain its beneficial uses.

Phosphorus

Phosphorus exists in several forms in freshwater systems, but the biologically available form that contributes to nuisance plant and algal growth is soluble inorganic orthophosphate, also known as soluble reactive phosphorus (SRP). Inorganic phosphates readily bind to soil particles and plant roots, so much of the phosphorus in aquatic systems is bound and transported as sediment. Organic phosphates, found in plant and organism cells, are not biologically available unless converted into inorganic forms.

Under anoxic (low oxygen) conditions, phosphorus bound to bottom sediments can be released, significantly increasing the concentration of biologically available orthophosphate in the water column. Sources of phosphorus in aquatic systems include soil erosion from steep slopes, disturbed ground, and stream channels, as well as surface runoff containing phosphorus from fertilizers, wastewater effluent, and decaying organic matter.

Total Phosphorus (TP) measures all forms of phosphorus in a sample, including inorganic, oxidizable organic, and polyphosphates. It accounts for phosphorus that is readily available, has the potential to become available, and stable forms. In lakes and reservoirs:

TP concentrations <12 µg/L indicate oligotrophic conditions (low productivity).

TP concentrations of 12–24 µg/L indicate mesotrophic conditions (moderate productivity).

TP concentrations of 25–96 µg/L indicate eutrophic conditions (high productivity).

TP concentrations >96 µg/L indicate hypereutrophic conditions (excessive productivity).

Soluble Reactive Phosphorus (SRP) is the measure of dissolved inorganic phosphorus (PO_4^{3-} , HPO_4^{2-} , H_2PO_4^- , and H_3PO_4). This form is readily available in the water column for phytoplankton growth in the water column.

Nitrogen

Nitrogen exists in a variety of forms within aquatic systems, including organic, inorganic, particulate, gaseous, and soluble states. The soluble, inorganic oxidized forms of nitrogen are nitrate (NO_3^-) and nitrite (NO_2^-), which are typically found in surface water. The reduced inorganic form, ammonia (NH_3), is more common in low-oxygen environments. Among these, the inorganic forms— NO_3^- , NO_2^- , and NH_3 —are the most readily available for primary productivity, such as algal growth.

Certain algae and cyanobacteria can also utilize atmospheric nitrogen (N_2) as a nutrient source through nitrogen fixation. Additionally, decomposition processes can produce various reduced forms of nitrogen. While particulate and dissolved organic nitrogen are not immediately available for algal uptake, they can be converted to ammonia by bacteria and fungi. This ammonia can then be oxidized to form nitrites and nitrates, completing part of the nitrogen cycle.

Surface runoff often contributes inorganic nitrogen from fertilizers and organic nitrogen from sources such as animal waste and wastewater, increasing nutrient loads in aquatic systems.

Total Nitrogen (TN) represents the total quantity of all nitrogen in the water, calculated by adding the measured forms of organic nitrogen, nitrate, nitrite, and ammonia.

Nitrates and Nitrites ($\text{NO}_3^- + \text{NO}_2^-$) are collectively referred to as total oxidized nitrogen and are readily available for algal uptake.

Ammonia ($\text{NH}_3\text{-N}$) is a reduced form of dissolved nitrogen that is readily available for phytoplankton uptake. Ammonia is prevalent in low oxygen environments, such as the hypolimnion of a eutrophic lake, and is produced by bacteria as a byproduct of decomposition.

Nitrogen/Phosphorus Levels and Ratios

Phytoplankton growth depends on macronutrients such as phosphorus, nitrogen, and carbon, as well as trace nutrients like iron, manganese, and other essential minerals. Growth is limited by the nutrient present in the smallest quantity relative to the organism's needs, a principle known as Liebig's Law of the Minimum (Liebig, J von, 1840).

The ratio of total nitrogen (TN) to total phosphorus (TP) in a water body is a useful indicator of nutrient limitation. When nitrogen is limited, many harmful cyanobacteria (blue-green algae) gain a competitive advantage over beneficial green algae because they can fix atmospheric nitrogen. In phosphorus-rich, nitrogen-limited environments, this ability allows cyanobacteria to dominate, increasing the risk of harmful algal blooms.

Maintaining a molar TN:TP ratio greater than 16:1 (or approximately 7:1 by weight) promotes balanced phytoplankton diversity and reduces the likelihood of cyanobacteria dominance. In some cases, the ratio of total inorganic nitrogen (TIN)—which includes nitrate, nitrite, and ammonia—to soluble reactive phosphorus (SRP) provides a more direct measure of phytoplankton growth potential, as these forms are the most readily available in the water column.

Trophic State

The Trophic state as described by Vollenweider (1970) is used as a guideline for describing water quality as it relates to the trophic state or biological productivity potential. Many indices assign numerical values to trophic state based on multiple water quality parameters. The following are typical characteristics of various trophic states:

Oligotrophic - lack of plant nutrients, low productivity, sufficient oxygen at all depths, clear water, often deeper lakes and can support trout.

Mesotrophic - moderate nutrient concentrations and plant productivity, hypolimnion may lack oxygen in summer, moderately clear water, mostly mixed or warm water fisheries.

Eutrophic - nutrient rich, blue-green algae dominate during summer, notable productivity, algae scums are probable at times, hypolimnion lacks oxygen in summer, poor transparency, rooted macrophyte problems may be evident.

Hypereutrophic – excessive nutrient enrichment and likely imbalance, very high productivity, algal scums dominate in summer, few macrophytes, no oxygen in hypolimnion, fish kills possible in summer and under winter ice.

Hardness

Hardness is a key water quality parameter that reflects the concentration of dissolved minerals, primarily calcium and magnesium which are influenced by geological characteristics of the watershed, land use activities, and hydrologic conditions. Hardness is an important factor in watershed monitoring because it affects aquatic life, drinking water quality, and the bioavailability and toxicity of certain pollutants, such as metals. In natural systems, hardness can help mitigate the effects of acidic inputs by providing buffering capacity, while excessive hardness may contribute to scaling in infrastructure.

Anions: Chloride and Sulfate

Anions, or negatively charged ions, such as chloride and sulfate, play a critical role in influencing water conductivity. These ions are typically derived from external sources, including human activities like deicing roads, treated wastewater discharge, and stormwater runoff, as well as natural processes such as mineral dissolution in groundwater. Elevated levels of chloride and sulfate can signal potential pollution in the watershed but may also originate from groundwater in contact with certain geologic formations. Since these anions are highly soluble, their presence increases the total concentration of dissolved ions in the water, directly raising conductivity. Monitoring these parameters helps track changes in water quality and identify pollutant sources.

Cations: Calcium, Magnesium, Sodium, and Potassium

Cations, or positively charged ions, such as calcium, magnesium, sodium, and potassium, are key contributors to dissolved solids concentrations in water. In natural landscapes, these cations primarily originate from sources like weathering of rocks and minerals, but they can also indicate human-related pollution, including de-icing agents, treated wastewater discharges and stormwater runoff which helps identify the major contributors to conductivity and assess the relative influence of natural versus human-induced sources the watershed.

Suspended Solids

Total Suspended Solids (TSS) include suspended sediments and other particulates in water. In lakes and reservoirs, TSS typically includes organic material such as algal cells and microorganisms, as well as inorganic particles like silt and clay. Suspended solids in streams include larger inorganic particles such as coarser silt and sand. Suspended solids can indirectly impact chl α concentrations by reducing light penetration, which limits photosynthesis by algae and other primary producers.

Water Quality Data

I. Historic Water Quality Data

The locations included in the current sampling and analysis plan have been monitored for various parameters and periods of time which are summarized in Table 2 and Table 3 below. This historical data has been included in the analysis in this report for a baseline reference for comparison with the current water quality data. The median concentrations and range between the 25th and 75th percentiles over the period of record (POR) for each site are displayed in the graphs in the report along with the median concentration or value from 2025.

Any data not detailed in this report are available per request and will be available via the Yampa River Dashboard (youryampariver.org) by the end of 2026.

Table 3. Stagecoach Reservoir Monitoring Locations, Parameters, Data Range, and Years Monitored.

























































Reservoir Location Name	Site Abv	Parameters	Data Range	Years
STAGECOACH RES NR INLET	SCR - Inlet TOP	   	2022-2025	4
STAGECOACH RES NR MARTIN CR	SCR - MC TOP	   	2022-2025	4
STAGECOACH RES NR LITTLE MORRISON CREEK	SCR - LMC TOP	  	2024-2025	2
STAGECOACH RESERVOIR AT DAM	SCR - DAM TOP	   	2012-2025	13

Table 4. Bear River Watershed Monitoring Locations, Parameters, Data Range, and Years Monitored.


Watershed Location Name	Site Abv	Parameters	Flow	Data Range	Years
BEAR RIVER D/S YAMCOLO RESERVOIR	BR D/S YCR	   		2013-2025	12
BEAR RIVER AT RD. 8	BR @ 8	   		2000-2025	25
PHILLIPS CREEK AT RD. 8	PHC @ 8	   		2001-2025	24
YAMPA R. BLW YAMPA @ CR21	YR D/S YMP	   		2000-2025	25
YAMPA R. ABV. PHIPPSBURG	YR U/S PB	   		2000-2025	25
LITTLE WHITE SNAKE CK @ HWY 131	LWS @ 131	   		2001-2025	24
YAMPA RIVER ABOVE STAGECOACH RES	YR U/S SCR	   		2000-2025	25
YOUNGS CREEK	YNGS Ck	  		2015-2025	10
LITTLE MORRISON CK @ RD 18A	LMC @ SCR	   		2001-2025	24
YAMPA RIVER BELOW STAGECOACH RES	YR D/S SCR	   		2000-2025	26

Parameter Legend for Table 3 & 4

Discharge - USGS  , Manual Discharge 

 Physical Parameters (Temp, pH, DO, Conductivity, etc.)

 Nutrients

 Dissolved Solids (ions, salts, minerals, etc)

 Metals

II. 2025 Water Quality Data

A. Bear River Watershed

The evaluation of conditions in the watershed has been refined to support water quality modeling efforts. Nutrients, particularly nitrogen and phosphorus, play a critical role in aquatic ecosystem health, influencing primary productivity, algal growth, and dissolved oxygen dynamics. This section presents an analysis of physical conditions, nutrient concentrations, and an analysis of other key factors to further characterize spatial and temporal variability.

Physical Parameters

The physical parameters measured in the watershed include temperature, pH, dissolved oxygen, specific conductivity, and oxidation reduction potential (ORP). **Figure 2** through **Figure 6** depict the values for each of these parameters at each of the watershed sites during the 4 monitoring events in 2025.

Figure 2 shows the stream temperatures measured during the 2025 sampling periods and the water quality standards (WQS). The instream water temperatures of most watershed sites were highest during the August monitoring event with the exception of the Little Morrison Creek and Youngs Creek. Both stream temperatures were notably higher in June 2025. In October, the Yampa River downstream of Stagecoach Reservoir was considerably higher than any of the other sites. The main section of the Yampa River downstream of Stagecoach Reservoir, COUCYA01a_B is currently impaired for temperature on the 303d list.

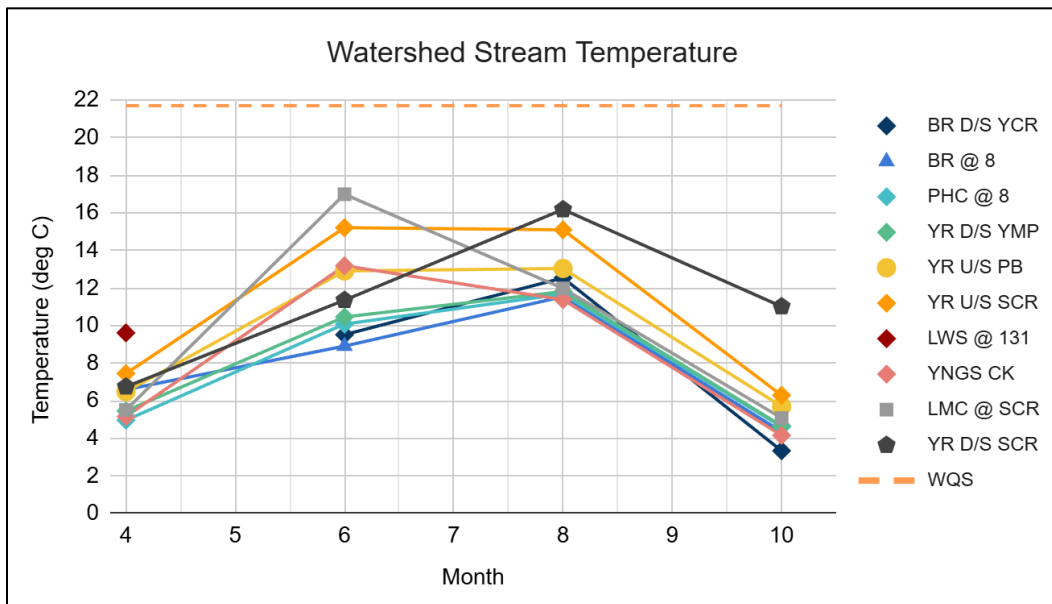


Figure 2. Bear River Watershed stream temperatures, 2025.

In 2025, watershed pH measurements were within the EPA’s Regulation 33 numeric water quality standard range of 6.5 to 9.0 for cold water aquatic life (Figure 3). The pH values were relatively consistent among watershed sites except for Little White Snake River which is consistent with what was observed in 2024.

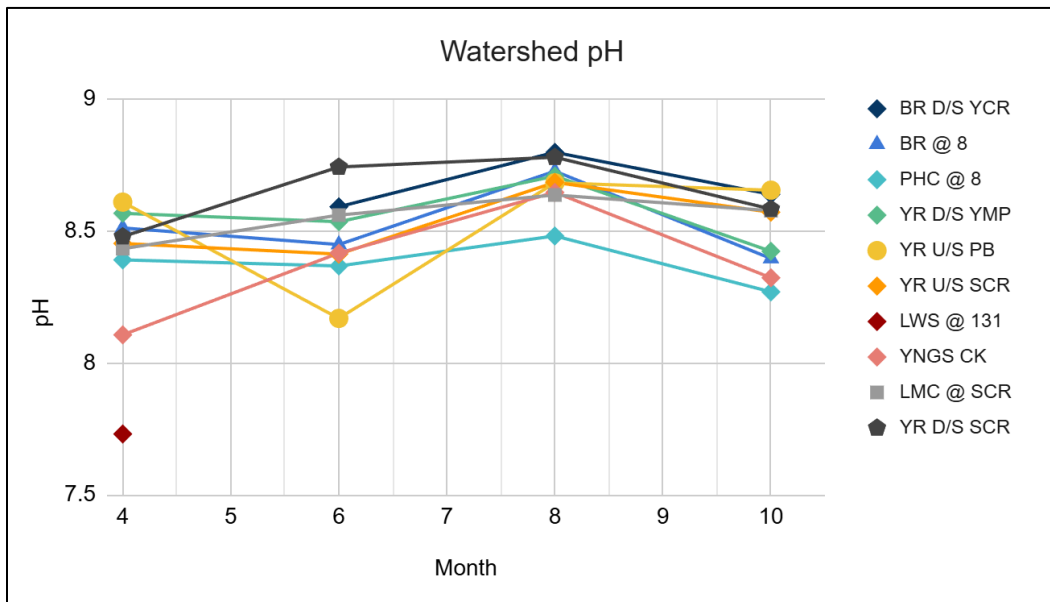


Figure 3. Bear River watershed stream pH field measurements, 2025.

The cold-water aquatic life standard for dissolved oxygen is a minimum concentration of 6.0 mg/L and 7.0 mg/L during spawning (February – March). All watershed sites monitored in 2025 had dissolved oxygen levels above these limits during monitoring events with the exception of the Little White Snake River (LWS @ 131) (Figure 4) which has consistently exhibited unusual water quality conditions. In general, dissolved oxygen levels for all the sites were lowest in August and highest during the fall and spring.

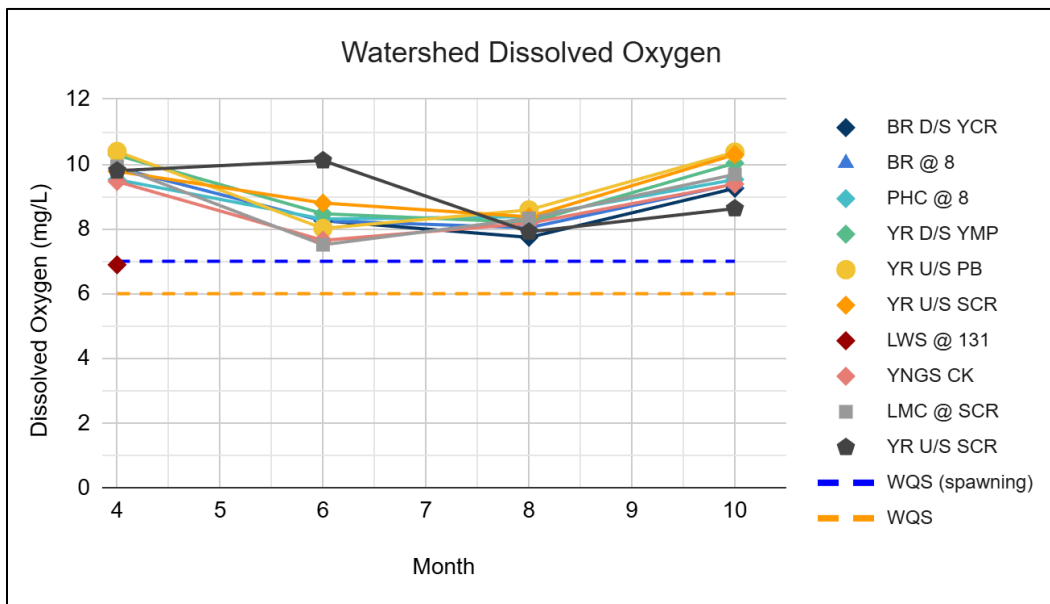


Figure 4. Bear River Watershed stream dissolved oxygen concentrations, 2025.

Although Colorado does not have a standard established for stream conductivity, the Environmental Protection Agency recommends that drinking water have a conductivity of less than 1000 $\mu\text{S}/\text{cm}$ and considers values higher than 1,500 $\mu\text{S}/\text{cm}$ above average. Measurements collected in 2025 within the Bear River sub-basin of the Upper Yampa Watershed had specific conductivity values well below the recommended drinking water standard, except for Little White Snake which was reported around 1,200 $\mu\text{S}/\text{cm}$ on the one date in April when it has sufficient water to sample (Figure 5).

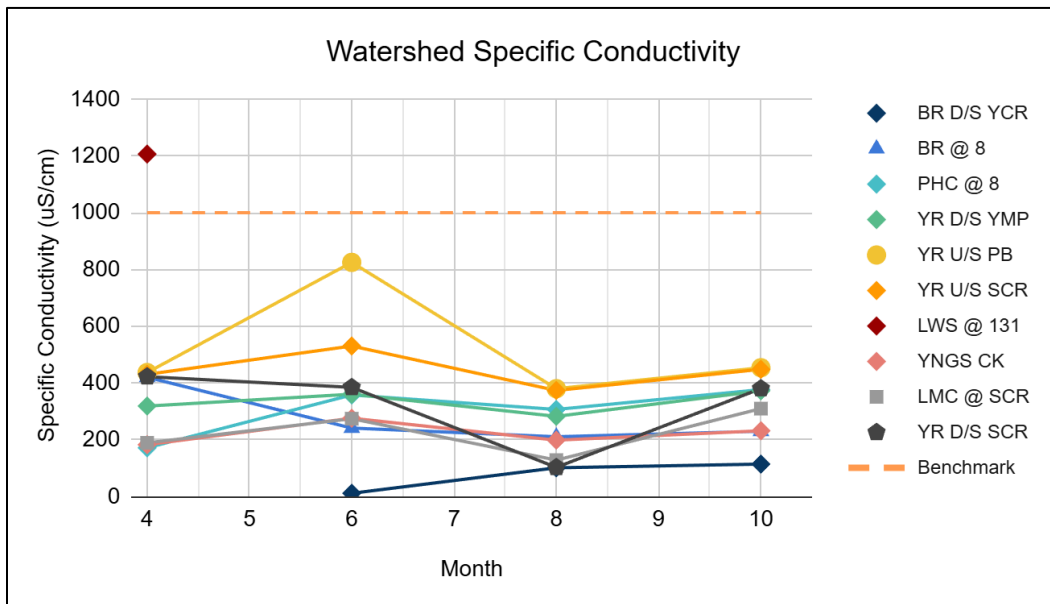


Figure 5. Bear River Watershed specific conductivity field measurements, 2025.

Overall, 2025 measurements for oxidation reduction potential (ORP) were lowest in June and increased in the fall and spring with the exception of the Bear River downstream of Yamcolo Reservoir (BR D/S YCR) which was lowest in August (Figure 6). This generally correlates with the seasonal trends observed for dissolved oxygen concentrations (Figure 4).

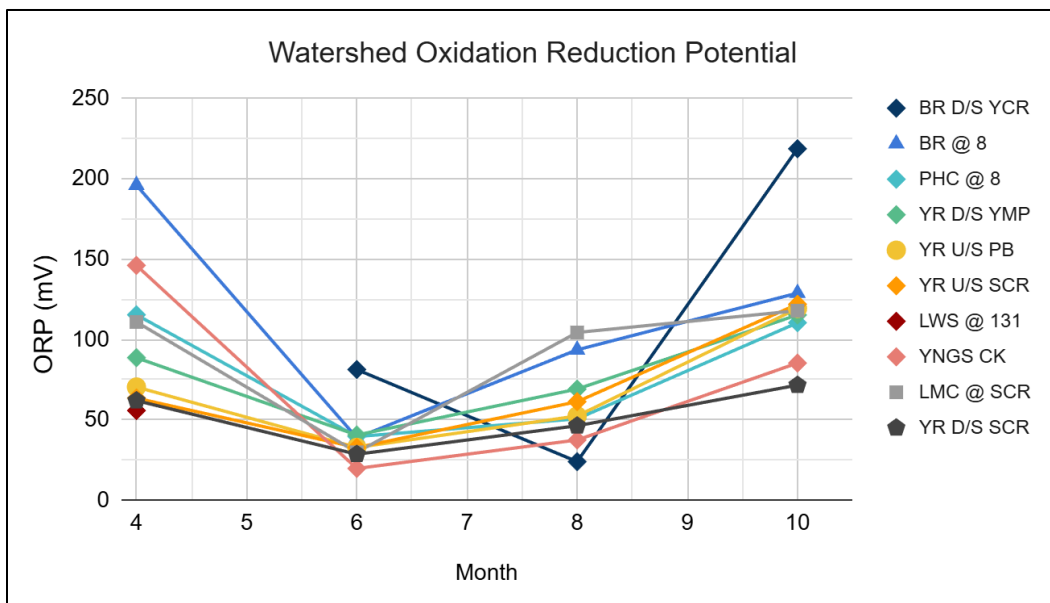


Figure 6. Bear River Watershed oxidation reduction potential, 2025.

General Chemistry

In addition to physical characteristics, other chemical parameters monitored in the watershed provide critical insights into overall watershed health and pollutant sources. These parameters help characterize water quality conditions, identify potential stressors, and support the interpretation of nutrient dynamics. The following section presents an analysis of key parameters, highlighting spatial and temporal trends that may help indicate nutrient sources and support water quality modeling efforts.

Figure 7 depicts spatial variability of hardness concentrations at the monitoring location in the watershed over the period of record (POR) and 2025. There is a notable increase in hardness upstream to downstream

from the Bear River downstream of Yamcolo Reservoir (BR D/S YCR) to just upstream of Stagecoach Reservoir (YR U/S SCR). The location on the Little White Snake (LWS @ 131) has significantly higher hardness concentration than any other site in the watershed. The other tributaries to Stagecoach Reservoir from Youngs Creek (YNGS CK) and Little Morrison Creek (LMC @ SCR) were in the same range as the other sites upstream and the outflow site (YR D/S SCR), and the 2025 median hardness at all sites were near the high end of the 75th percentile of historical data.

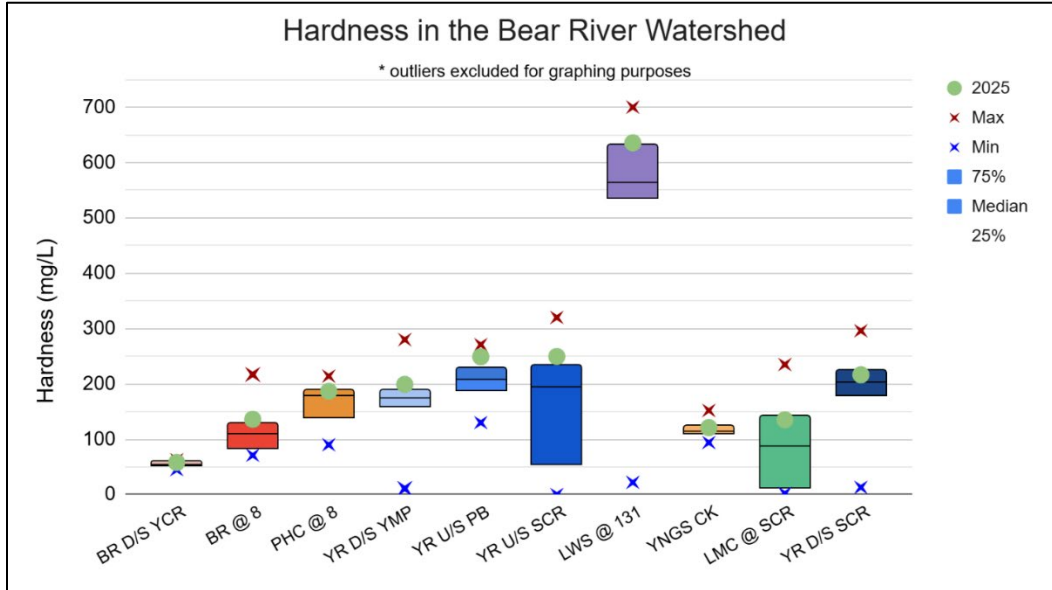


Figure 7. Bear River Watershed hardness concentrations, 25th/75th percentile over POR, 2025.

In general, temporally total suspended solids (TSS) were elevated during the spring months and decreased into the later summer months as base flows are reached with the exception of Phillips Creek (PHC @ 8) and the Yampa River upstream of Yampa (YR U/S YMP) which are highly variable (**Figure 8**). Spatially, TSS concentrations are highly variable in the watershed with the highest range in concentrations occurring at the Bear River site (BR @ 8), both historically and during the 2025 sampling events (**Figure 9**). All 2025 TSS concentration were near or below the median over the period of record with exception to the Little White Snake (LWS @ 131).

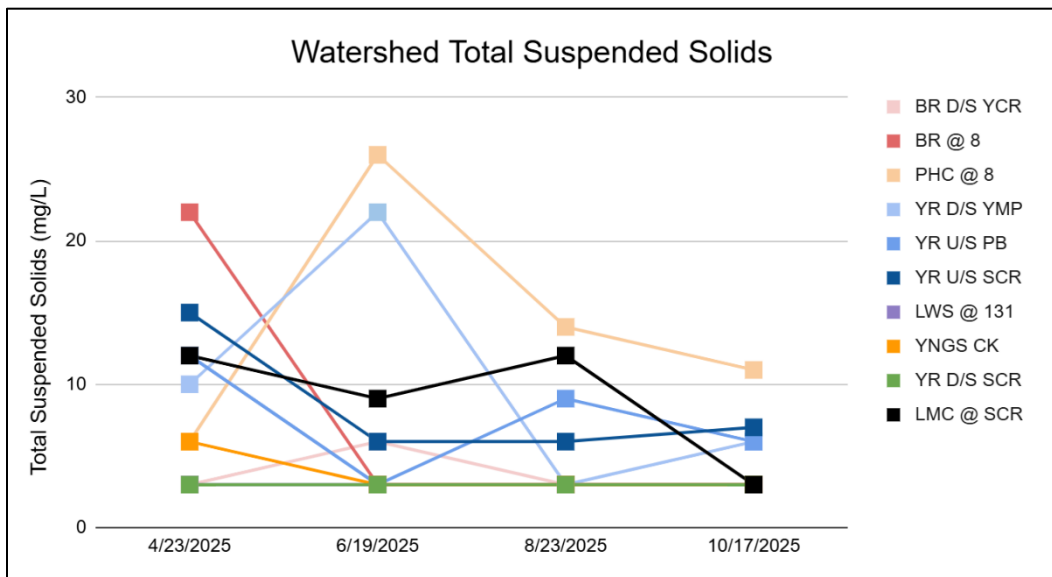


Figure 8. Bear River Watershed total suspended solids concentrations, 2025.

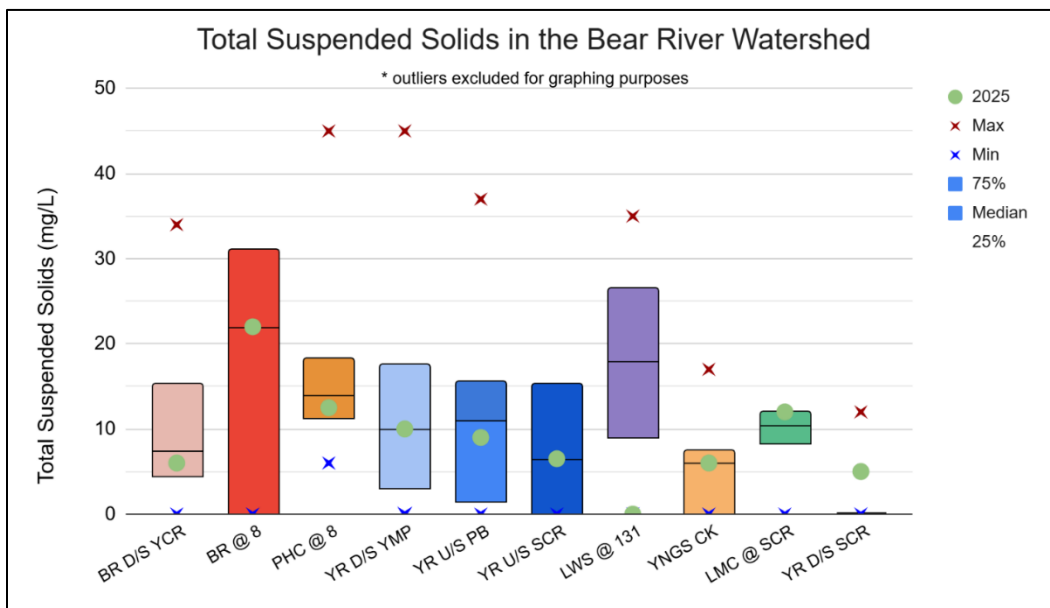


Figure 9. Bear River Watershed TSS concentrations, 25th/75th percentile over POR, 2025.

Again, there are no established water quality standards for sulfate in surface water however, the recommended limit for sulfate in domestic water for Colorado is 250 mg/L. All historical and 2025 concentrations were well below this value, with the exception of Little White Snake (LWS @ 131) which historically has values above this threshold (**Figure 10**).

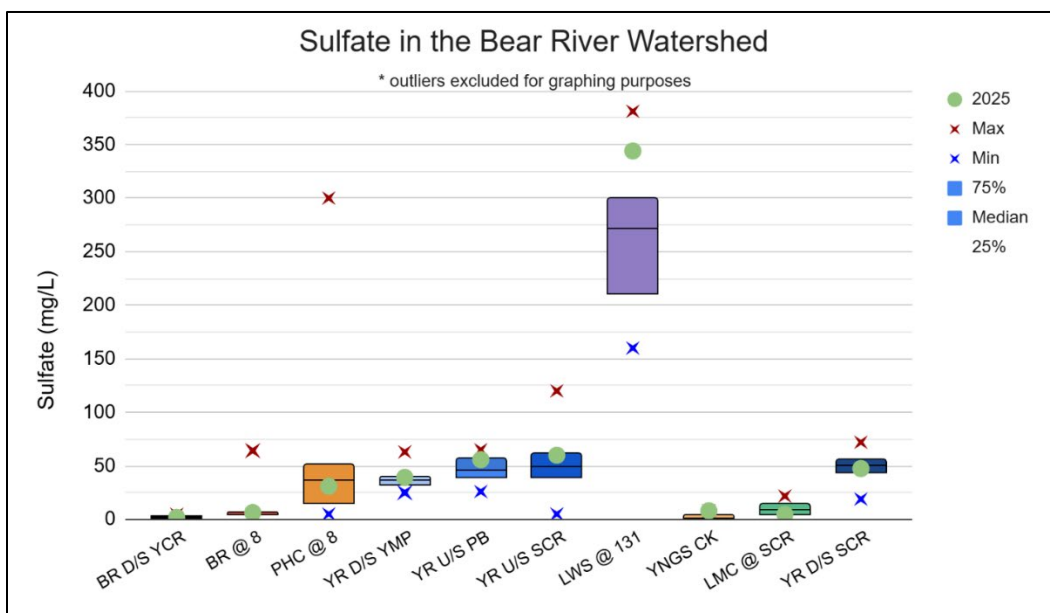


Figure 10. Bear River Watershed sulfate concentrations, 25th/75th percentile over POR, 2025.

Nutrients

The analysis of the samples collected in the Upper Bear River sub-basin demonstrated some patterns providing additional insight into the natural and anthropogenic processes and sources of nutrients

Figure 11 depicts the 2025 total phosphorus concentrations in the watershed. The data demonstrates a general increasing trend from spring into early summer and then decreasing through the late summer and fall for sites upstream of the reservoir. Elevated levels in the early summer generally correlate during snowmelt and runoff causing high streamflow. The concentrations at YR D/S SCR did not follow this same

trend and were elevated in October, which coincided with the turnover of the reservoir which likely mixed the nutrients through the water column. This was consistent with trends during the 2024 sampling period.

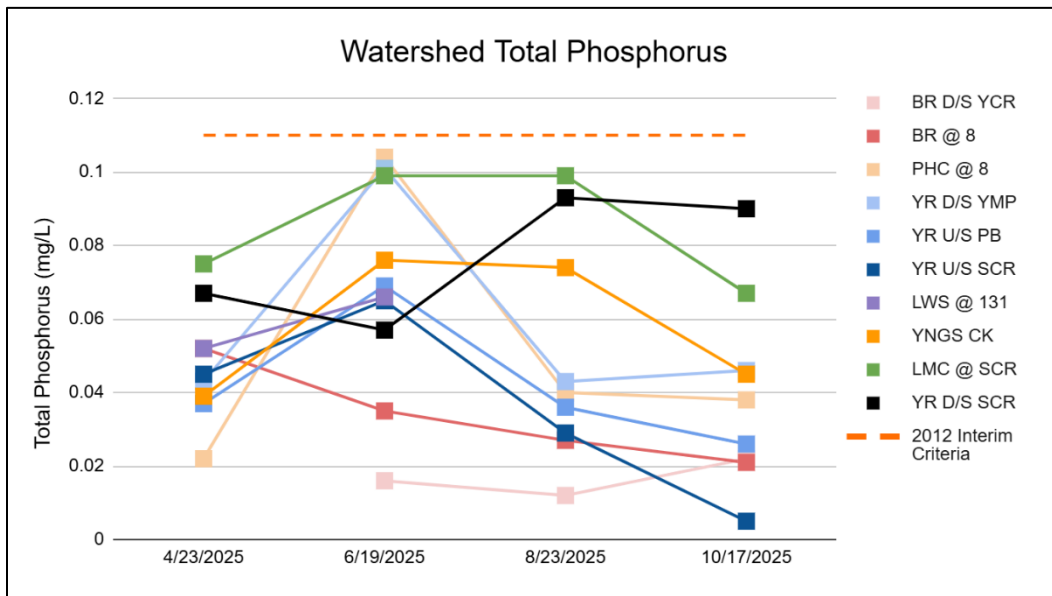


Figure 11. Bear River Watershed total phosphorus concentrations, 2025.

The total phosphorus concentration medians in the watershed in 2025 were within the historical range of record with the exception of Little White Snake (LWS @131) which was lower than that historically measured (Figure 12).

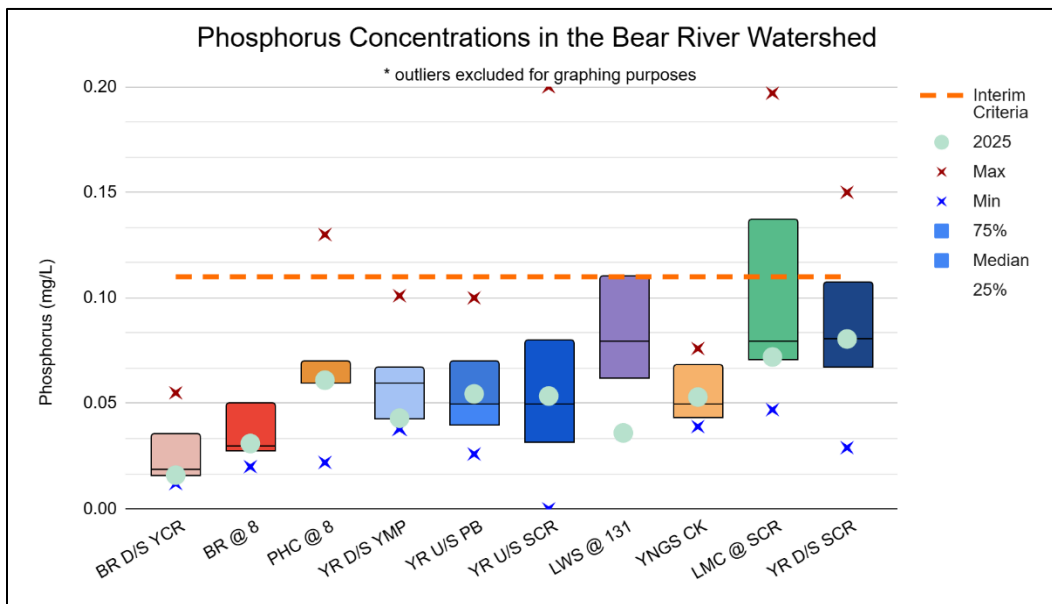


Figure 12. Bear River Watershed total phosphorus concentrations, 25th/75th percentile over POR, 2025.

Figure 13 depicts the 2025 total nitrogen concentration in the watershed. Like total phosphorus, the data demonstrates a general increasing trend from spring into early summer and then decreasing through the late summer and fall for sites upstream of the reservoir, with an exception to Phillips Creek (PHC @ 8). Elevated levels in the early summer generally correspond to high discharge during runoff and decrease as base flows are reached. The concentrations in the Yampa River downstream of Stagecoach Reservoir (YR D/S SCR) did not follow this same trend and were higher in the fall which is most likely influenced by the

reservoir release operations. The total nitrogen concentration medians in the watershed in 2025 were within the historical range of period with exception of Phillips Creek (PHC @ 8) and the Yampa River upstream of Stagecoach Reservoir (YR U/S SCR) (Figure 14).

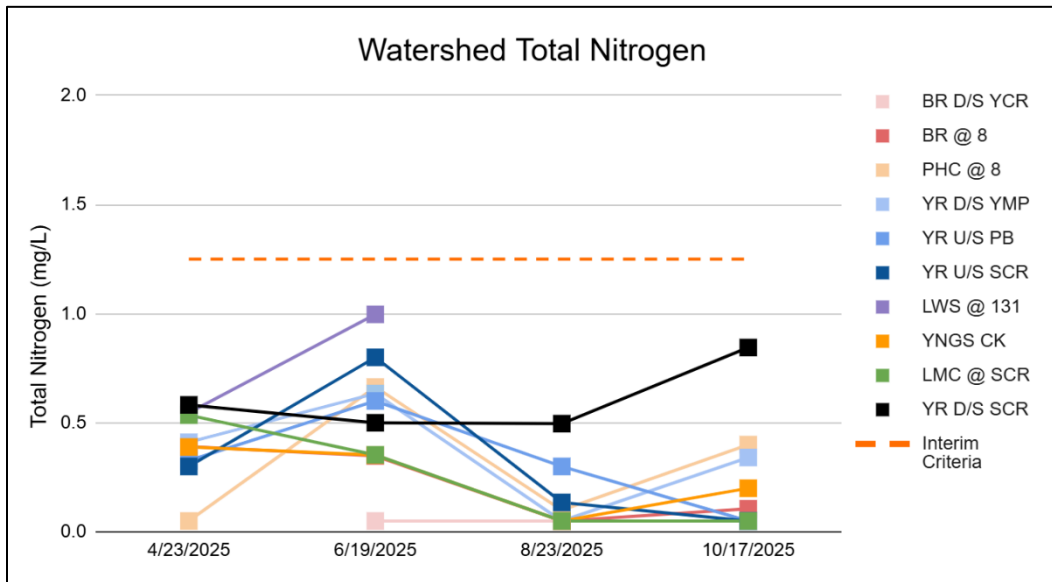


Figure 13. Bear River Watershed total nitrogen concentrations, 2025.

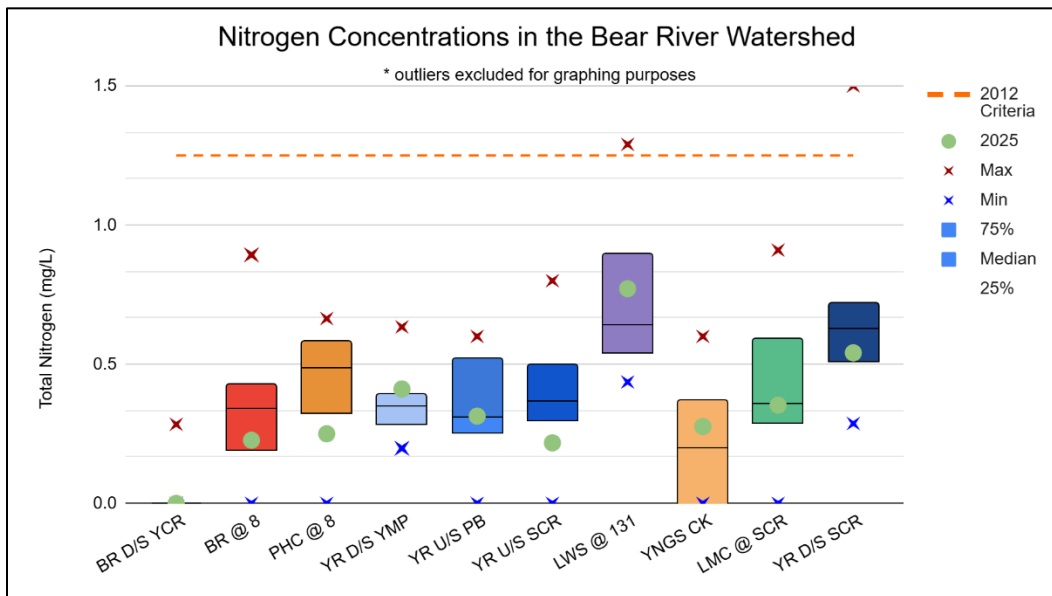


Figure 14. Bear River Watershed total nitrogen concentrations, 25th/75th percentile over POR, 2025.

B. Stagecoach Reservoir

During 2025, Stagecoach Reservoir monitoring was completed May through November to continue building on the historical sampling completed at or near the dam (SCR Dam) as well as more recently in the Martin Creek (SCR -MC) and Little Morrison Creek (SCR – LMC) coves, and near the inlet of the Yampa River (SCR - Inlet) (Figure 1).

Physical Parameters

The physical parameters measured in Stagecoach Reservoir include temperature, pH, dissolved oxygen (DO), specific conductivity, and oxygen reduction potential, in addition to Secchi depth to represent water transparency. Regulation 33 assigns water quality standards for Stagecoach Reservoir to protect aquatic life and other designated uses including recreation and direct use water supply (DUWS). Stagecoach Reservoir standards for temperature, pH and DO are protective of the Class I Cold Water Aquatic Life use. **Figure 15** through **Figure 19** represent the profiles for each of the physical parameters at the SCR Dam site along with the references to WQS, where appropriate. The SCR-Dam site is used for this section because it is representative of the deepest location in the Reservoir.

The water temperature in Stagecoach Reservoir demonstrated thermal stratification from June through September (**Figure 15**). The October and November monitoring events showed more consistent temperatures among the depths indicating a fall turnover event has occurred resulting in reservoir mixing which is expected when temperatures cool. All the values measured in the 2025 sampling period were below the acute WQS for temperature.

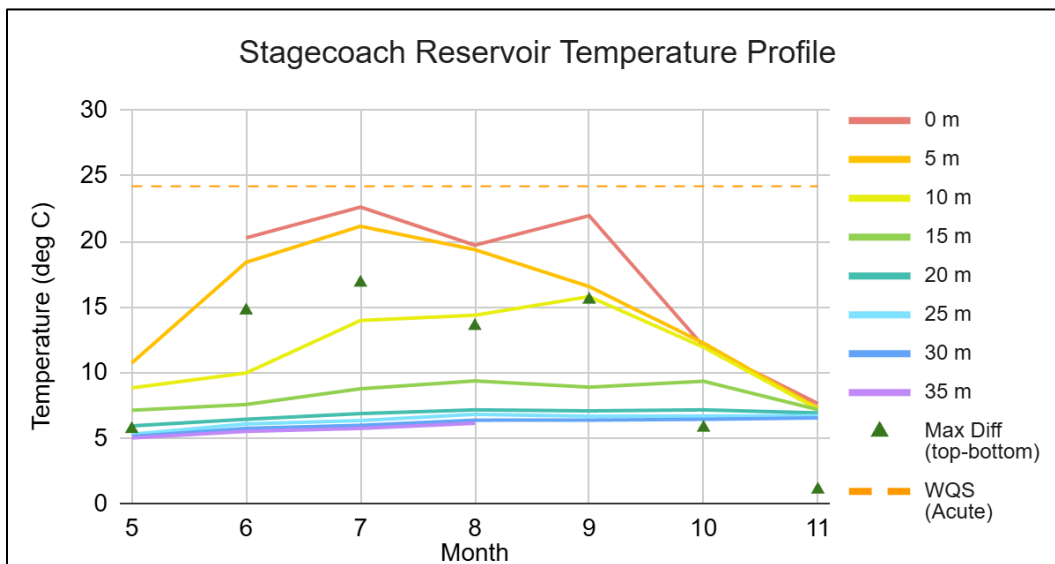


Figure 15. Water temperature profile for Stagecoach Reservoir measured at the SCR Dam location, 2025.

During the 2025 monitoring period, pH measurements at all depths were within the range established for aquatic life (6.0 to 9.0) (Figure 16). In general, pH decreased with greater depths, except for during the August sampling event which showed an inverse in measurements. Under low DO concentrations, decay microbes break down organic matter in the sediments. If the sediment is rich in iron, the reduction of ferric iron to ferrous iron releases phosphorus and consumes protons, which can increase the pH with depth.

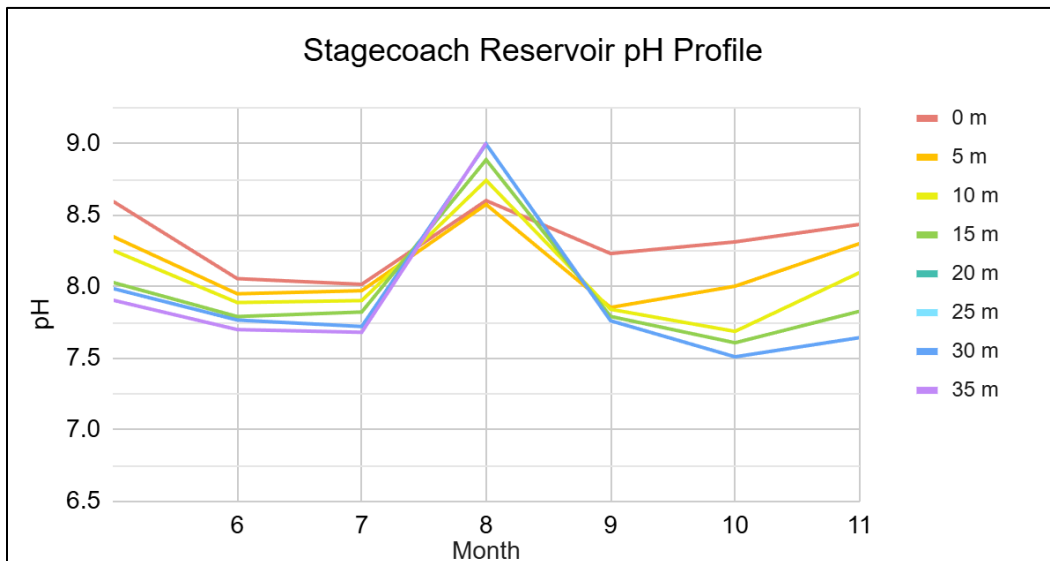


Figure 16. pH profile for Stagecoach Reservoir measured at the SCR Dam location, 2025.

Similar to temperature, Stagecoach Reservoir exhibited dissolved oxygen (DO) stratification throughout the season (Figure 17). DO concentrations decreased gradually with depth May – July but were the lowest during the late summer and fall months. Concentrations at the top and bottom were most similar during the late summer and fall months as well. In August, all DO concentrations were below 2 mg/L between 0 and 20 meters and remained low through October, with the exception of 10 m which observed an increase in DO in the later fall months.

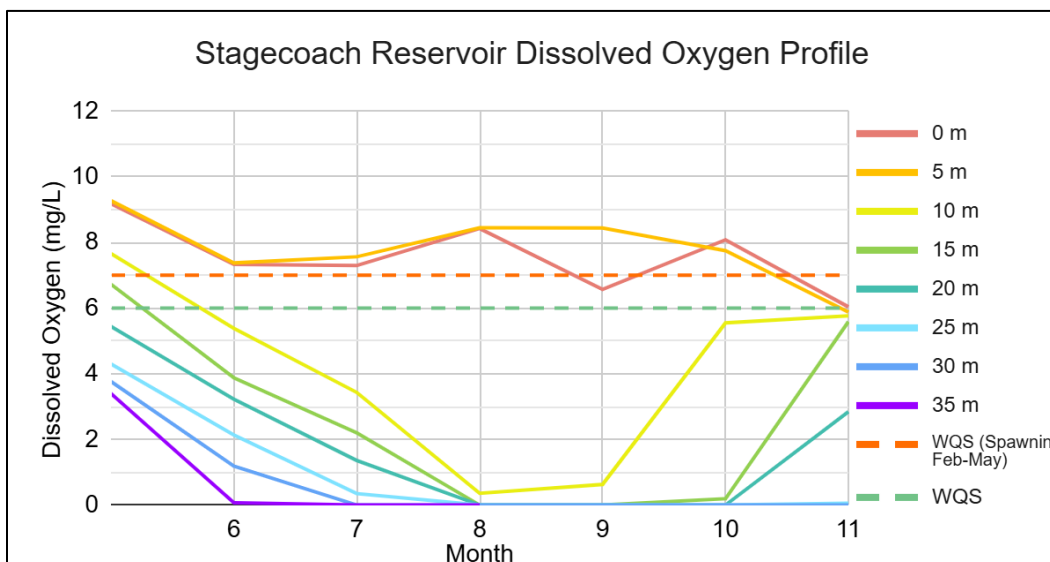


Figure 17. Dissolved oxygen profile for Stagecoach Reservoir measured at the SCR Dam location, 2025.

Oxidation reduction potential (ORP) is an indicator of the oxidation or reduction conditions in the water column, which influences nutrient cycling, metal solubility, and biological processes. The ORP values at the SCR Dam site were relatively stable April through July, and the surface to 10 m remained positive throughout the monitoring period indicating oxidizing conditions (Figure 18). ORP declined significantly in the deeper layers from August to November, transitioning into negative values, indicating reducing conditions. This suggests seasonal stratification and anoxic conditions developing in deeper waters.

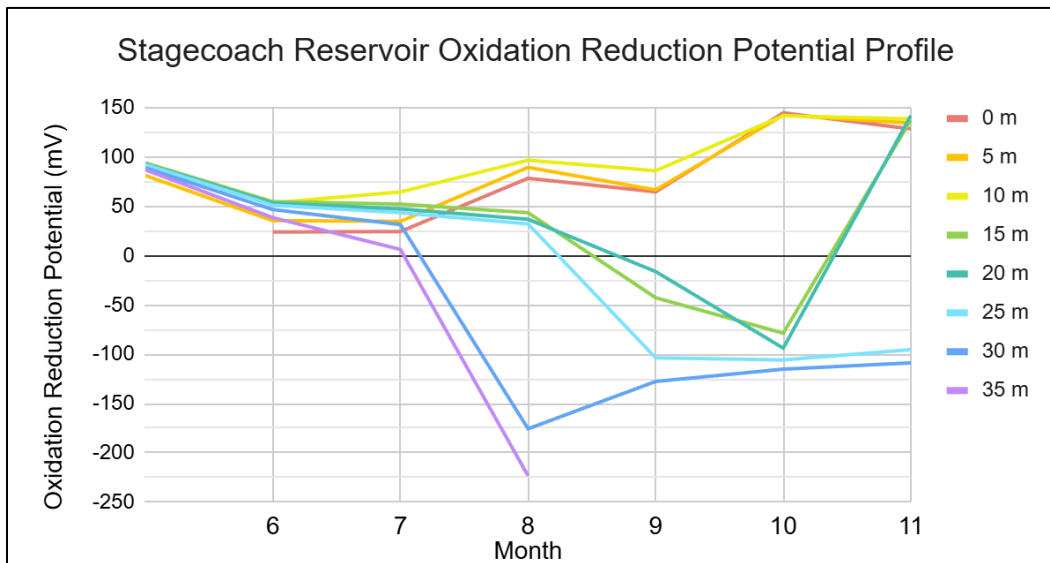


Figure 18. Oxidation reduction potential profile for Stagecoach Reservoir measured at the SCR Dam location, 2025.

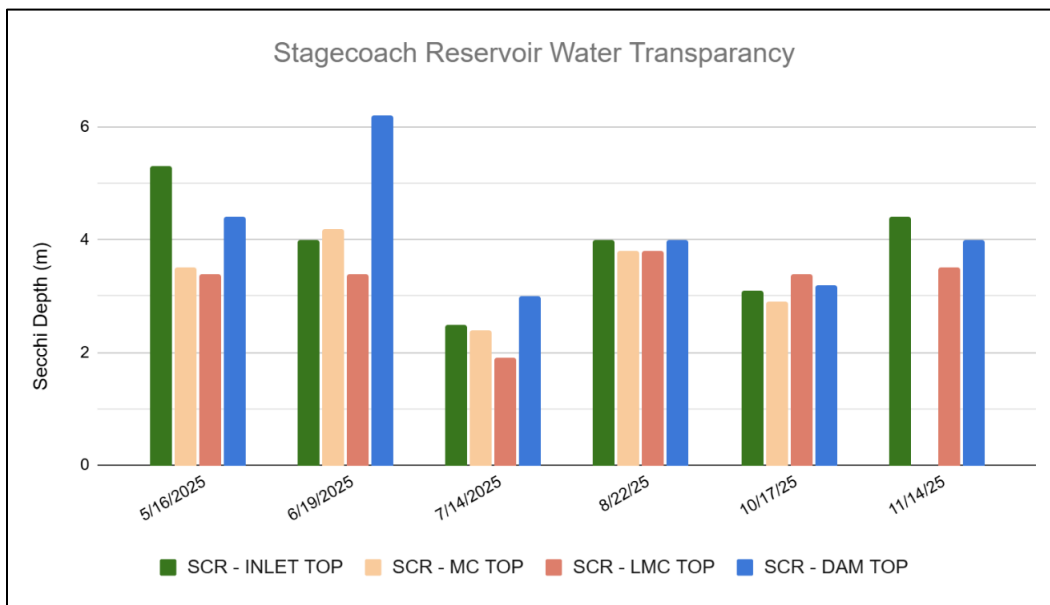


Figure 19. Water transparency in Stagecoach Reservoir Secchi Depth (m), 2025

.Secchi depth, which measures water transparency often directly reflects primary productivity since algal cells and colonies suspended in the water column reduce water clarity. The Secchi depth, indicating the depth where the majority of photosynthesis occurs (Figure 20), were greater early in the season and lowest in July, yet remained moderate despite the significant increase in algal productivity and associated chl-a concentrations (Figure 19). This suggests that the long colonies of cells, formed by *Aphanizomenon*, the dominant algal species present in the reservoir, have less of an impact on water clarity than similar concentrations of smaller colony forming species would. (see Plankton section)

Nutrients

Nutrient dynamics play a critical role in shaping water quality conditions in Stagecoach Reservoir particularly in relation to the occurrence of algal blooms. Elevated levels of phosphorus and nitrogen can contribute to excessive algal growth, leading to potential ecological and water quality concerns such as

decreased dissolved oxygen, altered food web dynamics, and impaired uses. This section of the report summarizes nutrient monitoring results for 2025, examining spatial and temporal trends in nutrient concentrations. The findings provide insight into the impacts of nutrient loading and inform potential management strategies to improve water quality conditions in the reservoir.

Figure 21. illustrates the total phosphorus (TP) concentrations for the top and bottom locations at each monitoring site in Stagecoach Reservoir during 2025 in relation to the 2012 Interim Criteria for total phosphorus. General seasonal trends are observed in the deeper dam sites which increases throughout the sampling period and the top sites all having their highest concentrations in November. The bottom locations for the inlet, and Martin and Morrison Creek cove sites have variable phosphorus concentrations throughout the sampling period.

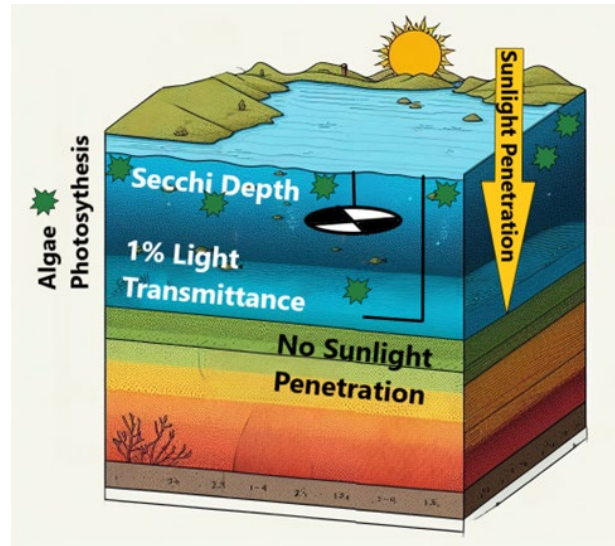


Figure 20. Water transparency, Secchi depth, and photic zone.

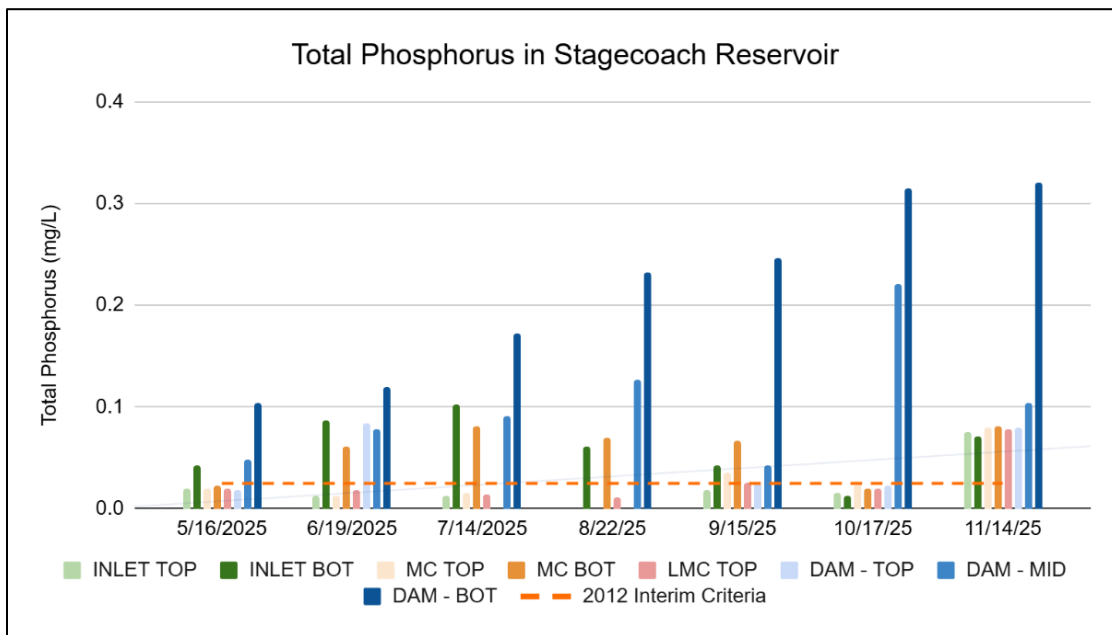


Figure 21. Total phosphorus concentrations in Stagecoach Reservoir, 2025.

Throughout the entire sampling period, all the sampling sites at the top of reservoir are below or near the applicable interim criteria for phosphorus, except for the November sampling when all sites are elevated and above the standard. The notable trend of increasing phosphorus concentrations in deeper waters later in the season suggests internal phosphorus loading, likely due to sediment release under lower oxygen conditions, as indicated in the DO (Figure 17) and ORP (Figure 18) profiles.

All the median phosphorus concentrations in Stagecoach Reservoir during 2025 were within the 25th and 75th percentiles over the period of record (Figure 22). Although Figure 22 shows the median concentration for all sampling events in 2024, assessment of the interim phosphorus criteria is based on concentration from July through September.

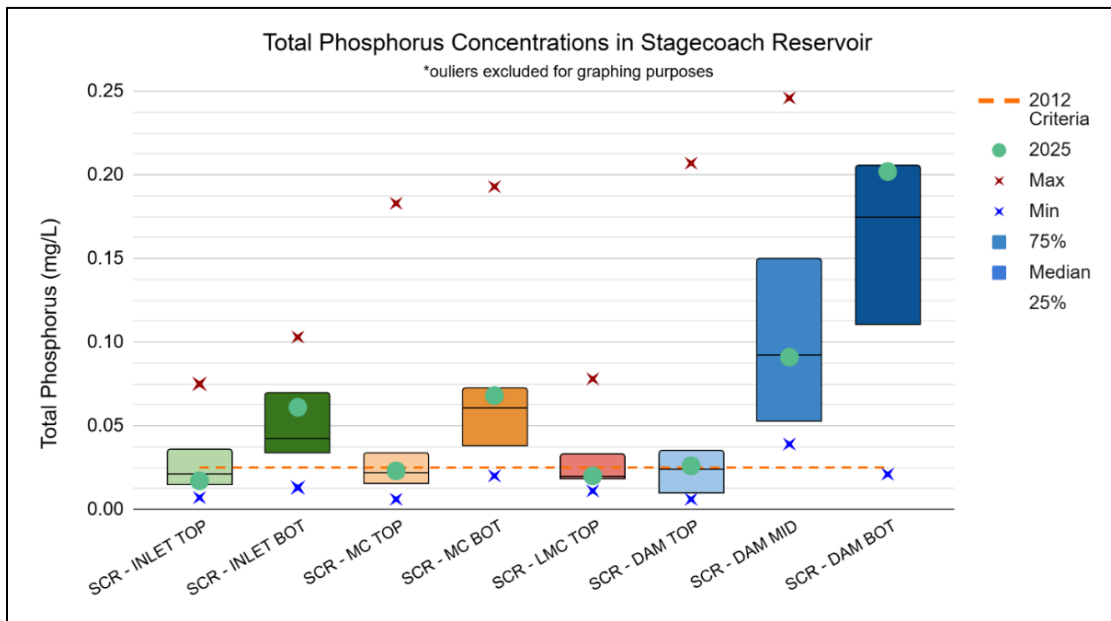


Figure 22. Total phosphorus concentrations in Stagecoach Reservoir, 25th/75th percentile over POR, 2025.

Figure 23 displays total nitrogen (TN) concentrations at various locations and depths in Stagecoach Reservoir from May through November 2025 with the seasonal interim Tn criteria value of 0.426 mg/L for reference. In general, TN concentrations gradually increased in the spring and throughout the summer, followed by a decline in September and then an increase through the remainder of the fall season.

Total nitrogen concentrations at all sites fluctuated seasonally, with noticeable increases in all sites in July and October, and the highest TN concentrations were observed at the deepest dam site (DAM – BOT), particularly in October and November, with values approaching 1.5 mg/L. Gradual increases in TN concentrations at the dam from September to November, specifically at the bottom, suggest internal nitrogen cycling, possibly due to sediment release from denitrification or mineralization processes under anoxic conditions.

Overall, most median TN concentrations in Stagecoach Reservoir during 2025 were within the 25th and 75th percentiles over the period of record, except for the surface sites at the inlet (INLET -TOP) and the dam (DAM – TOP) which were below (Figure 24). Although Figure 24 illustrates the median concentration for all sampling events in 2024, assessment of the interim phosphorus criteria is based on concentrations from July through September.

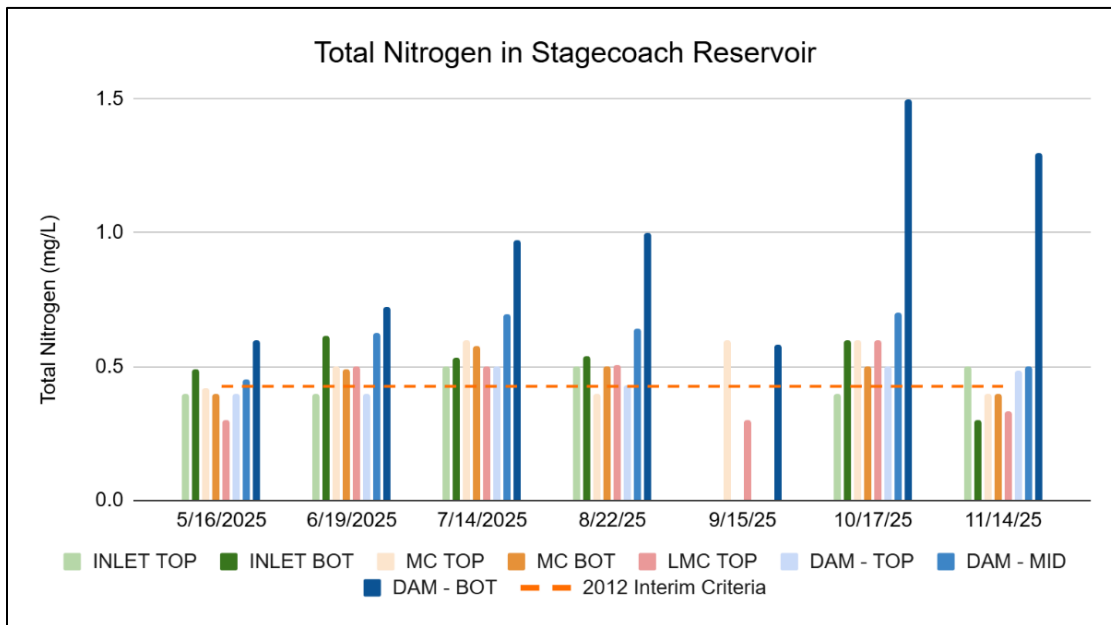


Figure 23. Total nitrogen concentrations in Stagecoach Reservoir, 2025.

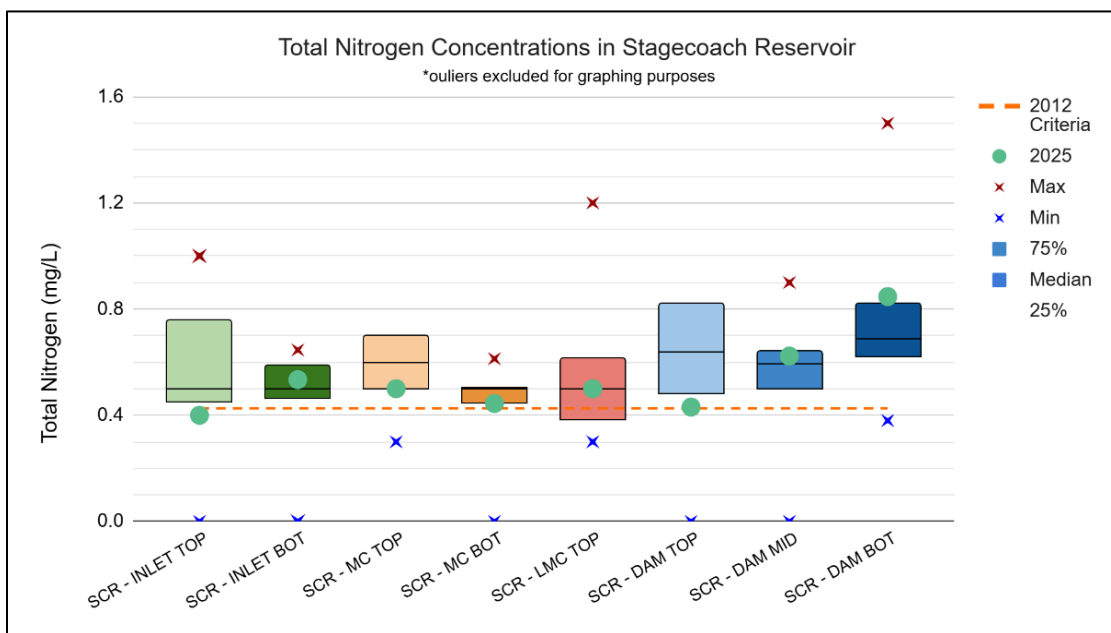


Figure 24. Total nitrogen concentrations in Stagecoach Reservoir, 25th/75th percentile over POR, 2025.

Nutrient availability is a key factor influencing primary productivity and algal community composition in Stagecoach Reservoir. In many freshwater systems, phosphorus is the primary limiting nutrient, meaning its availability controls algal growth. However, when phosphorus levels are elevated and nitrogen becomes scarce, conditions can favor nitrogen-fixing cyanobacteria, which can outcompete other phytoplankton and contribute to harmful algal blooms by fixing nitrogen from the atmosphere. Certain cyanobacterial species produce toxins that pose risks to aquatic ecosystems, drinking water supplies, and recreational activities. This section examines nutrient limitation patterns in assessing nitrogen to phosphorus ratios (N:P), potential shifts toward nitrogen limitation, and the implications for cyanobacteria dominance and water quality management.

The N:P ratio was highest in July and August when total N was elevated and total P was low at the surface locations for all the sites (**Figure 23**).

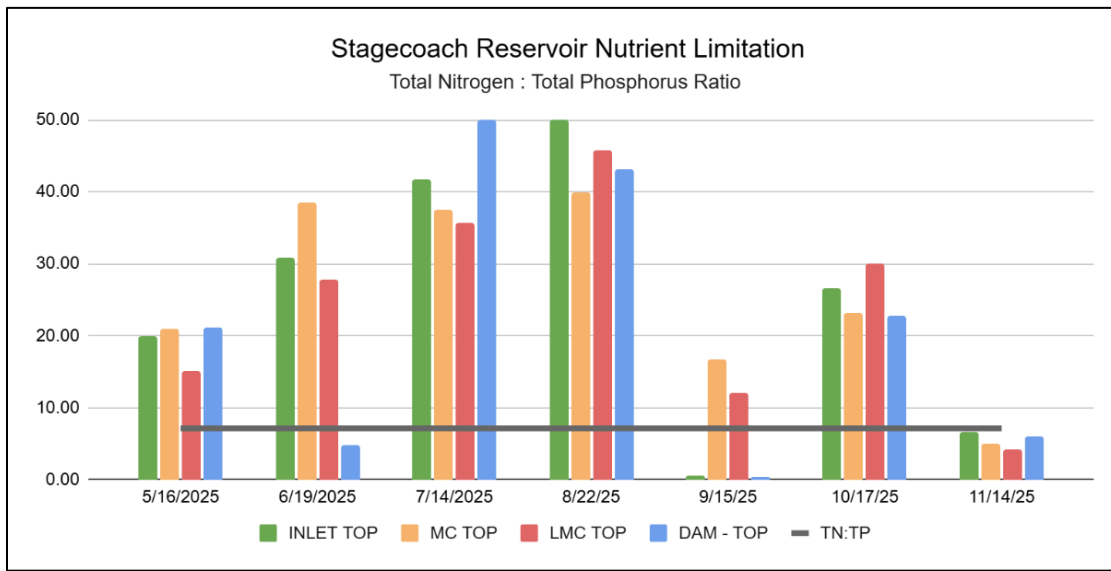


Figure 25. Nutrient ratio of total nitrogen to total phosphorus in Stagecoach Reservoir, 2025.

Chlorophyll-a

Chlorophyll-a concentrations represent the amount of algal pigment present in the sample as an indicator of overall “productivity” of the lake. Concentrations remained relatively low in early summer (May -July). Values began increasing in late August, with all sites exceeding the Cold Water Aquatic Life standard (8 µg/L) and the Direct Use Water Supply (DUWS) standard (6 µg/L). The seasonal peak occurred in mid-September, with the highest concentrations observed at MC TOP (~67 µg/L) and INLET TOP (~31 µg/L), coinciding with the late-summer algal bloom (**Figure 26**). Chlorophyll-a levels declined across all sites in October, but INLET TOP showed a notable secondary increase in November, suggesting continued algal activity later in the season than observed at other sites. Spatially, SCR – MC TOP exhibited the highest peak concentrations in 2025, in contrast to prior years when LMC TOP was the dominant site, which may reflect a shift in bloom location or nutrient dynamics within the reservoir. Comparison with water quality standards for both Cold Water Aquatic Life (8 µg/L) and DUWS (6 µg/L) highlights periodic water quality concerns, particularly from late August through November. Further analysis of nutrient sources, temperature stratification, and hydrologic conditions will help refine the understanding of these dynamics and inform mitigation strategies.

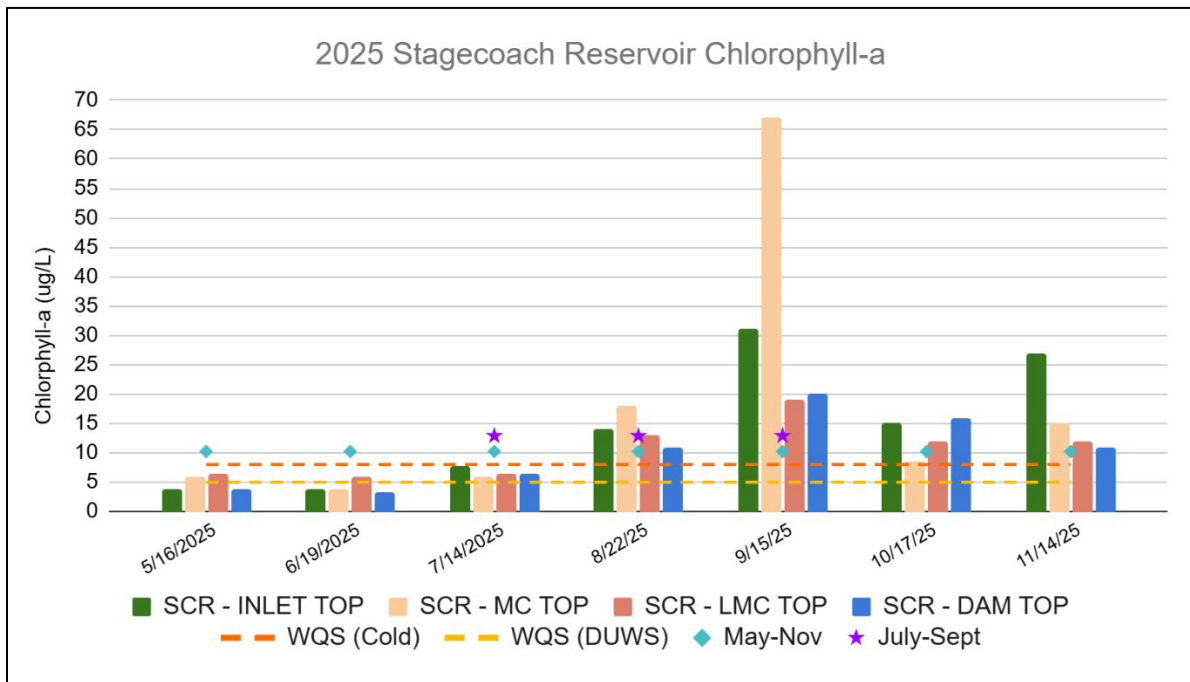


Figure 26. 2025 Stagecoach Reservoir Chlorophyll-a Concentrations

Plankton

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, representing many algal groups.

In many environmental instances, algal numbers (cells/mL) and algal biovolume ($\mu\text{m}^3/\text{mL}$) closely correlate with one another, but that is not always the case. Often during “bloom” conditions, the phytoplankton community can be dominated by a few algal species that are very large in size.

Chlorophytes (green algae) are usually the most diverse algal group and often are referred to as “good” algae since they provide a food source for zooplankton which are then fed upon by fish.

Cyanophytes (commonly called blue green algae or cyanobacteria) are probably responsible for most nuisance algal blooms that occur in freshwater ecosystems, and some species are also capable of producing algal toxins resulting in harmful algal blooms (HABs). Cyanophytes have the ability to use atmospheric nitrogen as a nutrient source and can also regulate their position within the water column by altering their buoyancy with the use of gas vacuoles. These characteristics give cyanobacteria a competitive advantage over other groups of phytoplankton.

Bacillariophytes (diatoms) can also be responsible for nuisance blooms, but those relate mainly to taste and odor problems in drinking water supplies, and those issues are not as common as nuisance cyanobacteria blooms.

Phytoplankton populations and biovolume were monitored at Stagecoach Reservoir from May through October 2025 to characterize community composition and assess the potential for harmful algal blooms (HABs), with particular attention to cyanobacteria (Cyanophyta), the group responsible for harmful cyanobacterial blooms (HCBs) of concern for recreational water users.

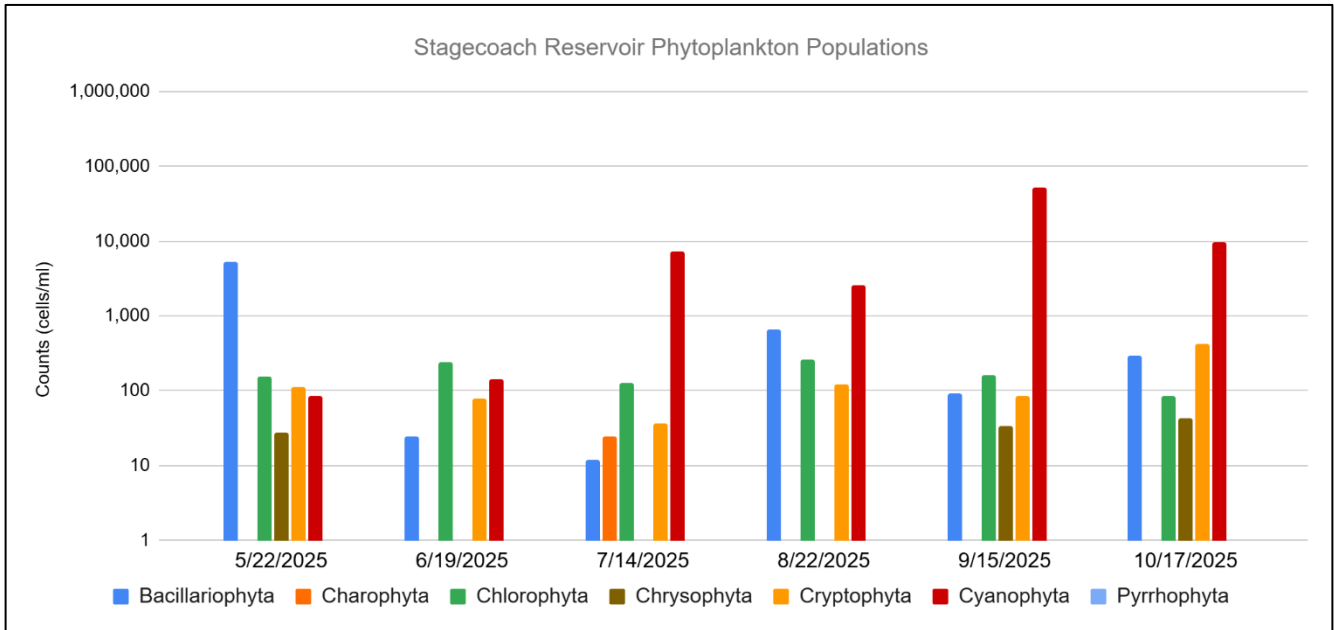


Figure 27. Phytoplankton Populations in Stagecoach Reservoir, 2025.

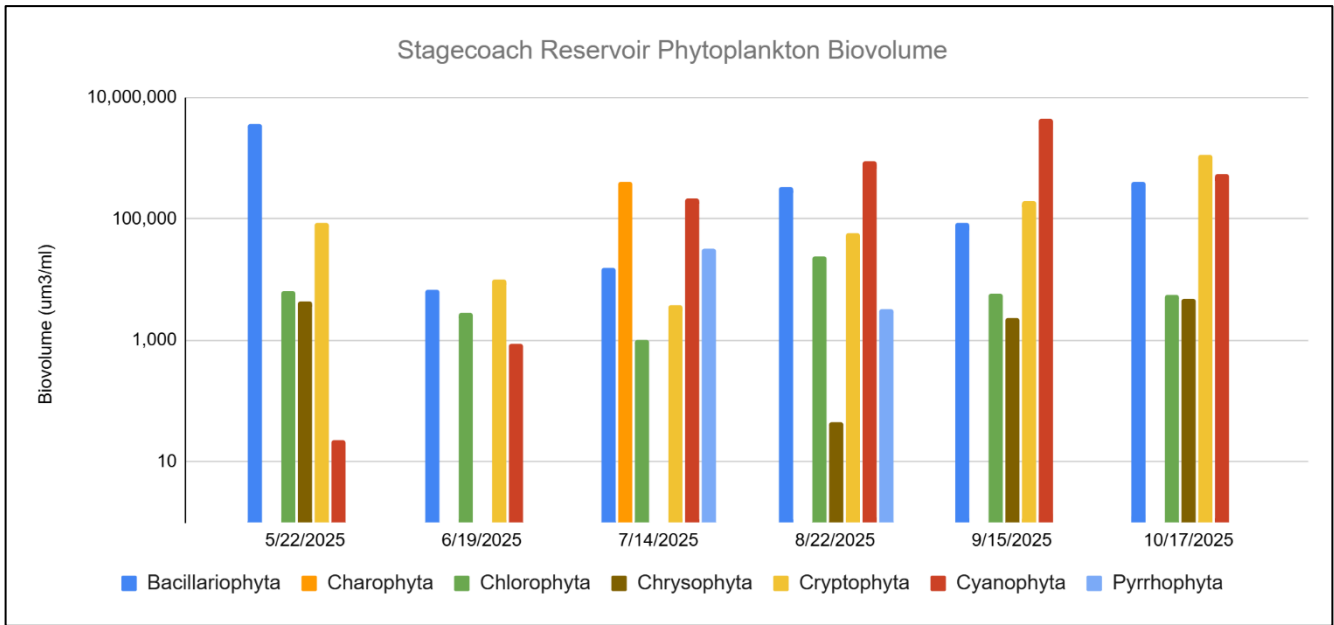


Figure 28. Phytoplankton Biovolume in Stagecoach Reservoir, 2025.

Cell count data (Figure 27) reveal a clear seasonal succession in phytoplankton community composition. Bacillariophyta (diatoms) dominated the early season in May, reaching approximately 5,000 cells/ml, which is characteristic of cool, well-mixed spring conditions that favor diatom growth. By June and July, diatom counts declined sharply as the water column warmed and stratified, giving way to a mixed community of Chlorophyta, Cryptophyta, and an emerging cyanobacterial presence.

Biovolume data (Figure 28) provides an important complement to cell counts, as they account for the large size difference between taxa. The May diatom dominance is even more pronounced in biovolume (~4,000,000 µm³/ml), reflecting the characteristically large cell size of diatoms relative to other groups. Despite low cell counts in early summer, Cryptophyta contributed meaningfully to biovolume in May and June, indicating that smaller-count taxa can still represent significant biomass.

The most significant finding from both graphs is the dramatic rise in Cyanophyta through the summer and fall. Cyanobacteria were present at low levels in May and June, increased modestly in July (~8,000 cells/ml), and then surged to a seasonal peak in mid-September of approximately 50,000–60,000 cells/ml — the single largest population of any group recorded across the entire monitoring season. This September bloom also dominated biovolume, reaching an estimated ~5,000,000 $\mu\text{m}^3/\text{ml}$, dwarfing all other taxa combined. Cell counts remained elevated in October (~9,000 cells/ml) before the season closed, suggesting the bloom persisted well into the fall recreation season.

These cyanobacterial cell densities are relevant to recreational risk assessment. Using WHO guideline thresholds, counts in the range of 20,000–100,000 cells/ml correspond to moderate-to-high recreational risk, including potential for skin irritation, gastrointestinal illness, and respiratory effects from toxin or cell exposure during contact recreation. The September peak at Stagecoach fell within this range and coincided with the elevated chlorophyll-a concentrations observed at the same time (see Chlorophyll-a section). Based on prior species identification, *Aphanizomenon* was the dominant cyanobacterial genus, which is a known toxin-producing genus capable of producing anatoxins and cylindrospermopsins, though toxin concentrations were not assessed as part of this monitoring effort.

The late-summer and fall timing of peak cyanobacterial growth overlaps with continued recreational use of Stagecoach Reservoir, underscoring the importance of ongoing monitoring and public communication during this period. The combination of high cell counts, elevated chlorophyll-a, and a potentially toxin-producing genus present warrants consideration of a tiered response framework — such as issuing recreational advisories when cyanobacteria exceed established thresholds — to protect public health. Continued monitoring of both cell counts and cyanotoxin concentrations in future seasons would strengthen the ability to issue timely and defensible advisories.

Trophic State

The trophic state index (TSI) of a lake is a relative expression of the biological productivity of a lake. The TSI developed by Carlson (1977) is among the most commonly used indicators of lake trophic state. TP is used in the index because phosphorus is often the nutrient limiting algal growth in lakes. Chl α is a plant pigment present in all algae and is used to provide an indication of the algal biomass in a lake. Secchi depth is a common measure of the transparency of lake water. The three are related in many lakes because transparency is often limited by algal growth and algal growth can be limited by phosphorus in productive lakes. However, the high phosphorus concentrations in Stagecoach Reservoir can lead to nitrogen limiting conditions.

In order to calculate TSI, mean values of TP, chl α , and Secchi depth for an individual lake are logarithmically converted to a scale of relative trophic state ranging from 1 to 100. Elevated values for the TSI are indicative of higher productivity. A TSI of less than 35 indicates oligotrophic conditions, a TSI between 35 and 50 indicates mesotrophic conditions, and a TSI greater than 50 indicates eutrophic conditions. Hypereutrophic, or excessively productive lakes, have TSI values greater than 70. Higher numbers are associated with increased probability of encountering nuisance conditions, such as algal scum.

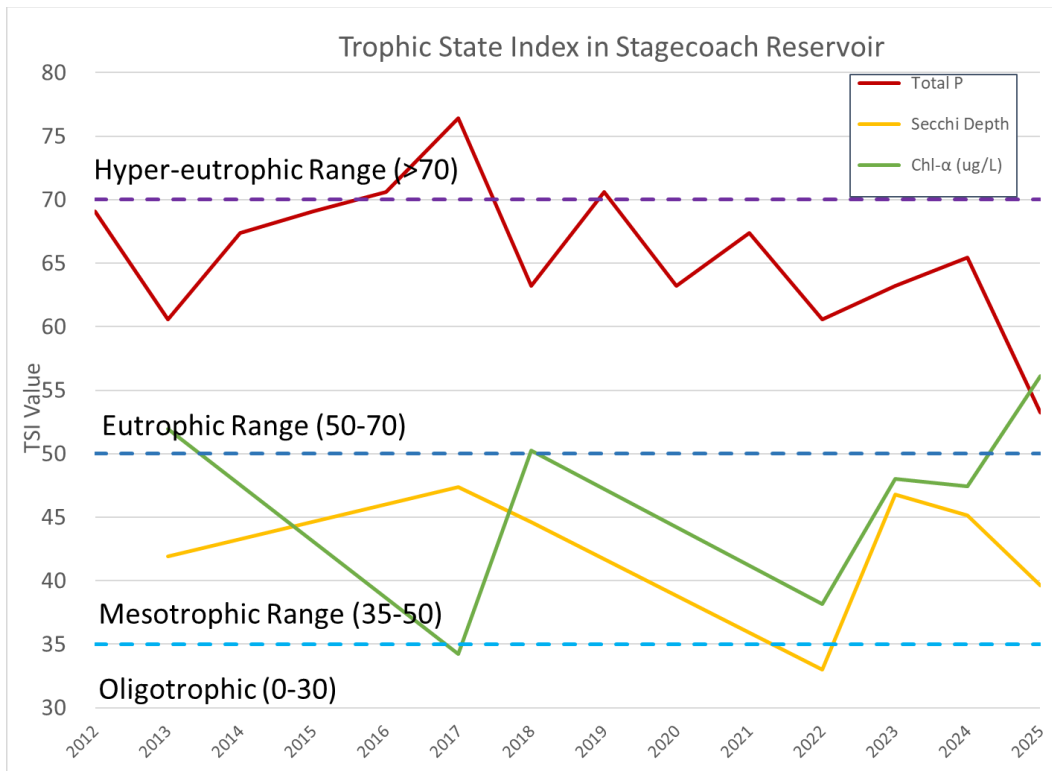


Figure 29. Stagecoach Reservoir Trophic State

Based on the TSI indicators, Stagecoach Reservoir is within the eutrophic and mesotrophic ranges (Figure 29). Historically, total phosphorus has indicated a eutrophic state, with exceptions to 2015, 2016, and 2018 where it was within a hypereutrophic state. In general, these ranges indicate potential for nutrient enrichment and considerable algal growth. The Secchi depth measurements representing water clarity and chlorophyll-a levels are within the mesotrophic range. This state indicated potential for moderate nutrient concentrations and plant productivity.

C. Reservoir Loading

Nutrient loading to Stagecoach Reservoir was estimated using long-term median concentrations of total phosphorus (TP) and total nitrogen (TN) from the Yampa River, combined with annual discharge data at upstream (YR U/S SCR) gage during 2025. In addition, nutrient loading from the Morrison Creek Water and Sanitation District (MCWSD) wastewater treatment facility was calculated using 2025 Discharge Monitoring Report (DMR) data. These estimates (Table 5) provide an initial assessment of the relative contributions of the Yampa River, the reservoir's primary inflow, and the MCWSD WWTF, a permitted point source.

Table 5. Inflow Loading from the Yampa River and MC WWTF and Outflow (other tributaries not included)

Location	Annual Discharge (AF)	Historical Median Concentration (mg/L)		Loading (lbs)	
		Total Phosphorus	Nitrogen	Total Phosphorus	Nitrogen
Yampa River Inflow	26,931	0.058	0.358	2,206	23,532
MCWSD*	82	4.6	-	848	-
Outflow	-47,808	0.71	0.667	-2,628	-60,000

*MCWSD concentrations are from 2025 (no TN available)

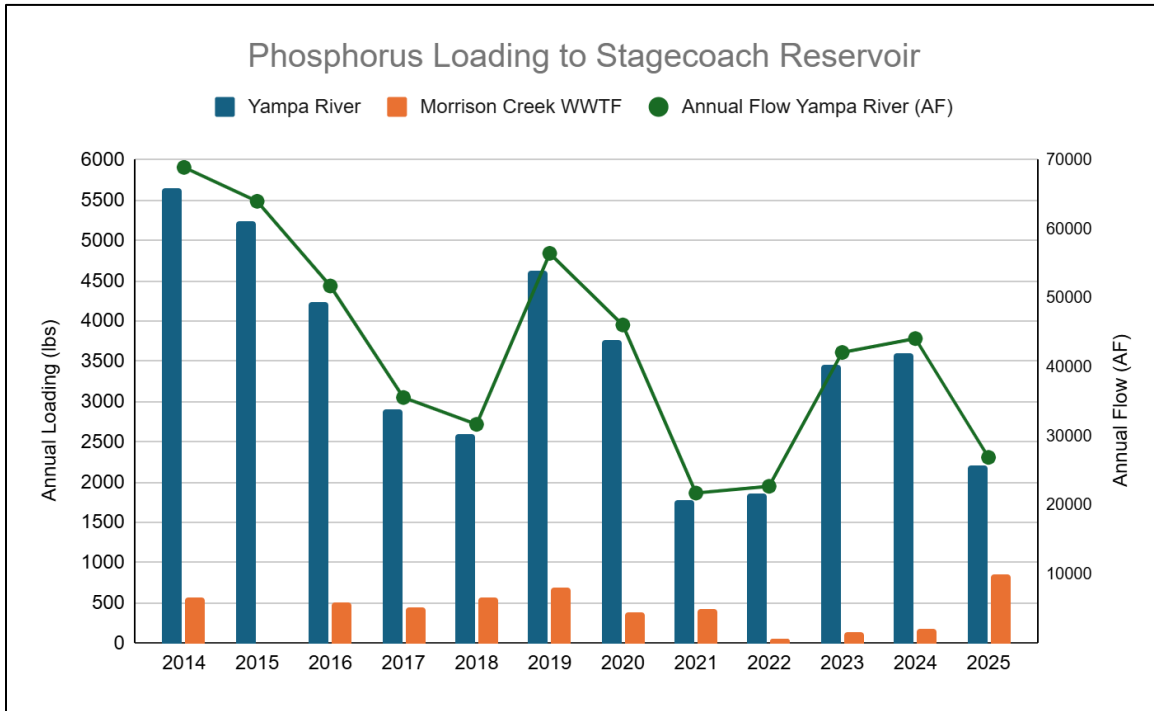


Figure 30. Phosphorus Loading to Stagecoach Reservoir from the Yampa River and Morrison Creek WWTF, 2024-2025.

Nutrient export from Stagecoach Reservoir was estimated based on 2025 discharge data and long-term median concentrations of TP and TN at the downstream Yampa River site (YR D/S SCR). Smaller tributaries such as Youngs Creek, Little Morrison Creek, and Middle Creek were excluded from this preliminary analysis. Consequently, mass balance calculations such as total in-reservoir nutrient storage were not completed due to the incomplete accounting of all inflow sources.

The comparison still highlights that the Yampa River contributes a significantly higher total nutrient load to Stagecoach Reservoir due to its substantially greater flow volume (Figure 28). However, despite the MCWSD's low discharge volume, which was ~ 0.3% of the Yampa River inflow for 2025, the effluent contributed disproportionately to nutrient loading, accounting for almost 40% of phosphorus loading contributed by the Yampa River. This reflects the importance of both flow magnitude and concentration in estimating total loads.

Ongoing monitoring of flow and water quality in tributaries will provide critical data for refining these estimates. This ongoing data collection is supporting the more detailed source analysis using the Hydrological Simulation Program FORTRAN (HSPF) model and CE-QUAL-W2 which will allow for a more comprehensive evaluation of nutrient sources, transport, and transformation processes affecting water quality in Stagecoach Reservoir.

Summary and Next Steps

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