

Grand County Stream Management Plan River Health Assessment Framework and Reach Prioritization Methodology

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Prepared for:



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Introduction

Healthy rivers sustain biodiversity, support communities, and adapt to change. Stream assessments provide a structured approach for evaluating stream conditions over time and tracking how conditions respond to natural variability and management actions. Beyond broadly characterizing a stream “good” or “poor,” a well-defined assessment framework identifies key stressors, highlights where intervention may be most effective and supports consistent comparison across stream reaches.

The Grand County Stream Management Plan River Health Assessment Framework (GC-RHAF) is central to this process and is built on a set of measurable physical, chemical, and biological variables that together provide a holistic view of stream conditions. As illustrated in Figure 1, these variables span watershed-scale influences, riverscape-scale connectivity and landscape context, and channel-scale in-stream conditions. Each variable is evaluated with multiple metrics that are scored against defined benchmarks allowing for consistent comparison and grading across stream reaches.

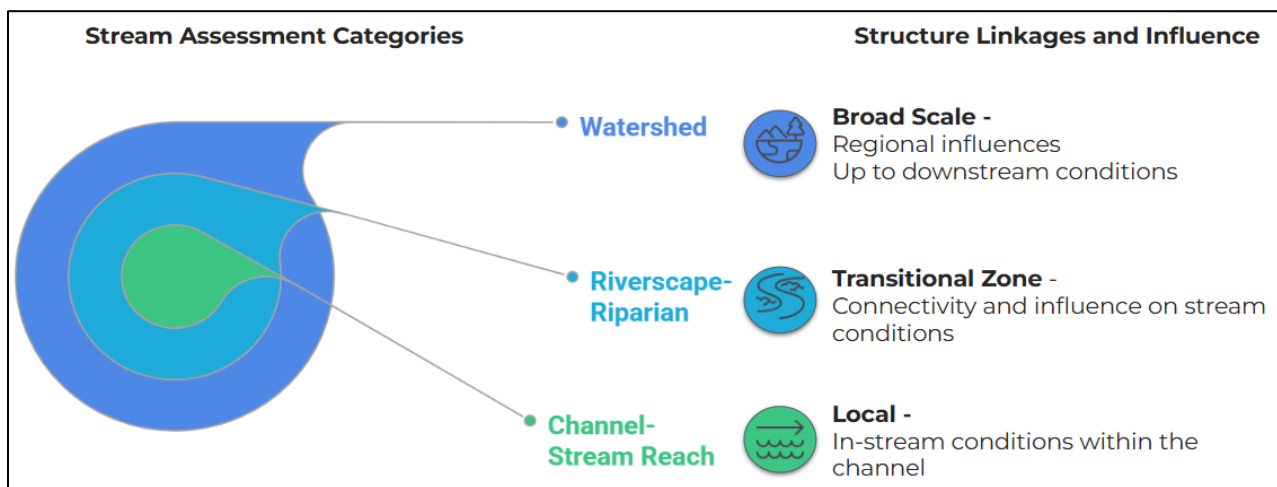


Figure 1. The GC-RHAF includes variables spanning watershed, riverscape, and channel scales, providing a multi-scale assessment of stream condition and function.

Application of the GC-RHAF

The GC-RHAF is designed to support **stream reach prioritization, project identification, and adaptive management** within the Cooperative Effort Area (CEA). The framework does not prescribe specific restoration actions or management decisions; rather, it provides a transparent and repeatable method for comparing stream conditions, identifying dominant stressors, and highlighting reaches where management or restoration actions may yield the greatest benefit.

Grades produced by the GC-RHAF should be interpreted as relative indicators of stream condition and function, not regulatory determinations or compliance findings. Higher grades generally reflect intact or resilient conditions, while lower grades indicate increasing levels of alteration or impairment and a greater potential need for targeted management or restoration.

Individual variables and metrics may influence prioritization differently depending on the management objective being evaluated (e.g., thermal stress reduction, post-fire recovery, habitat protection, or flow management). Accordingly, the GC-RHAF is intended to be applied by allowing emphasis on variables most relevant to specific planning and prioritization questions.

By grounding grades in clearly defined variables, metrics, and grading thresholds, the GC-RHAF provides context for interpreting stream condition and supports consistent comparison across reaches. Each variable contributes a distinct perspective on stream health, and together they inform reach-level grades used to identify, build, and maintain healthy, resilient streams while guiding prioritization and adaptive management.

This document focuses on the following topics:

- Introduction to Stream Assessment
Variables: what they are, why they matter, and how they interconnect.
- **Metrics and Grading Criteria:** specifics on metrics and grading criteria tied to each variable, so that assessments are transparent, defensible, and meaningful.
- How Stream Reach **Grades** Take Shape: how all these pieces fit into the broader stream assessment workflow, from data collection through scoring.
- How Stream Reaches are **Prioritized** to identify projects.

How to Read and Use This Framework

The GC-RHAF is designed to support comparison, prioritization, and adaptive management across stream reaches. Individual sections describe how each variable is measured and graded, while later sections explain how grades are combined and applied to prioritization. Readers interested in *why a reach scores as it does* should focus on the **variable** sections; readers interested in *how scores inform action* should refer to the **prioritization** methodology.

Key GC-RHAF Terminology

Stream Assessment Variable: A major component of river health that can be measured and assessed. Variables may capture physical, chemical, biological, and/or ecological processes such as flow, sediment, water quality, temperature, riparian condition, geomorphology, and aquatic ecosystems.

Variable Metric: A specific, measurable indicator tied to a variable. Metrics are the data points or calculations that translate field observations and monitoring data into an interpretable score (e.g., “15th percentile dissolved oxygen concentration”, “percentage of years above peak flow thresholds,” or “percent of area burned”).

Grading Criteria: The thresholds or benchmarks used to assign letter grades and numerical scores (or ratings) to metrics and variables. Grading criteria are often based on reference conditions, standards, or management targets. They allow comparisons across stream reaches and over time.

Stream Reach Grade: An A to F letter grade and associated numerical score for each stream reach in the CEA derived from the available variable and associated metric grades for each reach.

Condition Terminology: Terms such as optimal, healthy, and functional are used throughout this document to describe stream condition. These terms are applied consistently within the GC-RHAF grading framework and should be interpreted relative to the defined grade categories rather than as absolute or regulatory designations.

Custom Framework Development

The GC-RHAF was adapted from established methods, informed by best practices and rooted in local knowledge and data in the Learning By Doing Cooperative Effort Area (CEA). As illustrated in Figure 2, to develop the GC-RHAF, the team developed a custom framework built on the Colorado River Health Assessment Framework (CoRHAF) Guidance (CWCB, 2022) in line with applicable elements from other RHAFs developed in Colorado (Friends of the Yampa, 2024; Coalition for Poudre River Watershed, 2024) in conjunction with the Phase I Watershed Assessment variables and results (Lotic, 2024). The GC-RHAF was refined through several iterations and discussions with the Learning By Doing Monitoring and Management Committees.

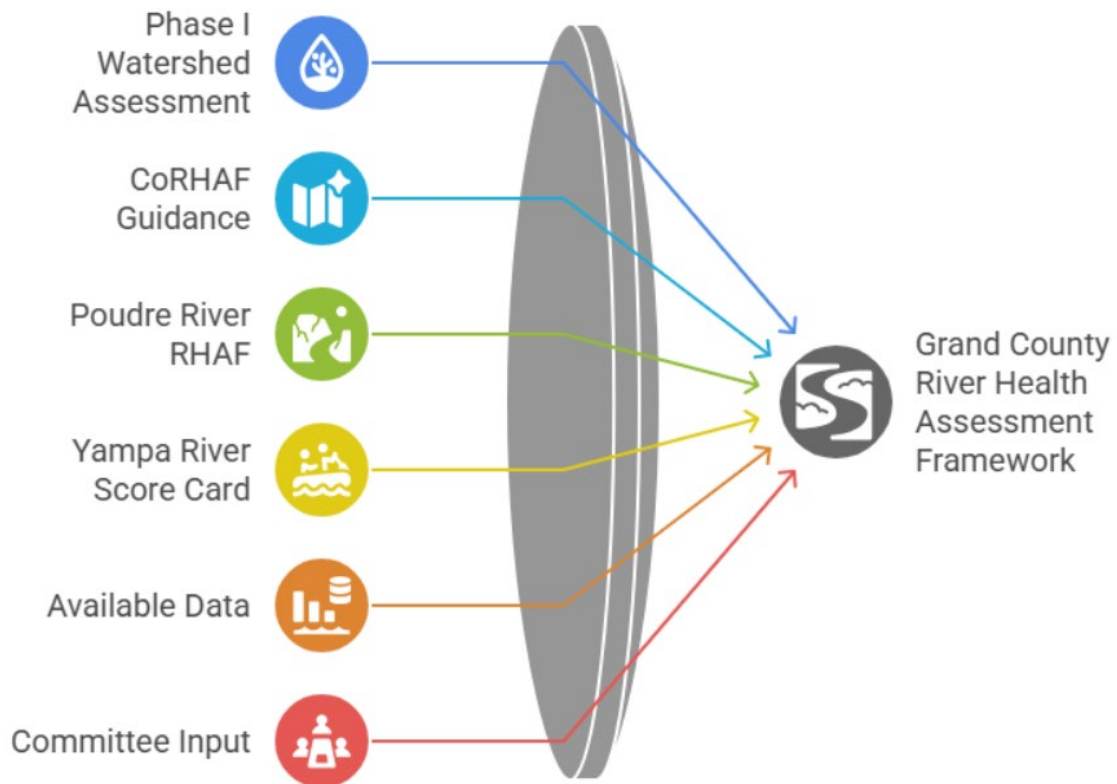


Figure 2. The GC-RHAF integrates established methods, best practices and local knowledge.

GC-RHAF Variables and Metrics

Table 1 presents the GC-RHAF variables and metrics. Appendix A contains a summary of each variable, including why it's important, its associated metrics, and how projects can potentially influence each variable.

Table 1. GC-RHAF Variables and Metrics

Category	Variable	Sub-variable	Metric
Watershed	Flow Regime	Flushing flows	Peak Flows
		Base flows	Winter Base Flows
			Summer Base Flows
	Sediment Regime	Watershed Supply	Land Development Index
			Wildfire Burned Areas
		Local	Local Supply
		Continuity & Transport	Dams
			Diversion Structures
	Water Quality	Nutrients	Total Nitrogen
			Total Phosphorus
		Physical	pH
			Dissolved Oxygen
	Temperature	Temperature	Total Iron
			Chronic (Weekly Average)
Riverscape	Riparian	Riparian	Acute (Daily Max)
			Riparian Condition
			Floodplain Fragmentation
Channel	Geomorphological Conditions	River Dynamics	Floodplain Confinement
			Planform Dynamics
	Aquatic Ecosystems	Habitat	Profile Dynamics
			Microhabitat for Macroinvertebrates
		Macroinvertebrates	Trout Spawning
			Macroinvertebrates
		Fish Communities	Fish

GC-RHAF Grade Descriptions

In several of the GC-RHAF variables, including the individual metrics in water quality, stream temperature, and aquatic ecosystem, the grading scales were refined to better reflect the generally high baseline condition of streams within the CEA. Standard grading thresholds applied without adjustment tended to cluster many reaches into the highest grades, limiting the framework's ability to differentiate relative condition and identify priority areas for protection or improvement.

To address this, grading criteria for select metrics were tightened to provide greater resolution across reaches while remaining grounded in applicable standards, reference conditions, and biological relevance. This approach allows the GC-RHAF to distinguish subtle but meaningful differences in condition among high-quality streams, supporting relative comparison and prioritization within the CEA rather than absolute classification. Table 2 provides a general interpretation for each grade which account for the resolution needed to accurately represent the stream reach conditions.

Table 2. Stream Reach Grade Interpretation

Grade	Condition Description	General Interpretation
A	Optimal (Reference)	Self-sustaining and resilient conditions with minimal alteration; protection-focused management.
B	Highly Functional	Minor stressors may be present, but core physical, chemical, and biological processes remain intact and balanced.
C	Functional	Generally satisfactory condition with moderate alteration; management actions may improve resilience and function.
D	Partially Functional	Noticeable degradation of key processes; targeted restoration or management likely needed.
F	Dysfunctional	Severe impairment with loss of core functions; substantial intervention required to restore condition.

Watershed

Flow Regime



The magnitude of flows in a river over time is a primary driver influencing the dynamics, patterns, and health of the river system. In the GC-RHAF, the flow regime variable has a potential effect on each of the other variables.

Measures of flow regime included for the GC-RHAF metrics pertain to annual peak flushing flows, summer base flows, and winter base flows. Each of these metrics have minimum flow targets identified for selected stream reaches to establish goals for habitat function and health. Although extreme flood flows have the power to significantly alter the physical and biological condition of rivers, the infrequent and unpredictable nature of floods precludes their inclusion as a GC-RHAF metric. Table 3 summarizes the 42 reaches in the CEA and indicates reaches with flow targets established in the 2010 Grand County Stream Management Plan (Tetra Tech, 2010). Table 3 also identifies reaches with flow gages and gage IDs that were the source of data used for the current grading analysis. For reference, a summary table listing all 42 reaches including Reach ID and location descriptions is included in Appendix B.

Table 3: Reach Gage and Flow Target Summary

Field ID	Reach ID	Gage Data	Available Gages or Natural Hydrology (Location ID)	Gages Used (Location ID)	Flow Targets Used for Assessment			Outside CEA Boundary
					Summer Baseflow High Target (cfs)	Winter Baseflow High Target (cfs)	3-day Peak Flushing Target (cfs)	
1	C-AC	X	AC-0.6					
2	C-CH							
3	C-EI	X	EI-0.1, Natural Hydrology					
4	C-NI	X	NI-0.1					
5	C-RE				2.1	1.2	12	
6	C-RF		Natural Hydrology					
7	C-ST							
8	CR1	X	NF-0.1					
9	CR2	X	CR-44.6, 09015000					
10	CR3	X	CR-35.6, CR-35.3, 09019500, CR-31 & CR-38.3	CR-35.6	160	100	200	
11	CR4	X	CR-28.7, CR-23.5, CR-22.1	CR-28.7	400	250	600	
12	CR5	X	CR-14.9	CR-14.9	500	250	800	
13	CR6	X	CR-9.1, 5102124	CR-9.1	500	250	850	
14	F-CB	X	CB-2.7					
15	F-CC							
16	F-EC	X	EC-5.5					
17	F-HC							
18	F-LCB	X	LCB-2.2					
19	F-LVC							
20	F-MC							
21	F-PC							
22	F-RC1	X	9032000 (2017 - 2022: January - March) RC-blwUSGS (2022: October - December - 2024)	09032000 & RC-blwUSGS	10	10	40	
23	F-RC2	X	RC-1.1	RC-1.1	50	30	150	
24	F-STL1	X	STC-5.4	STC-5.4	10	10	70	
25	F-STL2							
26	F-VC1		No Diversions, flows augmented by Vasquez Tunnel					
27	F-VC2	X	WS-FR-014, VC-0	WS-FR-014	8	8	50	
28	F1	X	FR-27.2					
29	F2							
30	F3	X	FR-22.5	FR-22.5	10	10	80	
31	F4				30	30		
32	F5							
33	F6	X	FR-14	FR-14	60	50	200	
34	F7	X	FR-12.4					
35	F8	X	09033300	09033300	100	100		
36	F9				120	100	400	
37	F10	X	FR-WGU, FR-0.1	FR-WGU	120	100	400	
38	W-SWF	X	9035900, Natural Hydrology					
39	WC2	X	WC-WCRD	WC-WCRD	10	10	50	
40	WF-1	X	09035500, 09035700, 09036000					
41	WF-2	X	09037500, WF-5.5					
42	WF-3	X	WF-2, WF-WFRD	WF-2	140	100	200	
	CR7				1000	600	2500	X
	MC2				90	60	350	X
	BR				300	300	1150	X
	TR				13	10	130	X

Notes:

1. Reach F-VC1: No dams or diversions above or within this reach. Flows augmented by Vasquez Tunnel.
2. Reach F8: Gage is just upstream of start of reach (in Reach F7) with no diversions between that gage and the end of the reach. This reach is the Fraser River canyon.

Flow Regime Metrics and Grading Criteria

Annual 3-day Peak Flows

Annual peak flows in the rivers of the CEA are typically created by snowmelt and often reach maximum levels in the June-July timeframe. Annual peak flows are important to flush accumulated fine sediments and algae from stream substrate to keep spaces between coarse bed material (i.e., gravel and rocks) open and oxygenated and able to support macroinvertebrates, spawning beds, and sculpin.

Annual peak flows are influenced by climatic conditions such as the amount of snowpack and the melt-off rate, early season precipitation, physical conditions affecting runoff, infiltration and exfiltration, and human activities such as water diversions and reservoir operations.

As shown in Table 3, minimum flow targets have been established for 15 reaches in the CEA. The Phase 1 Watershed Assessment recommended tracking the annual maximum 3-day rolling mean flow and comparing against the flushing flow target, reporting the percent of years the target was achieved with a goal of exceeding the flushing flow target at least once every two years.

The metric rating framework proposed for annual 3-day peak flows is shown in Table 4. Grading is applied to 5 stream reaches that experience natural flows upstream of a diversion and 13 stream reaches with an identified flow target and flow data for the recent timeframe of 2017 through 2024 used in the initial grading.

Table 4. 3-Day Peak Flow Metric Rating Framework

Grade	Scale	Description	Explanation
A	90-100	Optimally functional	Reach experiences natural flows upstream of a diversion or 3-day peak flow achieves flushing flow target once every two years in at least 90% of years or the drainage areas is unaltered by dams or diversion structures
B	80-89	Highly functional	3-day peak flow achieves flushing flow target once every two years in at least 80% of years
C	70-79	Mostly Functional	3-day peak flow achieves flushing flow target once every two years in at least 70% of years
D	60-69	Partly Functional	3-day peak flow achieves flushing flow target once every two years in at least 60% of years
F	50-59	Dysfunctional	3-day peak flow does not achieve flushing flow target once every two years in at least 60% of years
N/A	N/A	Not Graded	Not Graded

Summer Base Flows

Periods of low baseflows also affect the health of river systems. In the summer, after runoff from snowmelt has largely receded, minimum base flow targets are identified to establish goals for maintaining the health of aquatic biota. Like annual peak flows, baseflows are influenced by climate conditions, physical conditions, and diversions and reservoir operations.

The Phase 1 Watershed Assessment recommended tracking summer (April through September) daily mean flows and comparing against the minimum summer flow target, reporting the percent of summer days the target was achieved. To be more conservative in the grading criteria, the upper baseflow target was selected for grading as it maximizes habitat availability and quality for target species. The metric rating framework proposed for summer base flows is in Table 5. Five stream reaches that experience natural flows upstream of a diversion and 14 stream reaches with flow data and defined flow targets for the timeframe of 2017 through 2024 were graded according to these criteria.

Table 5. Summer Base Flows Metric Rating Framework

Grade	Scale	Description	Explanation
A	90-100	Optimally functional	Reach experiences natural flows upstream of a diversion or upper minimum flow target is achieved at least 80% of the days April through September or the drainage areas is unaltered by dams or diversion structures
B	80-89	Highly functional	Upper minimum flow target is achieved at least 60% of the days April through September
C	70-79	Mostly Functional	Upper minimum flow target is achieved at least 40% of the days April through September
D	60-69	Partly Functional	Upper minimum flow target is achieved at least 20% of the days April through September
F	50-59	Dysfunctional	Upper minimum flow target is not achieved at least 20% of the days April through September
N/A	N/A	Not Graded	Not Graded

Winter Base Flows

Low winter base flows also affect the health of river systems so winter minimum base flow targets have been identified to establish goals for maintaining the health of aquatic biota during this time. Like summer base flows, winter baseflows are also influenced by climate conditions, physical conditions, and by diversions and reservoir operations.

The Phase 1 Watershed Assessment recommended tracking winter (October through March) daily mean flows, comparing against the minimum winter flow target, and reporting the percent of winter days the target was achieved. To be more conservative in the grading criteria, the upper baseflow target was selected for grading as it reflects expected needs for trout egg incubation and spawning habitat quality. The metric rating framework proposed for winter base flows is shown in Table 6. Five stream reaches that experience natural flows upstream of a diversion and 10 stream reaches with an identified flow target and sufficient flow data for 2017 through 2024 were graded according to these criteria. Due to challenges with monitoring baseflows in winter conditions, four of the gaged reaches do not have baseflow data for the majority of the winter period and therefore are not graded.

Table 6. Winter Base Flows Metric Rating Framework

Grade	Scale	Description	Explanation
A	90-100	Optimally functional	Reach experiences natural flows upstream of a diversion or upper minimum flow target is achieved at least 80% of the days October through March or the drainage areas is unaltered by dams or diversion structures
B	80-89	Highly functional	Upper minimum flow target is achieved at least 60% of the days October through March
C	70-79	Mostly Functional	Upper minimum flow target is achieved at least 40% of the days October through March
D	60-69	Partly Functional	Upper minimum flow target is achieved at least 20% of the days October through March
F	50-59	Dysfunctional	Upper minimum flow target is not achieved at least 20% of the days October through March
N/A	N/A	Not Graded	Not Graded

Flow Regime Metrics Data Summary

Metric Weighting:

Peak Flow	Summer Base Flow	Winter Base Flow
17	66	17

Weighting was applied to the flow regime metrics to reflect the ecological significance, data availability, and management relevance of each flow component. Summer base flows are given the highest weight to better represent the impacts of lower flow conditions on stream health. Peak flushing flows and winter base flows are both weighted equally at a

lower level. While important, they are less representative of the flow regime conditions critical for trout survival. This approach also reflects limitations in winter baseflow data available due to cold weather monitoring challenges as well as the influence of dam and reservoir operations on the peak flushing flows.

Sources:

Flow data were obtained from the Grand County Water Information Network (GCWIN) database. This database compiles and standardizes continuous flow information from multiple sources, including the Colorado Water Conservation Board (CWCB) / Colorado Division of Water Resources (DWR), United States Geological Survey (USGS) and Northern Water.

Timeframe: 1/1/2017 – 12/31/2024

Metric Limitations & Data Gaps:

Of the 21 reaches with flow targets established in the 2010 Grand County Stream Management Plan, four reaches are located downstream of the CEA and several other reaches do not have adequate flow data. This leaves 13 reaches with established flushing flow targets and sufficient data (14 for summer baseflows and 10 for winter baseflows), plus five reaches that experience natural flows upstream of diversions, for grading.

For reach F8, Fraser River - Canyon below Strawberry Road downstream to the Strawberry Creek Confluence (at Granby Ranch Golf Course), flow targets have been developed for both summer and winter base flows, but targets have not been developed for flushing flows. Developing a flushing flow target for this reach would help fill in the flushing flow data gap for this reach. Although no flow gage is located within Reach F8, but there is a gage near the upstream end of the reach within Reach F7, Fraser River - Ranch Creek confluence downstream to Canyon below Strawberry Road. Flow data from Reach F7 was used because of the proximity to the upper end of the reach with minimal additional contributing drainage area and no diversions between the flow gage and the start of Reach F8, this is the Fraser River canyon. Installing a flow gage within reach F8 would allow for a more accurate comparison of the flows to the targets. Also, developing flow targets for Reach F7 would allow for another flow target comparison to the gage in this reach.

As mentioned, due to challenges with monitoring baseflows in winter conditions, fewer reaches have baseflow data for most of the winter period.

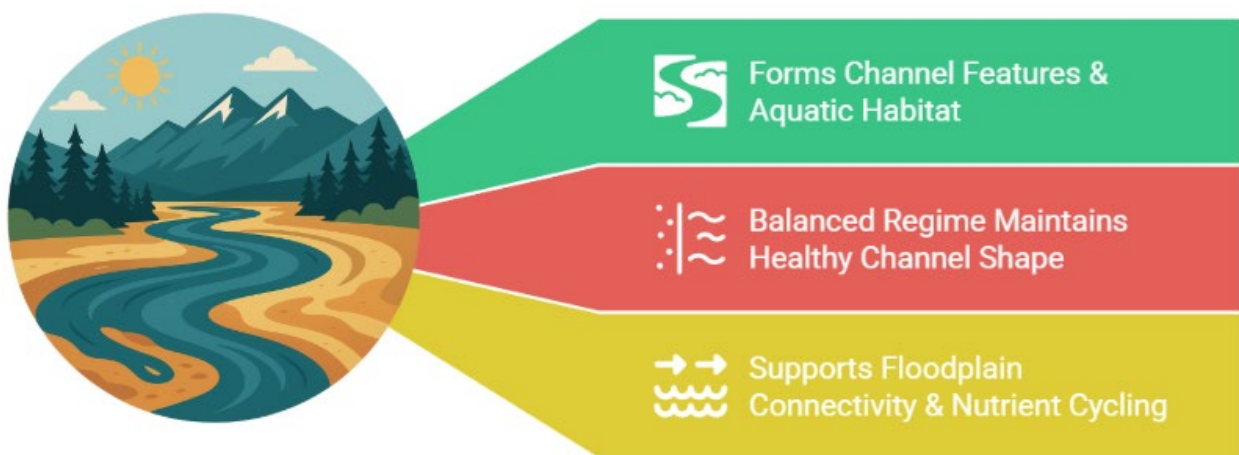
Assessment Recommendations

Given that that less than half of the 42 stream reaches in the CEA are able to be graded due to the limitations described above, efforts are recommended to establish flow targets for

additional reaches (approximately 13) where flow data exists and consider any reaches where additional monitoring would be beneficial to assess flow against established targets.

Since flow data is collected annually and grading is based on a quantitative analysis, flow regime assessment grades could be updated every year, if desired. If operational changes or collected data indicate systematic trends toward increased or decreased flows, a new period of analysis could be compared against previous conditions.

Sediment Regime



A river's sediment regime, including watershed sediment supply, local sediment inputs, and sediment continuity and transport, is a fundamental component of river health. Sediment shapes pools, riffles, and bars which are key habitats for aquatic life. Excess fine sediment can smother habitats and carry pollutants. A balanced sediment regime prevents excessive erosion or deposition, and sediment transport supports floodplain connectivity and nutrient cycling.

Sediment Regime Metrics and Grading Criteria

Watershed Supply: Land Development Index

Watershed supply is the amount and type of sediment delivered from the broader landscape into the river system influenced by factors like geology, land use, vegetation cover, and climate. A balanced sediment supply supports the formation of natural river features such as bars, banks, and floodplains. Too much sediment can lead to aggradation (buildup), while too little can cause erosion in the form of incision (downcutting) or lateral bank migration, all of which disrupt habitat and channel stability.

The land development index (LDI) is a good indicator of anthropogenic impacts within the watershed and is used to grade the watershed supply metric. The LDI index values were acquired from the National Land Cover Dataset (NLCD) that were modified to accurately account for agricultural land. The LDI was then graded according to the grading scale in Table 7 that was adapted from Brown, M., & Vivas, M. (2005). Grading scales for A and B scores were adjusted to match the range of results from the data collected with the watershed assessment. Grading scales for C through F scores more closely align with those provided by Brown, M., & Vivas, M. (2005).

Table 7. Watershed Supply: Land Development Index Metric Rating Framework

Grade	Scale	Description	Explanation
A	95	Optimally functional	No to minimal watershed development - natural (LDI <1.2)
B	85	Highly functional	Low watershed development - light agricultural or residential (1.2 < LDI < 1.83)
C	75	Mostly Functional	Moderate watershed development - heavy agricultural (1.83 < LDI < 6.0)
D	65	Partly Functional	Moderate to high watershed development - heavy residential (6.0 < LDI < 8.0)
F	55	Dysfunctional	Highly developed and- urbanized watershed (LDI > 8.0)
N/A	N/A	Not Graded	Not Graded

Watershed Supply: Wildfire Burned Areas

Fires significantly alter watershed sediment dynamics by removing vegetation and increasing erosion potential. The loss of vegetative cover, change in soil properties, and increased runoff in burned areas result in significant increase in sediment transport across the landscape and into streams. Elevated sediment loads can impact fish habitats, degrade water quality with associated nutrient transport, and alter natural sediment regimes.

An assessment on the burned areas within the contributing watershed of each stream reach was performed to quantify the percentage of the watershed affected by wildfire. Increased percentages of burned watershed area indicate a higher potential for increased sediment supply from the watershed impacting the river health and potentially requiring remediation. High intensity burn areas often destroy organic matter, microbial communities, and soil structure leading to higher sediment supply potential and longer recovery times ranging from 5 to 10 years. Lower intensity burn areas may only scorch

surface vegetation leaving soil structure and microbes intact leading to lower sediment supply potential and shorter recovery times ranging from 1 to 3 years. Additionally, the timing of wildfire will also play a role in the potential for sediment supply. Depending on the burn intensity, the potential for increased sediment supply will decrease to a natural state over a period of 1 to 10 years. Since the potential for increased sediment supply is continually changing and decreasing over time, it is difficult to represent with a static assessment and grade. The significant level of effort required to represent burn intensity, timing of wildfires along with changing conditions limited the ability to accurately represent more detail, so the percentage of burned area was the primary focus.

To complete the analysis of the wildfire burned areas, the Burned Areas Boundaries dataset from the USDA Forest Service was obtained and then the East Troublesome Fire (2020) and Williams Fork Fire (2020) were determined to be the most recent and relevant fires within the drainage basins. The burned areas boundaries for the East Troublesome and Williams Fork fires were then overlaid onto the reach drainage basins to develop sub-burn areas that are tributary to each of the 42 river reaches, see Figure 1. For basins without delineations, topography was used to determine the sub-boundary of the burned area draining to these reaches. Grading for watershed supply burned areas was based on the percentage of the drainage area burned for each reach. Then the percentage of each drainage area that was unburned was used to determine a grade for each reach according to the metric rating framework in Table 7.

Table 8. Watershed Supply: Wildfire Burned Areas Metric Rating Framework

Grade	Scale	Description	Explanation
A	90-100	Optimally functional	>90% Watershed Area Unburned
B	80-89	Highly functional	80% to 89% Watershed Area Unburned
C	70-79	Mostly Functional	70% to 79% Watershed Area Unburned
D	60-69	Partly Functional	60% to 69% Watershed Area Unburned
F	50-59	Dysfunctional	<60% Watershed Area Unburned
N/A	N/A	Not Graded	Not Graded

Local Supply

Local sediment supply represents sediment contribution from nearby sources such as channel incision and bank erosion. Local sediment inputs help maintain habitat complexity and channel form. For example, gravel from a nearby slope might replenish spawning beds for fish. If local sources are cut off (e.g., by dams or bank armoring), the river may become sediment-starved and degraded, leading to channel incision, bank

erosion, loss of natural planform, sediment imbalance, and shifts in macroinvertebrate and fish communities. If a river reach has excessive areas with bank erosion, channel incision, or heavy sediment deposition, this can be an indicator that the stream reach sediment regime is not healthy.

To collect high-level local sediment supply data, a desktop level assessment assessed the local supply by evaluating areas of sediment deposition and lateral bank migration. This is a high-level qualitative method to assess the health of the local sediment supply because these indicators are generally visible in aerial imagery. Additionally, identifying reaches with heavy sediment deposition or lateral bank migration at this high-level can aid in identification of future project locations within the assessment reach.

The local supply assessment evaluated each reach to find areas that appear to be impaired with sediment deposition and lateral bank migration. This evaluation used qualitative judgment paired with the most recent aerial imagery compared to historical aerial imagery.

Lengths of the segments identified as impaired by sediment deposition, lateral bank migration, or limited visibility during the analysis were summed by reach, then divided by the reach length to calculate the percentage of impaired length for each reach, excluding the segments with limited visibility. Grades were then applied to each reach using the criteria listed in Table 9.

Table 9. Local Supply Metric Rating Framework

Grade	Scale	Description	Explanation
A	90-100	Optimally functional	<2% Reach Length Impacted by Sediment Deposition, Bank Erosion, or Lateral Bank Migration
B	80-89	Highly functional	3% to 5% Reach Length Impacted by Sediment Deposition, Bank Erosion, or Lateral Bank Migration
C	70-79	Mostly Functional	6% to 10% Reach Length Impacted by Sediment Deposition, Bank Erosion, or Lateral Bank Migration
D	60-69	Partly Functional	11% to 20% Reach Length Impacted by Sediment Deposition, Bank Erosion, or Lateral Bank Migration
F	50-59	Dysfunctional	>20% Reach Length Impacted by Sediment Deposition, Bank Erosion, or Lateral Bank Migration
N/A	N/A	Not Graded	Not Graded

Continuity and Transport:

Sediment continuity and transport is the river's ability to move sediment downstream in a continuous and dynamic process. Healthy rivers transport sediment by maintaining equilibrium by balancing erosion and deposition. Disruptions (like dams, diversions, culverts, or channelization) can cause sediment to accumulate upstream and erode downstream, leading to habitat loss, infrastructure damage, and altered flow patterns.

Assessment of continuity and transport considered impacts from both tributary reach drainage area impacted by dams and the number of diversion structures within the tributary reach drainage area. A single grade was assigned to each reach using the lower of the two grades, either the dam grade or the diversion structure grade. This grading method prevents any dilution of the grade in the case where one metric is an A grade, like no dam impacts, and the other metric is an F grade, like heavy diversion structure impacts. The following sections provide additional details on the impacts that both dams and diversion structures have on the sediment continuity and transport as well as the methods and criteria used for grading each metric.

Continuity and Transport: Dams

Dams within or upstream of the tributary drainage area to each reach affect the natural flow regime in the river, impacting the ability for the river to maintain a healthy balance of sediment continuity and transport. For this assessment, the dam height or impoundment area was not considered, only that a dam is present and has the ability to impact the natural flow regime. The percentage of tributary drainage area to each reach impacted by dams was used to grade the continuity and transport metric. To calculate this, the tributary drainage area impacted by the dams was delineated for the entire reach, including any tributary drainage areas upstream of the reach. Where multiple dams were located upstream of the reach, the impacted areas were combined to calculate a cumulative impacted drainage area. The cumulative impacted drainage area was then divided by the total tributary drainage area of the reach (including any upstream tributary drainage areas) to get the percentage of the reach tributary drainage area impacted by dams. Grading scales were applied to these percentages, as shown in Table 10, with reaches impacted by 10% or less of the tributary drainage area receiving an A, and reaches with greater than 41% impacted receiving an F.

Table 10. Continuity and Transport: Dams Metric Rating Framework

Grade	Scale	Description	Explanation
A	90-100	Optimally functional	<10% Tributary Reach Watershed Area Cumulatively Impacted by Dams
B	80-89	Highly functional	11% to 20% Tributary Reach Watershed Area Cumulatively Impacted by Dams
C	70-79	Mostly Functional	21% to 30% Tributary Reach Watershed Area Cumulatively Impacted by Dams
D	60-69	Partly Functional	31% to 40% Tributary Reach Watershed Area Cumulatively Impacted by Dams
F	50-59	Dysfunctional	>41% Tributary Reach Watershed Area Cumulatively Impacted by Dams
N/A	N/A	Not Graded	Not Graded

Continuity and Transport: Diversion Structures

Diversion structures redirect flow, reducing the natural flow regime of a river which disrupts sediment continuity and transport. To evaluate this effect, the number of diversion structures within the drainage area of each reach were counted and divided by the reach drainage area resulting in a value representing the number of ditch structures per square mile. This value was then compared to the grading scale shown in Table 11 and a corresponding grade was assigned to each reach.

Table 11. Continuity and Transport: Irrigation Structures Metric Rating Framework

Grade	Scale	Description	Explanation
A	90-100	Optimally functional	0 - 0.2 structures per square mile
B	80-89	Highly functional	0.2 - 0.4 structures per square mile
C	70-79	Functional	0.4 - 0.6 structures per square mile
D	60-69	Partly Functional	0.6 - 0.8 structures per square mile
F	50-59	Dysfunctional	Over 0.8 structures per square mile
N/A	N/A	Not Graded	Not Graded

Sediment Regime Metrics Data Summary

Metric Weighting:

Watershed Supply		Local Supply	Continuity & Transport	
Land Development Index	Wildfire Burned Areas	Local Supply	Dams	Diversion Structures
17	17	33	Minimum metric value	
			33	

For the continuity and transport component of the sediment regime, the overall metric grade was assigned using the minimum score between the dams and diversion structures metrics. This approach was used because both dams and diversions can independently disrupt sediment transport, and the presence of either feature can substantially constrain sediment continuity within a reach.

Using the minimum score prevents sediment impacts from being masked when one metric receives a high grade while the other indicates significant alteration. In this way, the continuity and transport metric reflects the most limiting influence on sediment movement, rather than an average condition that may overstate functional connectivity.

This metric is weighted heavily because of the significant impact to the sediment regime, including the substantial sediment supply reductions caused by dams and diversions. The local supply metric, which reflects observed deposition and bank erosion, was given equally high weighting based on the direct indication of an imbalanced sediment regime. Watershed supply metrics, land development index and wildfire burn areas have been weighted lower because, while still important, have less of a direct impact on sediment supply to the river.

Source:

Data for the Land Development Index metric was collected as part of a reach-scale valley bottom condition assessment as part of the 2024 Comprehensive Watershed Assessment report by Lotic Hydrological (Lotic, 2024).

Wildfire burn areas were quantified using the Burned Areas Boundaries dataset from the USDA Forest Service. This dataset includes all fires greater than 1,000 acres.

For the local supply sediment analysis, the 2019 and 2022 Grand County EagleView Mosaic Imagery were used to grade the reaches, while the ArcGIS Imagery Hybrid Basemap was used to supplement the areas not included in the Grand County Aerial Imagery.

Dam and irrigation structure datasets were provided by Learning By Doing as part of the stream management plan update geodatabase.

Timeframe:

The Grand County EagleView imagery used was taken from 6/6/19 through 9/13/19 and 5/18/22 through 7/5/22. The ArcGIS Imagery Hybrid Basemap used the most up to date version as of 9/26/25.

Metric Limitations & Data Gaps:

Timing of wildfires plays a role in the potential for sediment supply and metric rating. Depending on the burn intensity, the potential for increased sediment supply will decrease to a natural state over a period of 1 to 10 years. Since this potential for increased sediment supply is continually changing and decreasing over time, it is difficult to represent with a static grade. For this assessment, no credit was given for the timing of the wildfire except that only wildfires that have occurred within the last 10-years have been considered as these fires are assumed to still be contributing to an increased sediment supply from the watershed. Future grading assessments should consider removing these fires from the GCRHAF grades and incorporating any new wildfires that have occurred after this assessment. Also, the effort to assess timing and intensity impacts should be weighed against the benefit for the reach level ratings, it may be better served to qualitatively consider this data with future reach prioritizations or develop a more detailed approach for project level prioritizations and improvements.

The assessment of local sediment supply was limited to aerial imagery which is helpful to identify areas that appear unstable due to excessive deposition or from bank migration and erosion, however, these areas are not always visible from aerial imagery and the severity of these features can be difficult to assess through aerial imagery only.

The assessment of dams was limited to only the presence of a dam and the tributary reach drainage area to the dam assuming that the dam could impact the natural flow regime. This metric could be further developed in future assessments by including the height of the dam and impoundment area, which could help to provide a magnitude of impact.

Assessment Recommendations

Reassessment of the wildfire burned areas and local sediment supply metrics every 5 to 7 years or after a significant runoff or storm event could be beneficial. As the land heals after wildfires, the contribution of sediment will be reduced which should be reflected in the sediment regime grades. Also, sediment deposition and bank erosion are dynamic processes and will continue to change over time. Reassessing this metric at regular

intervals will help to identify reaches that are actively changing, which can be a sign of an unhealthy sediment regime.

Strategic site visits to areas identified with sediment deposition and bank erosion will increase the quality of data used to grade the local sediment supply metric. Site visits to field verify the conditions of these areas are also recommended prior to selecting reaches or areas within a reach for stream restoration. Additionally, consultation on reach conditions with local experts is also recommended and should be used to truth assessments that may be limited by desktop evaluation.

Water Quality

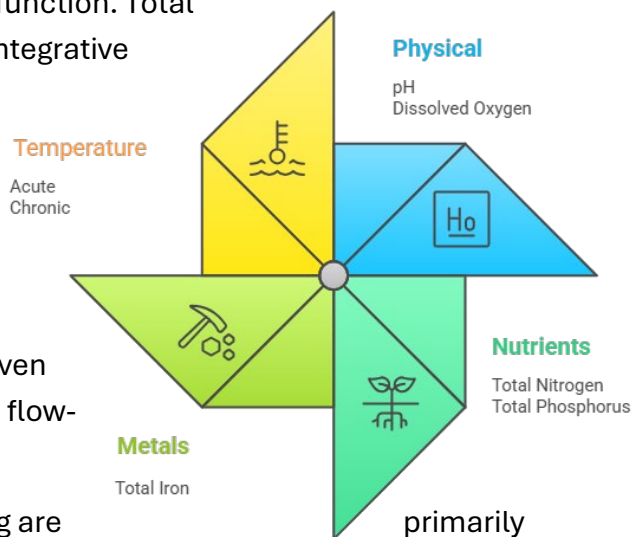


Water quality is a measure of the chemical, physical, and biological characteristics of water, and it reflects how suitable a stream is for supporting aquatic life, recreation, and human use. It is a critical component of a river health assessment framework because it directly affects the health of aquatic ecosystems, and the benefits streams provide to communities. Good water quality supports diverse fish and wildlife populations, maintains safe conditions for recreation, and ensures reliable water for agriculture and other uses. When water quality declines due to pollution, runoff, or habitat disruption, it can lead to ecosystem damage, reduced biodiversity, and increased risks to public health. Including water quality as a key parameter in the GC-RHAF allows for early detection of issues, supports science-based decision-making, and helps protect both environmental and community interests over the long term.

The GC-RHAF water quality grading assessment focuses on the following key parameters:

- Physical: pH and Dissolved Oxygen
- Nutrient: Total Nitrogen and Total Phosphorus
- Metals: Total Iron
- Temperature: Acute and Chronic (included as a separate variable below)

These metrics were selected because they represent core physical and chemical conditions that are widely monitored, ecologically relevant, and directly linked to aquatic life support in cold-water streams. pH and dissolved oxygen reflect fundamental physical water quality conditions necessary for biological function. Total nitrogen and total phosphorus were selected as integrative indicators of nutrient enrichment and potential eutrophication, capturing both point and nonpoint source influences. Total iron was included as a representative metal due to its prevalence in regional monitoring data and its relevance to water quality and habitat condition. Temperature metrics are addressed separately given their strong influence on aquatic ecosystems and flow-related processes.



The water quality assessment metrics and grading are centered on water quality as it relates to supporting aquatic life as described in Table 12. Temperature is called out as a separate variable from the other water quality parameters in this assessment due to its importance in the CEA.

Table 12. Water Quality Metric Rating Framework

Grade	Functionality Description	Definition
A	Optimally functional	Water quality parameters consistently support a fully functioning aquatic ecosystem, with no indicators of anthropogenic stress.
B	Highly functional	Water quality generally remains within regulatory thresholds. Trace pollutants may be detectable, but do not produce measurable ecological impacts.
C	Mostly Functional	Water quality exhibits moderate degradation with observable impacts on aquatic biota. Conditions remain within compliance but trend toward regulatory concern.
D	Partly Functional	Significant degradation of water quality with clear, adverse effects on aquatic communities. Parameters likely exceed regulatory thresholds.
F	Dysfunctional	Water quality is critically degraded and fails to support designated aquatic life uses. Parameters exceed regulatory thresholds.

Water Quality Metrics and Grading Criteria

pH

pH influences the solubility and biological availability of nutrients and metals in freshwater systems, directly affecting aquatic life and chemical processes. High or low pH values can impair physiological functions, reduce reproductive success of fish, and increase the toxicity of certain contaminants, such as ammonia and heavy metals. Measuring pH provides insight into buffering capacity, biogeochemical cycling, and potential anthropogenic impacts.

Dissolved Oxygen

Dissolved oxygen (DO) is a fundamental parameter in assessing the health of freshwater stream ecosystems. It supports aerobic respiration in aquatic organisms, including fish, macroinvertebrates, and aerobic microbes. Declines in DO concentrations are commonly associated with increased organic loading, eutrophication, elevated water temperatures, or reduced flow conditions. These factors can lead to hypoxic or anoxic conditions, resulting in fish kills, shifts in community composition, and overall loss of biodiversity. DO is also sensitive to diurnal and seasonal fluctuations, making it a valuable metric for detecting both acute and chronic stressors in aquatic environments. Measuring DO is

critical for evaluating stream function, identifying pollution sources, and informing watershed management.

The water quality metrics for physical parameters in this assessment are presented in Table 13 and are based on Regulation No. 33 from the Colorado Department of Public Health and Environment’s (CDPHE) Water Quality Control Commission (WQCC) (CDPHE WQCC, 2024a). Using CDPHE standards as benchmarks in the GC-RHAF ensures that metrics are tied to scientifically established thresholds with regulatory standing that have already undergone technical review and public input. The water quality standard value for cold streams was set as the threshold between the C and D grades. The DO spawning criteria was used for the threshold between B and C values. The minimum pH in the high or low range was used for the grade.

Table 13. Physical Parameters (DO and pH) Metric Rating Framework

Grade	Scale	Description	DO (ug/L) 15 th Percentile	pH Low Range 15 th Percentile	pH High Range 85 th Percentile
A	90-100	Optimally functional	>8	7.3-8.2	
B	80-90	Highly functional	7-8	6.9-7.3	8.2-8.6
C	70-80	Mostly Functional	6-7	6.5-6.9	8.6-9
D	60-70	Partly Functional	5-6	5.5-6.5	9-10
F	50-60	Dysfunctional	<5	<5.5	>10
N/A	N/A	Not Graded			

Nutrients

Nutrients, primarily nitrogen and phosphorus, are essential for aquatic plant and algal growth, but excessive concentrations can disrupt stream ecosystem balance. Nutrient levels that are too high can result in eutrophication, characterized by algal blooms, decreased dissolved oxygen, and loss of aquatic biodiversity. Measuring both total nitrogen (TN) and total phosphorus (TP) provides a comprehensive understanding of nutrient loading, supports the identification of pollution sources, and informs management strategies aimed at protecting water quality and ecological integrity.

TP encompasses all forms of phosphorus in a water sample, including both dissolved and particulate fractions and is a key driver of eutrophication in freshwater streams, where even small increases can lead to excessive algal growth and subsequent oxygen depletion. Common sources of TP include agricultural runoff, wastewater effluent, and erosion of

phosphorus-rich soils. Because TP reflects the cumulative nutrient load rather than just immediately bioavailable forms, it serves as a critical indicator for long-term nutrient enrichment and trophic status. Measuring TP is important for evaluating watershed nutrient dynamics and implementing effective load reduction strategies.

Total nitrogen (TN) includes all nitrogenous compounds in water, organic nitrogen, ammonia, nitrite and nitrate, providing a comprehensive measure of nitrogen pollution. Elevated TN levels are typically associated with agricultural inputs, urban runoff, wastewater discharges, and atmospheric deposition. High TN concentrations can lead to eutrophication, altered food web dynamics, and oxygen stress. TN is also important for tracking long-term nutrient trends and supporting integrated nutrient management and aquatic ecosystem protection.

The nutrient metric rating framework is presented in Table 14. Nutrient criteria are based on interim values in Regulation No. 31 for cold water streams (CDPHE WQCC, 2024b). Unimpacted streams in the CEA which have nutrient concentrations below the detection limit represent an A grade. The highest method detection limit for the data was set as the threshold between A and B. Half of the standard value was set as the threshold between B and C. The water quality standard value for cold streams was set as the threshold between the C and D grades. The criteria for warm streams were used as the D to F threshold.

Table 14. Nutrients (TN and TP) Metric Rating Framework

Grade	Scale	Description	Median Total Nitrogen (ug/L)	Median Total Phosphorus (ug/L)
A	90-100	Optimally functional	<220	<50
B	80-90	Highly functional	220-625	50-55
C	70-80	Mostly Functional	625-1250	55-110
D	60-70	Partly Functional	1250-2010	110-170
F	50-60	Dysfunctional	>2010	>170
N/A	N/A	Not Graded		

Metals

Metals such as iron, copper, lead, zinc, and mercury can enter stream systems through runoff, mining activities, and atmospheric deposition. While some metals are naturally occurring and essential in trace amounts, elevated concentrations can be toxic to aquatic life, impair biological functions, and accumulate in sediments and organisms. Metal toxicity is influenced by water chemistry, including pH, hardness, and dissolved organic matter.

Total iron, encompassing both dissolved and particulate forms, is a useful metal indicator for assessing stream water quality. Along with signaling potential pollution, iron is often mobilized in its dissolved ferrous form and can precipitate into particulate iron under oxygen-rich conditions. High concentrations of total iron may also indicate changes in redox conditions, which can influence the availability of other contaminants. Unlike many of the other metals in the CEA, iron is often present above detection limits, thus it was selected as the metal indicator metric for the GC-RHAF.

The iron metric rating framework is presented in Table 15. The water quality metrics for total recoverable iron are also based on the aquatic life-focused Regulation 33 (CDPHE WQCC, 2024a), which sets classifications and numeric standards for the Upper Colorado River Basin. The water quality standard value was set as the threshold between the C and D grades. The highest method detection limit values for the data was set as the threshold between A and B. Half of the standard value was set as the threshold between B and C.

Table 15. Iron Metric Rating Framework

Grade	Scale	Description	Median Total Recoverable Iron (ug/L)
A	90-100	Optimally functional	<100
B	80-90	Highly functional	100-500
C	70-80	Mostly Functional	500-1000
D	60-70	Partly Functional	1000-2000
F	50-60	Dysfunctional	>2000
N/A	N/A	Not Graded	No Data

Water Quality Metrics Data Summary

Metric Weighting:

Nutrients		Metals	Physical	
Total Nitrogen	Total Phosphorus	Iron	pH	Dissolved Oxygen
20	20	20	20	20

Source: Water quality data was obtained from the GCWIN database. This database compiles and standardizes water quality information from multiple sources, including Northern Water, Denver Water, USGS, LBD and Colorado Data Sharing Network (CDSN) contributors.

Timeframe: 1/1/2017 through 12/31/2024

Metric Limitations & Data Gaps:

The opportunity to leverage CDPHE aquatic life numeric standards provides consistent, science-based benchmarks for the GC-RHAF. The nutrient standards are still in development and may be updated when finalized (anticipated in 2033).

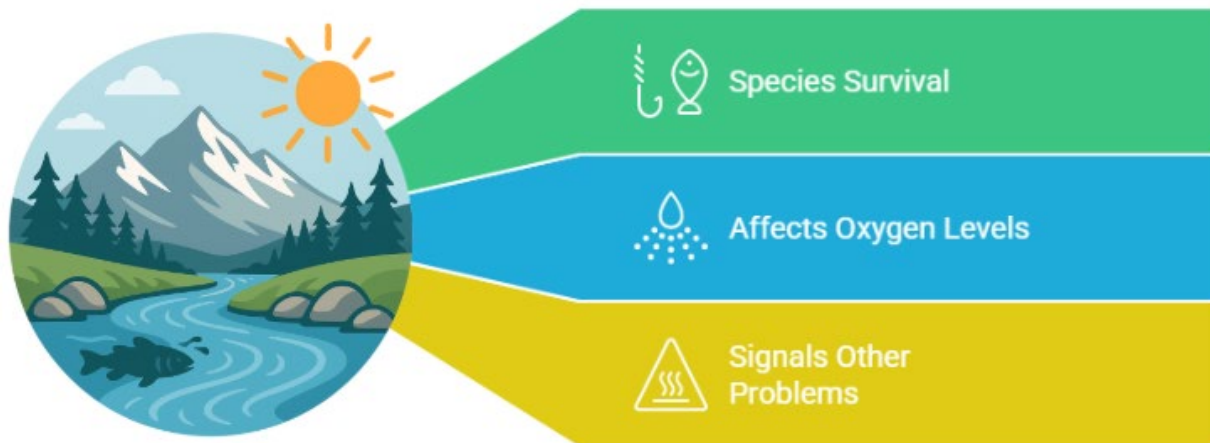
Robust water quality data is available for most of the stream reaches in the CEA, except for some portions of the lower Fraser River (e.g., from the Town of Fraser at Meadow Ridge Road downstream) and its tributaries, and the Colorado River downstream of the Williams Fork confluence.

Assessment Recommendations

Water quality data is collected and compiled into the GCWIN database on an ongoing basis, providing the opportunity to update grades on a rolling basis. Future assessments should include the previous eight years to align with the original GC-RHAF.

Additional water quality monitoring could be considered to fill data gaps, focusing on reaches that are identified as priorities and/or do not have corresponding temperature and/or aquatic ecosystem grades. Due to the generally high water quality within the CEA, concentrations for many water quality parameters are frequently reported below laboratory detection limits. The treatment of non-detect values has implications for summary statistics (e.g., medians or means) and, ultimately, for metric scoring and reach grades. As detection limits may vary by laboratory, analytical method, or data provider, future analyses should explicitly document how non-detects are handled and evaluate the sensitivity of results to detection limit changes. This approach helps ensure that grades reflect relative water quality conditions rather than artifacts of analytical resolution. Where non-detects are prevalent, grades should be interpreted in the context of detection limits and data resolution, particularly when differences among reaches are small.

Stream Temperature



Stream temperature is a critical element of stream health, affecting aquatic life functions, habitat suitability, and overall water quality. Many fish and insects that live in CEA rivers, especially cold-water species like trout, have a narrow temperature range to support optimal growth and reproduction. Elevated temperatures can increase metabolic stress, reduce dissolved oxygen availability, and limit habitat availability during low-flow periods. Warmer temperatures can also affect how pollutants behave in the water. Factors like reduced shade from streamside vegetation and shallow water depths can raise stream temperatures. Evaluating water temperature helps identify changes in stream conditions and protect aquatic habitats in the face of land use changes, drought, and climate impacts.

This variable informs prioritization by identifying reaches where thermal conditions may constrain aquatic life or where protection and mitigation actions could provide benefit.

Temperature Metrics & Grading Criteria

Regulation No. 33 (CDPHE WQCC, 2024a) establishes temperature standards to protect aquatic life by limiting both acute and chronic thermal exposures. Chronic standards protect fish from conditions that might reduce their growth and reproduction. Acute standards protect fish from temperatures that could result in fatality. Acute standards are assessed using a daily maximum (DM) two-hour rolling average over 24 hours, while chronic standards utilize a maximum weekly average temperature (MWAT) based on a seven-day rolling average. These standards vary based on stream classification, as detailed in Table 16. Cold Stream Tier I temperature criteria apply where cutthroat trout and brook trout are expected to occur. Cold Stream Tier II temperature criteria apply where

cold-water aquatic species, excluding cutthroat trout or brook trout, are expected to occur.

Table 16. Acute and Chronic Temperature Thresholds (degrees Celsius) by Stream Tier and Season

	CS-I		CS-II	
	Summer (Jun-Sep)	Winter (Oct – Apr)	Summer (Apr – Oct)	Winter (Nov-Mar)
Chronic (MWAT)	17.0	9.0	18.3	9
Acute (DM)	21.7	13.0	24.3	13.0

Degree days (°C-days), which are calculated by summing the daily average temperatures that exceed the standard over consecutive days, integrates both the magnitude of temperature (°C) above the standard as well as the duration (in days) and represents the cumulative temperatures above which growth or lethal impacts to fisheries are expected. Regulation 31 defines a “Warming event”¹ as the maximum allowable degree days:

- Acute: 2.4 °C-days
- Chronic: 13.5 °C-days

The stream temperature metric rating scale is presented in Table 17. The GC-RHAF focuses on summer temperatures. Limited winter data is available in CEA, and the significant temperature reduction results in exceedances that skew the assessment. The metric rating scale leverages thresholds established for temperature standards (e.g., MWAT, DM, degree days) as defined in Regulation 33 but does not apply the 303(d) listing methodology (e.g., one allowable exceedance in three years).

Table 17. Stream Temperature Metric Rating Framework

Grade	Scale	Description	Explanation
A	95	Optimally functional	All summer temperatures less than DM (acute) or MWAT (chronic) thresholds
B	85	Highly functional	1 summer warming period that does not exceed degree days
C	75	Mostly Functional	2 or more summer warming periods that do not exceed degree days
D	65	Partly Functional	1 summer warming event (degree days exceeded)
F	55	Dysfunctional	2 or more summer warming events (degree days exceeded)
N/A	N/A	Not Graded	No Data

¹ [Code of Colorado Regulations 5 CCR 1002-31](#) p. 53

Temperature Metrics Data Summary

Metric Weighting: The minimum, or lower, grade between the two metrics (Chronic (MWAT) and Acute (DM)) in any location on the reach in situations where multiple temperature gauges exist. This results in a conservative grade that would, for example, result in a “D” grade if the Acute grade is D and the Chronic grade is A.

Source: Continuous stream temperature data was obtained from the GCWIN database. This database compiles and standardizes water quality information from multiple sources, including Northern Water, USGS, and LBD.

Timeframe: 1/1/2017 through 12/31/2024

Metric Limitations & Data Gaps:

The opportunity to leverage CDPHE aquatic life numeric standards provides benchmarks that have undergone technical review and public input. These standards should be monitored, and benchmarks updated to incorporate any site-specific updates, if necessary.

Continuous temperature data is available for the majority of the CEA, except for the upper William Fork, Williams Fork downstream of the Reservoir, upstream of Granby Reservoir, and Crooked Creek and Pole Creek (tributaries to the Fraser River).

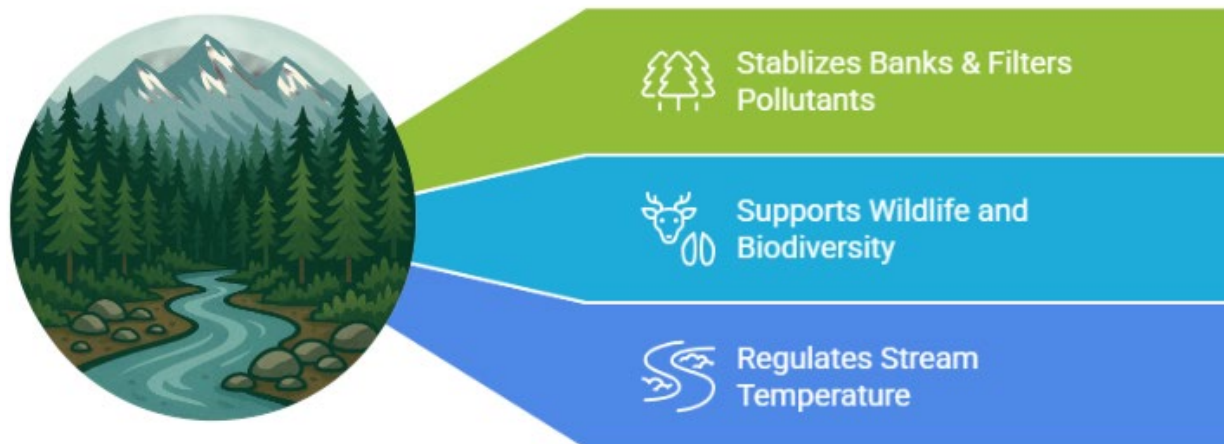
Assessment Recommendations

Continuous temperature data is collected and compiled into the GCWIN database on an ongoing basis, and associated statistics (e.g., MWAT and degree days compared to standards) are automated, providing the opportunity to update grades on a rolling basis. Future assessments should include the previous eight years to align with the original GC-RHAF.

Additional temperature monitoring could be considered to fill data gaps, focusing on reaches that are identified as priorities and/or do not have corresponding or low water quality and/or aquatic ecosystem grades. In addition, the weighting strategy of using the minimum result between the two metrics may be evaluated.

Riverscape

Riparian



The riparian area is located between the stream and the surrounding upland areas and plays a crucial role in the ecological and hydraulic function of the stream corridor, providing habitat for diverse species, as well as contributing to flood control and erosion prevention. Floodplain confinement, floodplain fragmentation, and riparian habitat condition all factor into the overall riparian condition. A healthy riparian area has adequate space for floodwaters to safely spread beyond the channel banks, which helps control high flows and infiltration into the floodplain, where hydration allows for highly functioning riparian vegetation. Unhealthy riparian zones can include encroachment and fragmentation by roadways and other development, hindering the ability of the stream corridor to spread, slow, and infiltrate the high flows. Poor riparian vegetation conditions diminish function of these areas reducing habitat and often leads to erosion.

Riparian Metrics and Grading Criteria

Floodplain Confinement

Floodplain confinement is a measure of how restricted the areas immediately adjacent to the channel banks are by surrounding topography or human encroachment. An unconfined floodplain allows high flows to spread beyond the channel banks, which slows and infiltrates high flows. This contributes to healthy riparian vegetation and resilience against erosion and other damage from floods. A confined floodplain does not allow space for floodwaters to spread, accelerates flow, and leaves these areas are more vulnerable to damage from high flows. For this assessment, floodplain confinement index was

measured as the ratio of the length of channel confined on either bank by a confining margin divided by the reach length. A value of 0 is completely unconfined; a value of 1.0 would be completely confined. The Valley Confinement tool (O'Brien et al, 2019) was used to obtain these values, with a detailed assessment description in the 2024 Comprehensive Watershed Assessment Report (Lotic, 2024). The corresponding metrics used in the GC-RHAF are presented in Table 18.

Table 18. Floodplain Confinement Metric Rating Framework

Grade	Scale	Description	Explanation
A	90-100	Optimally functional	Unconfined. Confinement index of less than 0.1
B	80-89	Highly functional	Partly confined, planform controlled. Confinement index of 0.1 -0.5
C	70-79	Mostly Functional	Partly confined, margin controlled. Confinement index of 0.5-0.8.
D	60-69	Partly Functional	Confined. Confinement index greater than 0.8.
F	50-59	Dysfunctional	Not Used
N/A	N/A	Not graded	

Floodplain Fragmentation

Floodplain fragmentation is a measure of the impact of human development that divides the floodplain into smaller, less connected areas. An intact minimally fragmented floodplain will contain little to no infrastructure within the floodplain. Whereas a highly fragmented floodplain will contain many features within the floodplain, separating the floodplain into smaller areas. A low fragmented floodplain is beneficial to the overall riparian condition by promoting continuity of water and sediment throughout a particular reach. A highly fragmented floodplain does not allow for this continuity, negatively impacting the hydraulics, sediment regime, and riparian vegetation and habitat. The Riparian Condition Assessment Toolbox (Gilbert et al, 2016) was used to conduct this analysis (Lotic, 2024). The metric values for floodplain fragmentation used in the GC-RHAF grading are shown in Table 19.

Table 19. Floodplain Fragmentation Metric Rating Framework

Grade	Scale	Description	Explanation
A	95	Optimally functional	Floodplain intact (low fragmentation)
B	85	Highly functional	Floodplain mostly intact (low to moderate fragmentation)
C	75	Mostly Functional	Floodplain moderately intact (moderate fragmentation)
D	65	Partly Functional	Floodplain significantly fragmented (moderate to high fragmentation)
F	55	Dysfunctional	Floodplain severely fragmented (high fragmentation)
N/A	N/A	Not graded	Not Graded

Riparian Condition

Riparian habitat condition is a measure of the ecological health of the riparian area, primarily including the evaluation of vegetation, also factoring in land cover and land use. A healthy, well-functioning riparian habitat shows little impact by human activities, self-sustaining and diverse vegetation, with the area being well connected to the channel. Healthy riverine vegetation aids in slowing down and infiltrating flood flows, as well as providing food, cover, and migration corridors for wildlife. An unhealthy, low functioning riparian habitat is highly altered by human activities, resulting in lower diversity and overall health of the vegetation with loss in connection to the channel.

All data analysis was completed and documented using GIS software with limited field or site visits (Lotic, 2024). 163 stream miles were analyzed within the CEA and 62 stream miles were analyzed using a detailed “polygon mapping” approach, where cover types, land uses, and conditional assessment rankings were delineated as polygons within a 100-meter swath along each side of the stream. The method was used primarily on the Colorado River, Fraser River, and Ranch Creek. A less-detailed “linear mapping” approach was used on the remaining 101 stream miles, primarily tributaries to the Colorado and Fraser rivers. Land cover, land use, and apparent riparian condition were all analyzed, but at a much less detailed scale than the polygon mapping approach. Weighted reach grades were calculated using segment grading criteria also developed (Lotic, 2024). The metric values used in the GC-RHAF for riparian condition are shown in Table 20

.

Table 20. Riparian Condition Metric Rating Framework

Grade	Scale	Description	Explanation
A	90-100	Optimally functional	Native riparian conditions are natural and appropriate for a well-functioning river. Vegetation is self-sustaining and species composition and diversity is characteristic of native riparian plant communities. Excellent channel connection and riparian supports characteristically patchy vegetation, with strong interspersions of patches and vertical structure. Habitats outside of the riparian zone are generally intact.
B	80-89	Highly functional	Riparian habitat resembles native conditions but with detectable changes. Vegetation species composition, diversity and structural complexity are self-sustaining. Native species predominate, although minor presence of problematic species may occur. Scattered individuals of noxious species may be present, but do not threaten function. Habitat retains good connection to the channel maintaining moisture conditions and a high degree of patchiness and interspersions, with little homogenization or loss of vertical structure. Land use changes in areas adjacent to the riparian zone have minimal deleterious effects on system health.
C	70-79	Mostly Functional	Riparian habitat is notably different from native conditions. Decreased plant diversity, loss of characteristic species or structural complexity, and/or homogenization of vertical structure, patchiness, and interspersions are evident, but patches of woody vegetation exist. Although diminished, channel connection is still present, supporting soil moisture, intermittent disturbance, and mesic vegetation. Small populations of noxious species may occur, and a large proportion of the species are commonly exotic or invasive natives. Lands adjacent to the riparian zone are typically altered but do not substantially degrade riparian or instream habitat.

Grade	Scale	Description	Explanation
D	60-69	Partly Functional	Riparian habitat is highly altered from native conditions. Decreased plant diversity, loss of characteristic species and structural complexity widespread. Homogenization of vertical structure and patchiness is expected to be severe. The habitat may be isolated from the river, and noxious weeds, invasive species, or exotics may be prevalent or dominant. Clearing all or most woody vegetation is expected. Bare ground or impervious surfaces may make up a significant portion of land cover. Vegetation is commonly under cultivation or landscaped. Land use outside of the riparian zone may be intensive and exacerbating degradation. Riparian zone conditions contribute to river dysfunction.
F	50-59	Dysfunctional	Riparian area is developed or wholly converted with predominantly bare ground, impervious surfaces or otherwise lacking vegetation owing to land use and management actions. Connection with the channel is expected to be severed. Riparian habitat function is essentially extinguished, and land use contributes substantially to river dysfunction.
N/A	N/A	Not Graded	Not Graded

Riparian Metrics Data Summary

Metric Weighting:

Riparian Habitat Condition	Floodplain Fragmentation	Floodplain Confinement
50	25	25

Riparian Habitat condition was weighted the heaviest since ecological function is the best indicator of overall riparian function. Floodplain fragmentation and floodplain confinement were weighted equally but lower than habitat condition based on the similar impact on riparian corridor function.

Source: Data for the Riparian Condition, Floodplain Fragmentation and Floodplain Confinement metrics was collected and assessed by Johnson Environmental Consulting and later presented in the 2024 Comprehensive Watershed Assessment report by Lotic Hydrological.

Timeframe: Riparian data in the Comprehensive Watershed Assessment report was collected and based on conditions in 2021.

Metric Limitations & Data Gaps:

Targeted field analysis in addition to the GIS and Aerial imagery used to assess riparian conditions and to measure confinement could improve the quality of this assessment.

The tributary data could also be improved by performing a more detailed polygon mapping approach.

Assessment Recommendations

To better understand the riparian condition, floodplain fragmentation and floodplain confinement in tributary reaches, it would be ideal to complete a detailed polygon mapping analysis for the remaining 101 stream miles that were mapping using the linear approach, however, this can be costly and could be phased to focus on priority reaches or even priority projects to help provide a better understanding of the improvements required. This could correspond to a boots-on-the-ground field analysis which could be completed for targeted high-priority reaches and potential project sites if needed in the future as well to verify that polygon mapping results support field analysis results.

The 2024 Comprehensive Watershed Assessment (Lotic, 2024) recommends a visual comparison to current riparian conditions with aerial imagery every 5-10 years to better understand and track changes over time without re-mapping of riparian corridors across the CEA.

Additionally, post-project assessments are recommended to track improvements to the riparian condition.

Channel

Geomorphic Conditions



River dynamics, including planform dynamics and profile dynamics, are fundamental to understanding and maintaining river health and the geomorphologic condition of fluvial systems. River dynamics are not just about the shape of the river; they are about the life of the river. Understanding and preserving these dynamics is essential for sustainable river management and ecological integrity. Together, planform and profile dynamics:

- **Maintain Natural Morphological Processes:** Healthy rivers are dynamic, adjusting naturally to changes in flow, sediment load, and vegetation.
- **Support Ecosystem Services:** These include water purification and habitat provision.
- **Indicate Anthropogenic Impacts:** Alterations in dynamics often signal human disturbances like damming, channelization, or land use changes.

Geomorphology Metrics and Grading Criteria

Planform Dynamics

Planform dynamics refer to the lateral configuration of a river including, its meanders, braids, and straight segments that support the following channel functions:

- **Habitat Diversity:** Meandering and braided rivers create a mosaic of habitats (e.g., pools, riffles, oxbow lakes) that support diverse aquatic and riparian species.

- **Sediment Transport and Deposition:** Lateral movement redistributes sediments, maintaining floodplains, and preventing excessive buildup or erosion in one area.
- **Floodplain Connectivity:** Dynamic planforms allow rivers to interact with their floodplains, which is vital for nutrient cycling, groundwater recharge, and flood mitigation.

Understanding the limitations or pressures on natural river systems caused by human activities preventing natural and dynamic planform adjustments, including belt width and sinuosity, is an important metric to understanding the health of the river. To better understand the anthropogenic constraints to the river's planform, a desktop assessment was performed to identify features along the river like development, roads, railways, bridges, and agriculture that have already impacted or can impact the natural belt width and sinuosity of the river. This qualitative approach identifies reaches that are more heavily affected by anthropogenic impacts relative to other reaches within the CEA. This assessment looks at the percentage of length of each reach that the planform is impaired and assigns a rating in the form of a letter grade. It is recommended that a more detailed geomorphic planform assessment be completed at the project level.

Planform dynamics were graded qualitatively by adapting the 2024 Cache la Poudre Watershed River Health Assessment Framework (Coalition for the Poudre River Watershed, 2024) to fit the GC RHAF. This assessment used GIS data available including the 2022 Grand County EagleView Mosaic Imagery, USGS 2023 Digital Elevation Model (DEM), and ArcGIS Imagery Hybrid Basemap.

A desktop assessment of this metric was performed to identify areas where the belt width and sinuosity appear to be limited by development, roads, railroads, bridges, or agriculture and are not able to naturally adjust to these stressors. For areas with reduced belt width and sinuosity caused by anthropogenic changes, the length of impairment was measured, for use in calculating the overall reach grade, and a qualitative severity assigned in the form of a letter grade according to the rating framework described in Table 21.

For rating purposes, only sections within each reach with impaired planform dynamics were identified, measured and rated using B, C, D, or F. The remaining reach length of the assessed reach is assumed to be healthy and given an A grade. Once the severity ratings were finalized for each area within the channel reach, the severities were summarized by length and then used to calculate a length weighted average grade for each reach.

Table 21. Planform Dynamics Metric Rating Framework

Grade	Scale	Description	Explanation
A	90-100	Optimally functional	Low planform stressors (river has the ability to naturally adjust and has minimal to no anthropogenic impacts from developments and roadways).
B	80-89	Highly Functional	Low to moderate planform stressors (river maintains the ability to naturally adjust but is in minimally impacted by anthropogenic impacts from developments and roadways).
C	70-79	Mostly Functional	Moderate planform stressors (river's ability to naturally adjust is moderately impacted by anthropogenic impacts from developments and roadways).
D	60-69	Partly Functional	Moderate to high planform stressors (river's natural ability to adjust is moderately to highly impacted by anthropogenic impacts from developments and roadways).
F	50-59	Dysfunctional	High planform stressors (river's natural ability to adjust has been highly impacted by anthropogenic impacts from developments and roadways).
N/A	N/A	Not Graded	Not Graded

Profile Dynamics

Profile dynamics involve the longitudinal profile of a river, including its slope, elevation changes, and channel depth. A balanced slope ensures efficient energy dissipation, reducing the risk of erosion or sedimentation problems and will create variations in depth and flow velocity along the profile creating niches for different aquatic organisms. Changes in gradient can lead to incision (downcutting) or aggradation (buildup), both of which can destabilize the river system.

Understanding the anthropogenic constraints on a river that prevents the river from making natural slope and elevation adjustments to its profile is an important metric to understanding the health of the river. To better understand the human-based stress or limitations to the river's profile, a desktop assessment was performed to identify features in the river like bridges, diversion dams, and grade control structures that prevent the river from making natural adjustments to its profile. This qualitative approach identifies reaches that are more heavily affected by anthropogenic impacts relative to other reaches within the CEA. This assessment looks at the number of structures per mile and assigns a rating in the form of a letter grade. It is recommended that a more detailed geomorphic profile assessment be completed at the project level.

Profile dynamics were graded based on the density of bridges and in-stream grade control structures, including diversion structures. In each reach. A desktop GIS data review using the 2022 Grand County EagleView Mosaic Imagery and ArcGIS Imagery Hybrid Basemap were used to identify features that act as stressors on the channel's profile. Structures on each reach were counted and normalized by the reach length to determine the number of structures per mile. Existing constructed habitat structures (cross vanes, j-hooks, etc.) were excluded as they are intended to benefit stream function and health, unless they were associated with diversion structures. The grading criteria shown in Table 22 was used to assign a grade to each reach.

Table 22. Profile Dynamics Metric Rating Framework

Grade	Scale	Description	Explanation
A	90-100	Optimally functional	Low profile stressors (river has the ability to naturally adjust and has minimal to no anthropogenic impacts from in-stream grade control structures). Less than 1 grade control structures per mile.
B	80-89	Highly functional	Low to moderate profile stressors (river maintains the ability to naturally adjust but is in minimally impacted anthropogenic impacts from in-stream grade control structures). 1 - 2 grade control structures per mile.
C	70-79	Mostly Functional	Moderate profile stressors (river's ability to naturally adjust is moderately impacted anthropogenic impacts from in-stream grade control structures). 2 - 3 grade control structures per mile.
D	60-69	Partly Functional	Moderate to high profile stressors (river's natural ability to adjust is moderately to highly impacted by anthropogenic impacts from in-stream grade control structures). 3-4 grade control structures per mile.
F	50-59	Dysfunctional	High profile stressors (river's natural ability to adjust has been highly impacted by anthropogenic impacts from in-stream grade control structures). Greater than 4 grade control structures per mile.
N/A	N/A	Not Graded	Not Graded

Geomorphology Metrics Data Summary

Metric Weighting:

Planform Dynamics	Profile Dynamics
50	50

Planform dynamics and profile dynamics are weighted equally as together these metrics provide a more complete understanding of the geomorphological condition.

Source:

For geomorphologic analysis, the 2022 Grand County EagleView Mosaic Imagery, USGS 2023 DEM, ArcGIS Imagery Hybrid Basemap, and Google Earth Pro were used to grade the reaches.

Timeframe:

The Grand County Aerial imagery used was taken from 5/18/22 through 7/5/22. The USGS DEM File was published on 6/2/23. The ArcGIS Imagery Hybrid Basemap and Google Earth Pro used the most up to date version as of 8/26/25.

- Grand County Aerial Imagery: COGRAN22 (COGRAN007)_OM (2022 EagleView Mosaic, By: EagleView, Capture dates: 05/18/2022-07/05/2022, <https://svc.pictometry.com/Image/5C68DD26-3E19-3A1D-0F8B-56EACE62B919/wmts>
- Hillshade: Created from DEM using ArcGIS Pro
- DEM <https://www.sciencebase.gov/catalog/item/64800f48d34eac007b56a850>
- GIS Imagery Hybrid basemap <https://www.arcgis.com/home/item.html?id=86265e5a4bbb4187a59719cf134e0018>
- Google Earth (using most up to date as of 8/26/2025)

Metric Limitations & Data Gaps:

The assessment was limited to aerial imagery in combination with Hillshade and DEM data, which is not fully representative of all geomorphologic conditions, to assess planform dynamics. This assessment could be enhanced by performing field reconnaissance at select locations. An additional limitation of using only aerial imagery for assessing profile dynamics is the potential to miss grade control structures or to identify the severity of the grade control structure. The aerial imagery itself was also limited, as some reaches were outside of the very detailed 2022 Grand County EagleView Mosaic

Imagery and the reach assessments had to rely on a combination of the GIS basemap and google earth. Also, portions of some reaches were covered by the tree canopy limiting aerial imagery assessment.

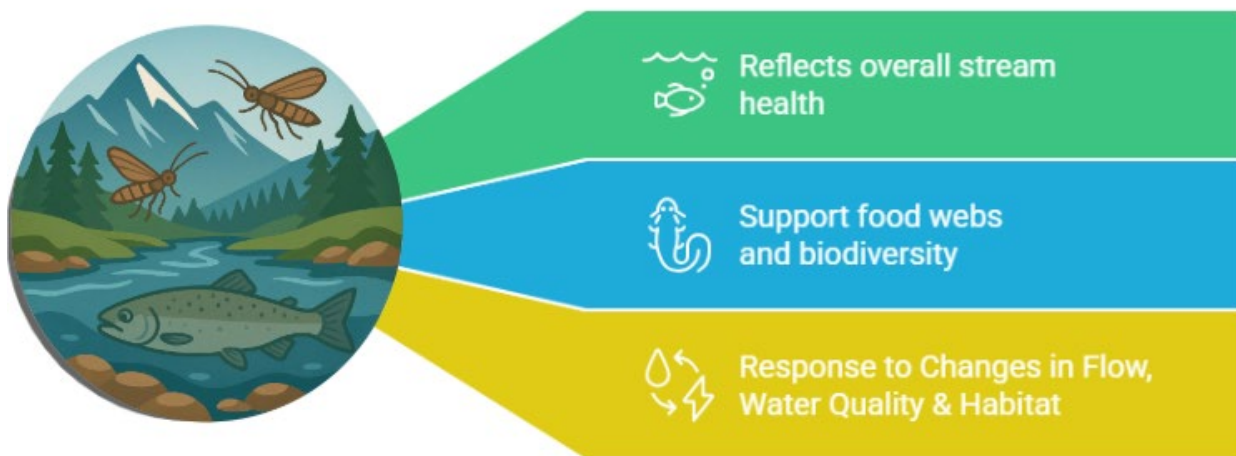
Another limitation of both the planform and profile dynamic assessment is that grading is qualitative. Although the procedure for grading planform dynamics was developed to be as consistent as possible, there is room for interpretation, and the process is not as definitive as performing a detailed geomorphic survey and completing a departure analysis as described in Section 3.6. Using average structures per mile to grade profile dynamics could be misrepresentative of some sections of the reach. For instance, there may be large sections of river within a reach that do not have any grade control structures or bridges and should receive a much higher grade or vice versa. Also, the density of grade control structures is easily influenced by the reach length, and this can result in lower grades for shorter reaches.

Assessment Recommendations

A detailed geomorphic assessment for all 42 reaches within the CEA would be a significant effort and would require significant data collection which is not practical considering the scale of the GC-RHAF. It is recommended that a more detailed geomorphic assessment, including a geomorphic survey with a departure analysis, be completed for priority reaches or areas within a priority reach selected for stream restoration. A departure analysis will help to identify geomorphic parameters that may be out of the expected ranges, which will help to determine appropriate restoration efforts. This departure analysis should be performed by comparing geomorphic metrics (belt width, sinuosity, meander wavelength, pool to pool spacing, width to depth ratio, etc.) measured on a nearby reference reach to the same metrics measured within the reach of interest. Completing a departure analysis on reaches of interest would highlight the geomorphic metrics within the project reach that may need to be restored to help improve the river health. The Colorado Stream Management Plan website can be consulted for more information on how to perform more in-depth channel analysis (<https://www.coloradosmp.org/smp-nuts-and-bolts/assess-conditions-risk/biological-conditions/channel-morphology/>)

At this level, the geomorphic planform and profile dynamics assessment does not need to be reassessed very often as the metrics assessed do not tend to change dramatically over short periods of time. For efficiency, these metrics could be reassessed at the same time as the local sediment supply metric, which is recommended every 5 to 7 years, since they both require a similar level of desktop analysis using aerial imagery.

Aquatic Ecosystems



The aquatic life in a watershed ecosystem is directly impacted by the physical and chemical characteristics of the river. Healthy aquatic ecosystems sustain diverse biological communities and provide essential ecological services such as nutrient cycling, energy transfer, and fish production.

Because excessive fine sediment is one of the most widespread stressors in mountain streams, the percentage of smaller particle fines provides a sensitive and ecologically meaningful indicator of habitat condition for aquatic macroinvertebrates and fish. As such, this assessment relies solely on sediment size measurements.

The GC-RHAF water quality grading assessment focuses on the following key metrics:

- Sediment deposition on macroinvertebrates and trout spawning habitat
- Benthic macroinvertebrate community structure, and
- Trout biomass

Aquatic Ecosystem Metrics and Grading Criteria

Microhabitat for Macroinvertebrates

The streambed, with its mix and arrangement of substrate sizes (fines, sand, gravel, cobble, and boulder), provides habitat for aquatic insects. A diverse and well-structured substrate supports sensitive macroinvertebrate species that form the base of the aquatic food web. These insects are important indicators of stream health and are an essential food source for fish and other wildlife.

Within this GC-RHAF, streambed sediment conditions are evaluated using the percentage of substrate particles less than 2 millimeters in diameter (% fines <2 mm), consistent with the methodology outlined in WQCC Policy 98-1 (CDPHE WQCC 2024c). While biological metrics such as SedTIV exist to assess macroinvertebrate response to sediment, they are not used in this framework because some sites an assigned sediment region which would result in incomplete coverage based on MMI v4 regions. However, MMI v5 includes more comprehensive sediment region assignments from Policy 98-1. If future assessments and grades are based on MMI v5, SedTIV would be incorporated to those calculations or they could be calculated separately based on the criteria for each region assignment.

In the LBD CEA, Sediment Regions 1 and 2 correspond to high-gradient alpine and mid-elevation forested mountains, respectively. Region-specific thresholds 27.7% for Region 1 and 42.2% for Region 2 were established using reference site data and represent the upper bound of expected natural conditions. Fine sediment accumulation in excess of these thresholds is known to degrade critical benthic habitat by filling interstitial spaces among coarse substrates, thereby reducing available habitat complexity, oxygen exchange, and foraging surfaces for macroinvertebrates. These physical changes can shift community composition toward more sediment-tolerant taxa and reduce biological diversity, abundance, and overall functional integrity. Table 23 presents the grading criteria used in the GC-RHAF.

Table 23. Microhabitat for Macroinvertebrates Habitat Metric Rating Framework

Grade	Scale	Description	% <2mm fines Sed. Region		Explanation
			1	2	
A	90-100	Optimally functional	0-10%	0-15%	Near-pristine coarse-bed substrate with minimal embeddedness. Interstitial spaces among cobble and gravel are well-developed, supporting high macroinvertebrate diversity and abundance.
B	80-90	Highly functional	10-20%	15-30%	Slightly elevated fines; minor infilling of coarse substrate. Habitat structure remains largely intact with minimal effects on community composition or richness.
C	70-80	Mostly Functional	20-27.7%	30-42.2%	Fines approaching the regional sediment threshold. Some

Grade	Scale	Description	% <2mm fines Sed. Region		Explanation
			1	2	
					reduction in habitat complexity is likely, but the streambed still supports a diverse, though potentially altered, macroinvertebrate assemblage.
D	60-70	Partly Functional	27.7-35%	42.2-50%	% fines exceed the protective regional threshold. Significant substrate infilling likely restricts habitat availability and leads to dominance by sediment-tolerant taxa. Watershed review recommended to determine anthropogenic influence.
F	50-60	Dysfunctional	>35%	>50%	Excessive fine sediment results in smothered substrates and loss of interstitial habitat. Likely severe reductions in diversity, sensitive taxa, and ecological function. Watershed review recommended to confirm human-caused sediment sources.
N/A	N/A	Not Graded			No Data

Trout Spawning Habitat

Trout reproduction depends on clean gravel substrates where females build redds and deposit eggs. Excess fine sediment, particularly particles less than 8 mm in diameter, fills interstitial spaces between gravels and reduces oxygen exchange to developing embryos. Sediment-related impacts to trout spawning habitat are assessed under Colorado's Water Quality Control Commission Policy 98-1 (CDPHE WQCC 2024c), which implements the narrative sediment standard in Regulation 31. In stream reaches where salmonid spawning is expected to occur, habitat quality is evaluated using the percentage of bedded sediment less than 8 millimeters in diameter (% fines <8 mm), measured within potential spawning areas. Scientific studies cited in Policy 98-1 (Appendix G) demonstrate that when these fines exceed 20% by area, trout embryo survival and fry emergence are significantly impaired due to reduced oxygen exchange in the gravel. Accordingly, the policy establishes a protective guideline of ≤20% fines <8 mm as the threshold for attainment of the narrative standard. Assessment includes measuring fines within identified spawning microhabitat

using a modified pebble count procedure, comparing results to the 20% threshold and determining whether any excess sediment can be attributable to human-caused point or nonpoint source discharges.

Table 24 presents the grading criteria used in the GC-RHAF. Sediment conditions in trout spawning areas is graded using the 20% threshold between grades C and D. This framework provides a biologically relevant and policy-aligned method to evaluate spawning habitat quality and identify potential sediment-related impairments to aquatic life use.

Table 24. Trout Spawning Habitat Metric Rating Framework

Grade	Scale	Description	% <8mm fines	Explanation
A	90-100	Optimally functional	0-5%	Near-pristine habitat and redds, providing excellent oxygen exchange and larval emergence potential.
B	80-90	Highly functional	5-10%	Minor fines are present with very limited effects on egg development and survival.
C	70-80	Mostly Functional	10-20%	Sediment fines are near the upper end of sediment tolerance which may reduce larval emergence, but the habitat still supports spawning.
D	60-70	Partly Functional	20-30%	Levels are beyond the protective sediment threshold, and fry emergence is likely compromised. Watershed review recommended to confirm human-caused sediment sources.
F	50-60	Dysfunctional	>30%	High fines are present which are likely to have severe impacts on embryo survival and emergence. Watershed review recommended to confirm human-caused sediment sources.
N/A	N/A	Not Graded		No Data

Macroinvertebrates

Benthic macroinvertebrates assimilate and respond to water quality and habitat conditions over time, making them a robust indicator of aquatic ecosystem health. Macroinvertebrates are a key indicator of stream health because their diversity and sensitivity to disturbance reflect long-term water quality and habitat conditions. In the GC-

RHAF, benthic community conditions are assessed using Colorado’s Multi-Metric Index (MMI). The MMI is Colorado’s standardized tool for evaluating the health of aquatic macroinvertebrate communities documented in CDPHE Policy 10-1: *Aquatic Life Use Attainment*. It combines multiple measures such as the richness of sensitive taxa, the balance of functional feeding groups, and overall community diversity into a single score. It evaluates community composition, richness, and tolerance to disturbance with thresholds tailored by stream zone. For example, in the Transition Biotype, a score greater than 75 represents optimal function, while in the Mountain Biotype, optimal function is achieved above 78. Scores falling below 30 in either zone are considered non-functional. These graded thresholds allow comparison across watersheds and highlight reaches where aquatic life use is impaired. Table 25 presents the GC-RHAF grading framework. Streams with MMI values of 80% of the reference condition) are considered fully supporting aquatic life (Grade A), while values ≤ 0.2 indicate severe biological impairment (Grade F). Grades B–D reflect partial attainment, with community shifts toward more tolerant taxa and reduced diversity. The current grades were based on MMI v4 but can be updated to MMI v5 when needed.

Table 25. Macroinvertebrates Metric Rating Framework

Grade	Scale	Description	MMI Median		Explanation
			Transition Biotype	Mountain Biotype	
A	90-100	Optimally functional	>80	>81	Communities equal to reference sites, undisturbed conditions
B	80-90	Highly functional	75 - 80	78 - 81	Attainment of standard, similar to reference conditions
C	70-80	Mostly Functional	45.3 - 75	47.6 - 78	Attainment of standard, acceptable variability from reference conditions
D	60-70	Partly Functional	33.7 - 45.3	39.7 - 47.6	Gray zone - between the thresholds for attainment and impairment suspected water quality problems
F	50-60	Dysfunctional	<33.7	<39.7	Impairment of standard, failure to meet designated uses, 303d list
N/A	N/A	Not Graded			No Data

Fish Communities

Fish communities reflect the availability of food, habitat, and connectivity and are good ecological and social indicators of stream health. Fish depend on adequate flow, suitable habitat structure, good water quality, and access to spawning and feeding areas. The presence of diverse fish species and higher biomass signals a healthy and balanced stream, while reduced abundance or biomass often indicates stress from altered flows, degraded habitat, or water quality problems.

Colorado Parks and Wildlife (CPW) designate “Gold Medal Waters” where trout fisheries meet the highest standards of productivity and recreational value (CPW). These waters support a minimum of 60 pounds of trout biomass per acre, with at least 12 trout per acre greater than 14 inches. While this designation represents exceptional conditions statewide, many Grand County streams exhibit biological productivity and habitat integrity that exceed these thresholds. Fisheries biologists generally support using higher biomass thresholds in high-elevation, cold-water systems like those in Grand County, where temperature, flow, and habitat conditions can naturally sustain high trout densities. Consistent with the GC-RHAF approach used for other aquatic ecosystem metrics, the highest grade (A) is reserved for reference or near-reference conditions, systems that are largely unaltered and support trout populations well above average stream conditions and benchmarks.

Table 26. Fish Communities Metric Rating Framework

Grade	Scale	Description	Pounds Trout per Acre	Explanation
A	90-100	Optimally functional	>120	Optimal conditions to support an exceptional fishery
B	80-90	Highly functional	80-120	High value fishery with excellent recreational fishing conditions
C	70-80	Mostly Functional	60-80	CPW designated “Gold medal” waters, functional stream conditions
D	60-70	Partly Functional	10-60	Satisfactory recreational fishing conditions
F	50-60	Dysfunctional	<10	Limited if any fish >14” present, no spawning
N/A	N/A	Not Graded		No Data

As illustrated in the GC-RHAF framework shown in Table 26, ≥ 120 lbs./acre represents optimal conditions supporting exceptional fishing, with 80-120 lbs./acre representing excellent fishery conditions, 60-80 lbs./acre is considered a highly functional stream (Grade C), while biomass between 20-60 lbs./acre represents satisfactory conditions

(Grade D), and less than 10 lbs./acre represents conditions with limited to no fish often linked to habitat degradation, flow alteration, or water quality stressors.

Aquatic Ecosystems Metrics Data Summary

Metric Weighting:

Habitat		Communities	
Macroinvertebrates	Trout Spawning	Macroinvertebrates	Fish
25	25	25	25

Source: Pebble count data and MMI data were obtained from the GCWIN database.

Pebble count data is provided by LBD, and MMI data is provided by Northern Water and LBD. Fisheries data was obtained from CPW under a non-disclosure agreement.

Timeframe: 1/1/2017 through 12/31/2024

Metric Limitations & Data Gaps: Aquatic ecosystem indicators in the GC-RHAF are subject to data limitations that should be considered when interpreting aquatic condition scores. Macroinvertebrate values will likely need to be updated as Colorado transitions to MMI v.5, which refines scoring thresholds and may shift condition ratings.

Due in part to the complexity of sampling and analysis of these aquatic habitat metrics, there are fewer sampling sites across the CEA and fewer results per site compared to other variable metrics such as water quality and temperature. For example, MMI measurements are typically taken once a year and focus primarily on mainstem reaches, and several sites only have a few measurements. In some cases, data is available only for MMI, so the variable grade does not reflect all the aquatic resource metrics and is not an “apples-to-apples” comparison to reaches with additional data. Fish data are limited by the irregular timing of surveys and access, so results may underrepresent true species distribution or abundance.

Assessment Recommendations

Additional assessment of Aquatic Ecology metrics could include updating macroinvertebrate evaluations to the most recent MMI v5, which incorporates revised scoring methods and attainment thresholds to better reflect current standards. An initial comparison of assigned grades based on macroinvertebrate populations demonstrated limited differences between MMI v4 and MMI v5. However, updating these grades based MMI v5 when implemented in 2026 would provide alignment with state standards.

In addition, efforts should focus on addressing data gaps in priority areas by expanding fish surveys and macroinvertebrate sampling, particularly in reaches where monitoring has

been limited, such as private lands or segments with infrequent surveys. These actions will strengthen spatial coverage and improve the defensibility of ecological assessments.

Making the Grade: How Stream Reach Grades Take Shape

Watershed data representing a range of variables is ultimately translated into a final reach grade (Figure 3). Raw data is converted into a condition metric, that is then compared against the metric grading criteria detailed in the sections above (Figure 4). For metrics with discrete scoring, numerical differences reflect relative ranking among grades rather than proportional differences in condition. As a result, small differences in overall reach scores should not be interpreted as representing meaningful differences in magnitude or severity. Instead, grades are intended to indicate general condition classes and support prioritization at a reach scale rather than fine-scale ranking of closely scored reaches.

The metric grades are combined into their associated variable grades based on relative metric weighting. Finally, the variables for each stream reach are combined into a stream reach grade based on the variable weighting values shown in Table 26.

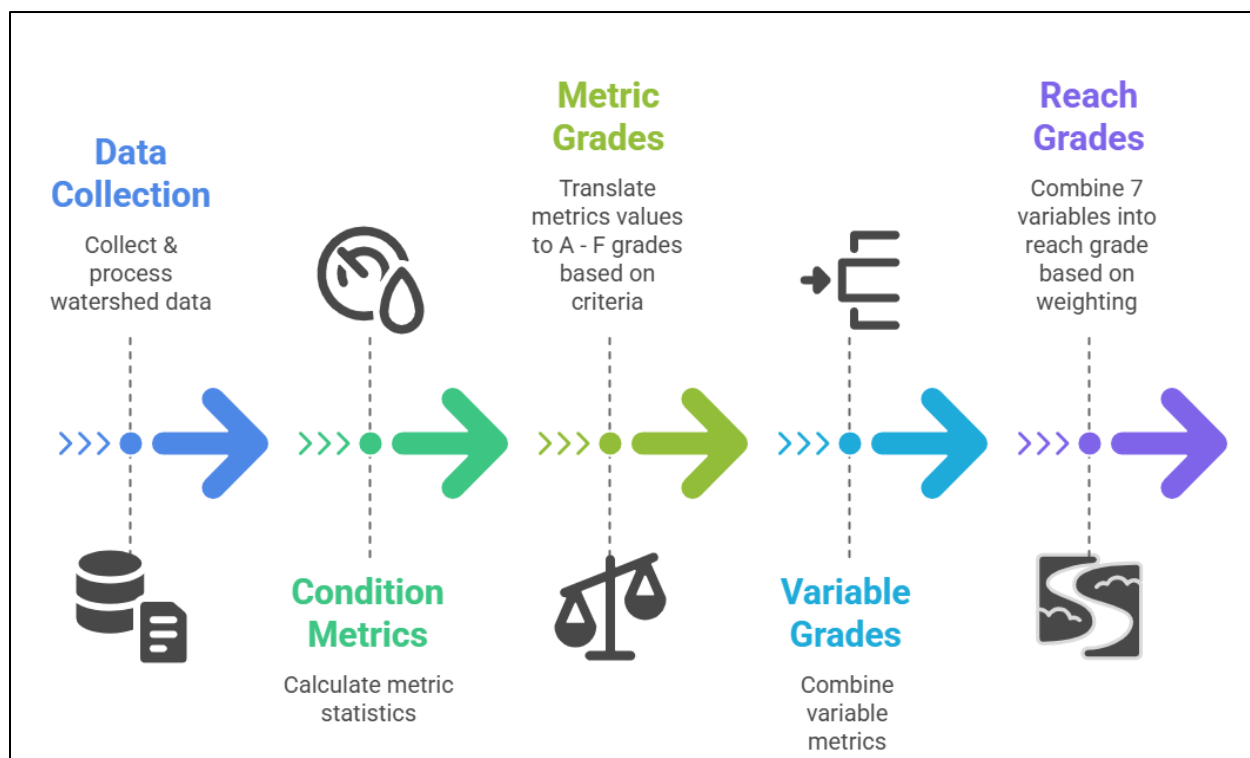


Figure 3. Stream Reach Grade Calculation Process

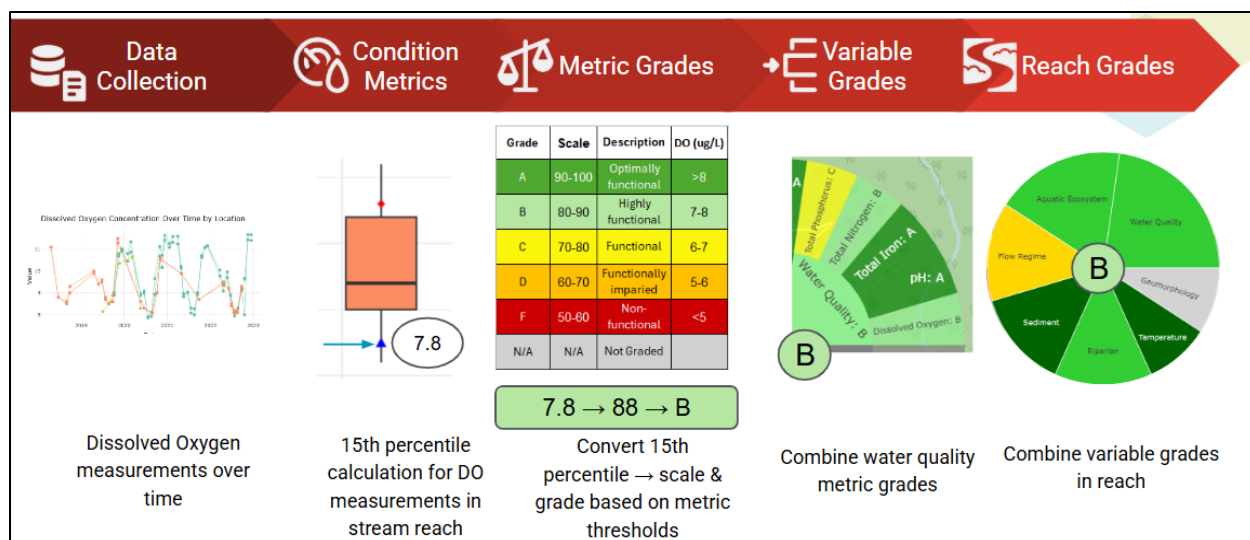


Figure 4. Stream Reach Grade Calculation Example

Variable Weighting

Not all variables contribute equally to the overall picture of stream health, and not all variables are equally responsive to management actions. To reflect this, variables in the GC-RHAF are assigned weighting values. Weighting ensures that the overall grades align with both ecological importance, restoration potential, and community priorities rather than treating every variable as if it carried the same influence.

The weighting values were developed through discussions and feedback from the Stakeholder Advisory Committee. This process incorporated two main considerations:

Community values – Input gathered during the Grand County Stream Management Plan (SMP) update identified which aspects of river health matter most to stakeholders, including:

- The importance of rivers and streams to the economy and livelihood of the Grand County community,
- The importance of maintaining healthy ecosystems,
- Concern with high water temperatures and low flows,
- Concern with post-fire sediment deposition, and
- The need to collaborate on projects to create solutions.

Potential project influence – Some variables are more directly affected by management actions than others. For example, riparian condition can often be improved through restoration projects, while sediment regime may be constrained by infrastructure and

geology. Weights account for these differences by placing more emphasis on variables where projects are likely to have a measurable impact.

Together, these considerations help balance ecological science with practical management relevance. The outcome is a grading system that is transparent, grounded in community priorities, and designed to guide investments toward actions that deliver the greatest ecological and social benefit. The final GC SMP Stream Reach Grades are in Appendix C.

Table 27. GC-RHAF Stream Reach Variable Weighting Values

Stream Health Variable	Variable Weighting
Flow Regime	5
Sediment Regime	2
Water Quality	2
Temperature	3
Riparian	3
Geomorphology	5
Aquatic Ecosystem	4

Ripple Effect: Links Between Stream Health Variables

Stream health variables do not act in isolation. Figure 5 and Table 28 illustrate some of the potential links between variables. For example, all variables can influence aquatic ecosystems. In addition, a shift in one variable often ripples through several others, sometimes in obvious ways and sometimes in ways that are easy to miss when looking at a single variable.

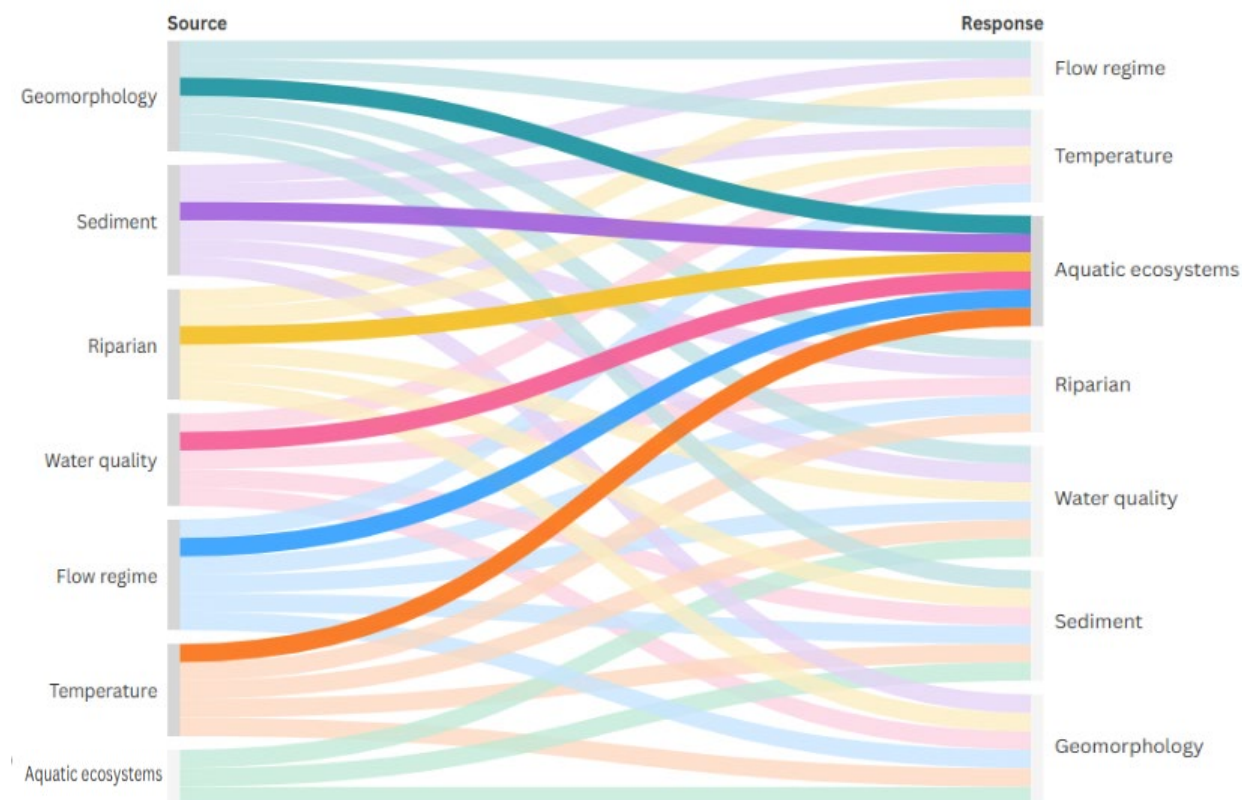


Figure 5. The Sankey diagram illustrates the relationship between variables.

For example, degraded riparian conditions can lead to bank erosion (increasing sediment), reduce shading (raising water temperature), and allow more pollutants to reach the stream (lowering water quality). High sediment loads can bury aquatic habitat, carry attached pollutants, and alter channel shape in ways that affect flow patterns. Elevated temperatures can reduce oxygen levels, change chemical processes, and stress sensitive aquatic species. Changes in one or more of these variables affect other variables, reflecting the interconnected and dynamic nature of these aquatic systems.

These linkages are important for grading because they provide context. If a reach scores low in a category where direct measurements are lacking, related variables can sometimes

serve as proxies. Poor riparian conditions might indicate potential water quality and temperature concerns. High sediment scores could hint at possible geomorphology or habitat issues. Holistically examining variable information on a reach can help address data gaps and help avoid blind spots in the assessment.

Understanding these connections also guides reach prioritization and project selection allowing targeting multi-benefit projects that improve one variable in ways that cascade into others. Riparian restoration can stabilize banks (reducing sediment), provide shade (lowering temperature), and filter runoff (improving water quality). Sediment reduction projects can restore aquatic habitat, improve water quality, and reduce channel instability. This leads to greater impact per dollar and a better chance for lasting improvements. The strength and direction of these linkages can vary by reach. The same action may have different ripple effects depending on geology, hydrology, and land use context. Specific projects prioritization and evaluation will focus on local realities and the key variables that matter most for the specific stream.

Table 28. Examples of Interrelated Variables

Response→ Cause ↓	Flow regime	Sediment	Water Quality	Temperature	Riparian	Geomorphology	Aquatic Ecosystems
Flow Regime		Fast flows wash more dirt into the stream; low flows let it settle and build up.	High flows can wash pollution in; low flows make pollution more concentrated.	Less water warms up faster, and big flow changes cause temperature swings.	Too much or too little water can harm plants along the stream.	Flow shapes the stream's path, depth, and bends over time.	Fish and bugs need the right flow to find food, spawn, and survive.
Sediment	Too much or too little sediment can change how water flows in streams.		Sediment can carry pollution and nutrients into the stream.	Muddy water warms up more easily.	Sediment can cover plant seeds or change where water reaches.	Too much or too little sediment changes the shape and stability of the stream.	Too much sediment can bury fish eggs and bug homes.
Water Quality	Water pollution does not usually change flow, but algae can slow water.	Pollution can get bound in sediment and move with it.		Warm water holds less oxygen and can change chemical reactions.	Healthy streamside areas filter pollution before they reach the stream.	Stable stream shapes help filter and slow down pollutants.	Polluted water can hurt fish and bugs by lowering oxygen or adding toxins.
Temperature	No direct effect, but can support algae growth indirectly slowing flow	Muddy water heats up faster.	Hot water holds less oxygen and changes how chemicals behave.		Trees and plants near streams give shade and help keep water cool.	Wide, shallow channels warm faster than deep, narrow ones.	Hot water can stress or kill sensitive fish and bugs. Cold water released from reservoirs can disrupt spawning cycles and reduce bug populations.

Response→ Cause ↓	Flow regime	Sediment	Water Quality	Temperature	Riparian	Geomorphology	Aquatic Ecosystems
Riparian	Plants near streams slow water and help it spread during floods.	Roots help hold soil in place and catch sediment.	Streamside plants trap pollution and nutrients before they reach the water.	Shade from trees keeps water cooler.		Roots help shape the stream and create bends and channels.	Riparian zones give food, shade, and shelter to fish and bugs.
Geomorphology	The shape of the stream affects how water moves and spreads.	The stream's shape controls where dirt builds up or gets washed away.	Stable channels help trap and filter pollution.	Deep pools stay cooler; wide shallow channels warm up.	Stream shape affects where plants can grow and get water.		Pools, riffles, and bends give fish and bugs places to live.
Aquatic Ecosystems	Fish and bugs don't change flow much, but some may help keep streambeds clear for water to move.	Insects and fish can stir up or help move fine sediment in the streambed.	Fish and bugs help recycle nutrients and can improve or worsen water conditions depending on their numbers.	They have little impact on temperature directly.	Fish and bugs don't usually affect plants along the stream.	Some bugs burrow or dig in the streambed, which can slowly change the stream's shape.	

Stream Reach Prioritization Methodology

Building on the GC-RHAF grading results, the next step is to translate these assessments into actionable priorities. While the GC-RHAF provides a comprehensive evaluation of stream health through measurable physical, chemical, and biological variables, prioritization focuses on identifying which reaches would benefit most from stream restoration activities. To accomplish this, LBD developed a set of prioritization elements that aligned with the GC SMP management themes and goals developed by the Stakeholder Advisory Committee (SHAC).

These elements provide context for where protection, enhancement, or restoration actions may be most effective, without prescribing specific projects. The prioritization elements, listed below, highlight critical river functions, stressors, and resource needs, ensuring that restoration efforts target areas where interventions will have the greatest ecological and community benefit.

Reach Characteristic Prioritization Elements

Two reach characteristic elements were included to capture restoration opportunity and social feasibility. These characteristics and quantifications are outlined in Table 29.

1. Reach Length
2. Public Access

Reach Length

Reach length was converted to a percentile score across all reaches and assigned a numeric value of 1-5, where longer reaches received higher prioritization values due to greater potential variability within the reach. Each length is included as a screening-level proxy for scale of opportunity rather than a prescriptive factor.

Public Access

The percentage of each reach that is publicly accessible was similarly converted to a percentile-based score based primarily on the Colorado Ownership, Management and Protection (CoMap) dataset which provides a standardized, statewide framework for characterizing land ownership and management along stream reaches and integrates information from numerous federal, state, local, and non-governmental sources to include attributes such as managing entity, conservation easements, and public access. Higher public access was interpreted as increased feasibility for implementation, monitoring, and community benefit.

Limitations include coverage of private, unprotected lands may be less detailed, updates occur only once or twice per year, and spatial accuracy reflects that of the original source data.

Grand County parcels were assessed for additional validation where COMap did not accurately reflect the amount of available open space / public access in a few areas. Another layer, *Open Lands/Forestry*, was added to the analysis, which helped capture some previously missing public land along the Fraser River. However, after reviewing the layer by parcels (throughout the CEA), several private properties under conservation easements were identified which were removed from the analysis.

Two stream reach areas were manually updated based on land acquisition or redesignation that took place after the most recent COMaP data set available:

CR4: Incorporated the 58 acres recently acquired Windy Gap Ranch.

WC2: Incorporated the new CPW state wildlife area designated in 2025.

Table 29. Reach Characteristic Quantification

Prioritization Rating	Public Access (%)	Reach Length (Percentile)
5 (High)	100	1.0
4	80	0.8
3	60	0.6
2	40	0.4
1 (Low)	20	0.2

Conditional Prioritization Elements

The ecological and physical condition-based elements (e.g. thermal stress, sedimentation, nutrient enrichment, riparian condition, geomorphic needs, ecological value) were based on A–F grades assigned through the GC-RHAF.

To maintain a consistent numerical framework:

Grades were converted to a 1–5 numeric scale, where:

- A = 1 (lowest concern / highest condition)
- F = 5 (highest concern / lowest condition)

For prioritization elements that are linked to multiple metrics grades (thermal stress, nutrient enrichment, ecological value), the lowest metric grade was used to represent the most limiting condition (i.e. Ecological Value – the lowest of up to 4 possible Aquatic

Ecosystem metrics was used: Micro Habitat (A), Trout Spawning (C), Macro (B), Fish (C) would lead to the C grade or a score of 3 used).

Using the minimum condition within a reach is consistent with ecological limiting factor concepts, particularly for aquatic organisms sensitive to thermal, nutrient, or habitat constraints.

Conditional Prioritization Elements

1. Thermal Stress
2. Fire Impacts
3. Sedimentation
4. Nutrient Condition
5. Floodplain Connectivity
6. Riparian Potential
7. River Form
8. Ecological Value

Metrics

To ensure consistency between the GC-RHAF and decision making, prioritization elements were paired with a corresponding metric(s) from the GC-RHAF. The metrics provide a quantitative basis for evaluating priorities of each reach by incorporating key conditions and characteristics.

By linking the prioritization elements to established GC-RHAF metrics, the process maintains transparency and scientific rigor, allowing stakeholders to compare reaches objectively and align restoration priorities with measurable indicators of river health.

Each prioritization element was associated with a quantifiable metric based on available data, primarily derived from existing stream reach condition grades (A–F) or reach-scale attributes.

The full list of both conditional and characteristic elements and their associated GC-RHAF metrics is presented in Table 30 below and the reach characteristic quantification is in Table 30.

Table 30. Prioritization Elements, Metrics and Criteria

Prioritization Element	Metric	Quantification
Reach Characteristic		
Reach Length	-	Percentile of Max
Public Access	-	% of reach public
Conditional		
Thermal Stress	Temperature	Minimum grade
Fire Impact	Watershed Supply: Wildfire Burned Area	1-5 (A-F)
Sedimentation	Local Supply	1-5 (A-F)
Nutrient Enriched	Nitrogen and Phosphorus	Minimum grade
Floodplain Connectivity	Riparian Fragmentation	1-5 (A-F)
Riparian Potential	Riparian Condition	1-5 (A-F)
River Form	Planform Dynamics	1-5 (A-F)
Ecological Value	Aquatic Ecosystem metrics	Minimum grade

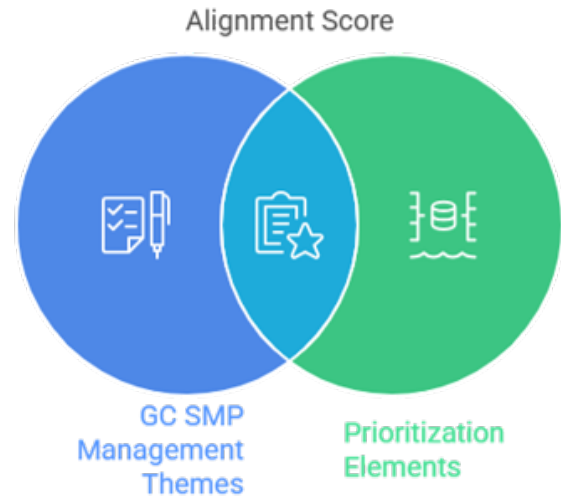
If a prioritization element lacked sufficient data for a given reach, that metric was excluded from the scoring for that reach to ensure:

- Missing metrics were not assigned default or penalty values.
- The overall prioritization score was calculated using only available metrics, maintaining comparability while avoiding bias against data-limited reaches.

Excluding metrics with data gaps can underrepresent certain stressors, which could then be addressed through the secondary prioritization elements, highlighting their importance.

Alignment Score

Multi-criteria decision frameworks commonly begin with explicit goal–metric alignment to avoid implicit weighting and to ensure consistency across disciplines. To ensure that the prioritization aligns with the broader objectives of the GC SMP, each prioritization element was aligned with the plan’s management themes and associated goals identified by LBD and the SHAC creating a clear link between restoration priorities and strategic outcomes.



An alignment score was then calculated to reflect the strength of these connections. This score represents the number of prioritization elements associated with each management theme, providing a way to visualize how well proposed actions support the overarching goals of the GC SMP and providing a weighting logic to how strongly each element should contribute to the prioritization score.

Table 31 illustrates this alignment, highlighting areas where restoration efforts can deliver the greatest benefit across multiple management themes.

Table 31. Alignment Score with GC SMP Management Themes

	GC SMP Management Themes					
Prioritization Element	Water Mgmt. & Flow	Community Engagement	Water Quality	River Function	Aquatic Habitat	Alignment Score
Reach	✓	✓	✓	✓	✓	5
Public Access	✓	✓	✓	✓	✓	5
Thermal Stress	✓		✓	✓		3
Fire Impact			✓	✓		2
Sedimentation	✓		✓	✓		3
Nutrient Enrichment			✓			1
Floodplain Connectivity			✓	✓		2

Riparian Potential	✓	✓	✓	✓	✓	5
River Form	✓	✓		✓	✓	4
Ecological Value	✓	✓	✓	✓	✓	5

Note: There may be additional overlap with prioritization elements and GC SMP themes, but this activity focuses on the key connections identified during the process.

Additional Priorities and Action

In addition to the primary prioritization elements, secondary prioritization elements were developed to capture other priorities such as flow management, filling data gaps, and community engagement which fall outside the stream reach prioritization but remain essential for supporting long-term watershed resilience.

Secondary Prioritization Elements

1. Operations Management
2. Establish Flow Targets if Applicable
3. Additional Monitoring Recommended to Fill Data Gap
4. Preserve Reference and Restored Reaches
5. Community Education and Outreach

Identification of Secondary (Non-Project) Goals

In addition to project-based prioritization, reaches were evaluated for secondary management goals that do not necessarily imply near-term restoration actions:

Table 32. Secondary Goals and Criteria

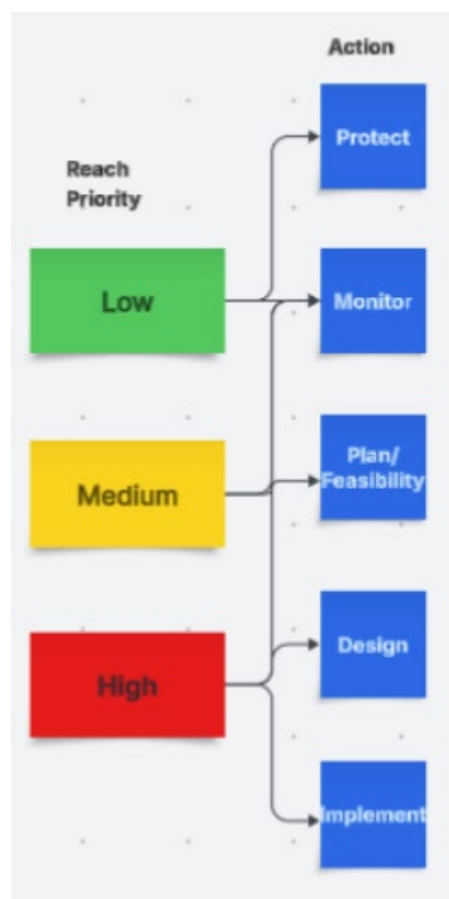
Secondary Goal	Criteria
Operations Management	Minimum flow metric = F
Establish Flow Targets	No flow grades available
Monitor	Data gaps in element-related reach grades
Protect	Overall reach grade = A
Education and Outreach	Explicit education/outreach relevance

These designations and criteria in Table 32 allow reaches to be flagged for protection, monitoring, operational planning, or community engagement, even if they are not immediate restoration priorities.

From Grades to Action: How Prioritization Shapes Restoration Decisions

All of the information, which includes the GC-RHAF metrics, prioritization elements, and alignment scores, was integrated into a stream reach prioritization tool designed to provide an objective, data-driven ranking of stream reaches. This tool assigns each of the 42 stream reaches a numerical score based on the combined influence of physical, chemical, and biological conditions, as well as alignment with management themes. Using the numerical scores, reaches are categorized into High, Medium, and Low priority tiers, with each tier linked to its corresponding numeric value. These tiers are intended to support strategic planning rather than dictate project selection.

This structured approach ensures that restoration efforts and their associated actions are focused where they will deliver the greatest ecological and community benefit, while maintaining transparency and consistency across the decision-making process. The final GC SMP Stream Reach Prioritization is available in Appendix D.



References

Peer-Reviewed Literature

Brown, M., & Vivas, M. (2005). Landscape development intensity index (LDI): Grading scales for assessing watershed development impacts. *Environmental Monitoring and Assessment*, 101(1–3), 289–309. <https://doi.org/10.1007/s10661-005-0296-4> (Brown & Vivas, 2005)

O'Brien, G. R., Wohl, E., & Lane, B. A. (2019). Valley confinement as a metric of floodplain function. *River Research and Applications*, 35(3), 220–232. <https://doi.org/10.1002/rra.3405> (O'Brien et al., 2019)

Regulatory Standards and Guidance

Colorado Department of Public Health and Environment, Water Quality Control Commission. (2024). Regulation No. 33: Classifications and numeric standards for Upper Colorado River Basin and North Platte River Basin (5 CCR 1002-33; effective Dec 31, 2024). Denver, CO. (CDPHE WQCC, 2024a)

Colorado Department of Public Health and Environment, Water Quality Control Commission. (2024). Regulation No. 31: The basic standards and methodologies for surface water (5 CCR 1002-31; effective Dec 31, 2024). Denver, CO. (CDPHE WQCC, 2024b)

Colorado Department of Public Health and Environment (CDPHE), Water Quality Control Division. 2010. *Policy 10-1: Aquatic Life Use Attainment*. Denver, CO.
<https://cdphe.colorado.gov/water-quality/water-quality-engagement/policy-10-1-aquatic-life-use>

Colorado Department of Public Health and Environment, Water Quality Control Commission. (2014). Policy 98-1: Guidance for Implementation of Colorado's Narrative Sediment Standards, Regulation #31, Section 31.11(1)(a)(i) (Approved November 12, 2024, expires: December 31, 2027.) (CDPHE WQCC, 2024c)

Colorado Department of Public Health and Environment (CDPHE), Water Quality Control Division. 1998. *Methodology for Determining Sediment Impacts from Stream Projects and Activities (98-1)*. Denver, CO.

Colorado Water Conservation Board (2022). Colorado River Health Assessment Framework (CoRHAF) https://www.coloradosmp.org/wp-content/uploads/2022/10/CORHAF_Pre-Conference_Workshop.pdf (CWCB, 2022)

Colorado Parks and Wildlife (CPW). *Colorado Fishing Brochure: General Information: Gold Medal Waters*. <https://cpw.widencollective.com/assets/share/asset/pplak0hxb1>

Technical Reports and Tools

Coalition for the Poudre River Watershed (2024). 2024 Cache la Poudre Watershed River Health Assessment Framework Introduction + Users Guide.
<https://drive.google.com/file/d/1KTFXAfW4pDlGZ2bYHfpBII79ZVv4qX8t/view>

Colorado Natural Heritage Program. 2024. The Colorado Ownership, Management and Protection Map (COMaP), 2024. Colorado State University, Ft. Collins, CO.
<https://comap.cnhp.colostate.edu>

Friends of the Yampa. Yampa River Scorecard. Retrieved from <https://yampascorecard.org> (Friends of the Yampa, n.d.)

Gilbert, J. T., Macfarlane, W. W., & Wheaton, J. M. (2016). The riparian condition assessment toolbox (RCAT). Utah State University. <https://www.usu.edu/rcat> (Gilbert et al., 2016)

Lotic Hydrological. (2024). Grand County Comprehensive Watershed Assessment report. Prepared for Learning By Doing. https://www.grandcountylearningbydoing.org/uploads/6/2/2/2/62221315/watershed_assessment_final_052124.pdf (Lotic, 2024)

Tetra Tech, Grand County, (2010). Colorado Stream Management Plan Grand County, Colorado, Phase 3. Prepared for Grand County, Colorado, <https://www.co.grand.co.us/DocumentCenter/View/866/Draft-Report?bidId=>

Flow Regime		
Drives stream function: shapes habitat, moves sediment, and supports aquatic life High flows flush sediment, clean streambeds, and maintain channel form, Low flows provide steady water during dry or cold periods		
Metrics	Flushing flows- Annual 3-day Peak flows	Important to flush accumulated fine sediments and algae from stream substrate to support macroinvertebrates and fish; target achievement desired at least once every two years.
	Summer base flows	Upper target identified to maximize habitat availability and quality for select species; graded based on % of summer days (April - September) the target is achieved.
	Winter base flows	Upper target identified to reflect expected needs for trout incubation and spawning habitat quality; graded based on % of winter days (October - March) the target is achieved.
Project Influence	Flow regime is influenced by weather patterns and water management, not modified by reach scale stream restoration projects. Reach scale projects may affect the dynamics of flow (width, depth, and velocity) in the stream. Many of the reaches in the assessment represent natural or unaltered flow and are given an A grade. Reaches that without flow targets were not graded.	

Sediment Regime		
Shapes habitat: forms pools, riffles, and bars that support fish and insects Too much fine sediment can smother habitat and carry pollutants; too little sediment leads to channel downcutting and habitat loss Post-fire runoff increases sediment loads: erosion from burned areas can overwhelm streams Healthy balance prevents erosion and supports floodplain connectivity and nutrient cycling		
Metrics	Watershed Sediment Supply: Land Development Index and Wildfire Burn Areas	The ability for the watershed to provide a natural supply of sediment to the river. Watershed sediment supply can be affected by the density of development within the watershed and wildfires located within the watershed.
	Local Sediment Supply	The ability for the adjacent streambanks and bars to provide a natural supply of sediment to the river. Local sediment supply can be affected by excessive streambank migration and erosion, or by excessive sediment deposits within the river.
	Sediment Continuity and Transport: Dams & Diversion Structures	The ability for the river to naturally transport sediment and achieve a balanced sediment regime. Sediment continuity and transport can be affected by flow reductions in the watershed caused by dams and diversion takeouts.
Project Influence	Local sediment supply is highly influenceable by stream restoration projects through planting vegetation buffers to reduce offsite sediment supplies, addressing eroding streambanks and channel bed, and enhancing channel shape (planform, profile, and cross section) to support sediment transport and continuity. Watershed sediment supply and sediment continuity and transport are affected by development and wildfires and are not modified by stream restoration projects.	

Water Quality Directly affects aquatic life: poor water quality can harm fish, insects, and other organisms Reflects land use and watershed conditions: shows the impact of runoff, pollution, and upstream activities Provides early warning signs: detects issues before visible damage occurs Supports multiple uses: clean water benefits recreation, agriculture, and community health		
Metrics	Nutrients: Total Nitrogen and Total Phosphorus	Excessive nutrients can lead to algal blooms and reduce oxygen in the water, leading to potential harm for fish and insects.
	Dissolved Oxygen (DO)	Sufficient DO is critical for the survival of fish, aquatic insects and other stream life. Low DO levels indicate pollution, warm temperatures, or stagnant conditions. Healthy DO indicates a well-functioning, balanced stream.
	pH	Measures water chemistry balance and biological stress. If the water is too acidic or too alkaline, it can harm fish and insects, increase the toxicity of certain pollutants, and disrupt natural processes.
	Metals: Iron	Indicator of pollution and geochemical shifts. Excessive iron can harm aquatic life.
Project Influence	Restoration projects improve water quality by reducing runoff and stabilizing stream conditions. Riparian vegetation filters pollutants, helps keep the water cooler, and supports natural chemical balance. Stabilized banks help trap nutrients and metals and reconnecting floodplains improves flow and aeration of the water.	

Stream Temperature Determines which aquatic species thrive: cold-water fish, like trout, need cool, stable temperatures Affects oxygen levels: warmer water holds less oxygen, which stresses aquatic life Signals other problems: high temperatures may indicate low flows, loss of shade, or land use impacts		
Metrics	Chronic (Maximum Weekly Average or MWAT)	Tracks long-term exposure to warm temps, which can reduce fish growth and reproduction
	Acute (Daily Maximum or DM)	Identifies short-term thermal spikes that can cause immediate stress or death in sensitive species
Project Influence	Local stream restoration projects can help cool water by adding shade from riparian vegetation, reconnecting floodplains, and reshaping channels to reduce shallow, sun-exposed areas. These changes can support reductions in peak temperatures and create more stable conditions for cold-water species like trout.	

Riparian Connects land and water systems: riparian zones act as ecological buffers that stabilize banks, filter pollutants and regulate stream temperature Supports wildlife and biodiversity: provides critical habitat and migration corridors Enables natural river function: intact floodplains help absorb floods, recharge groundwater, and reduce erosion		
Metrics	Floodplain Confinement	Restriction of the areas immediately adjacent to the channel banks due to surrounding topography or human encroachment. Confined areas lead to faster flow and more erosion.
	Floodplain Fragmentation	Impact of human development that breaks the floodplain down into smaller, less connected areas. Fragmented areas lose the ability to slow and absorb water and break up migration corridors.
	Riparian Condition	Ecological health of the riparian area, primarily vegetation, but includes land cover and land use as well. Healthy zones stabilize banks, filter runoff, and support habitat.
Project Influence	Riparian conditions are highly influenceable by stream restoration projects through planting of more diverse native vegetation, expanding streamside cover, and reconnecting riparian areas to the stream. Floodplain confinement and fragmentation are more challenging to address through individual projects since they're largely shaped by existing development or natural terrain.	

Geomorphology Defines the river's shape and ability to adjust: healthy streams shift naturally with flow, sediment, and vegetation Supports habitat and resilience: dynamic rivers form pools, riffles, and floodplain connections that sustain aquatic life Signals disturbance or recovery: changes in geomorphology reflect impacts from development, wildfire, or flooding		
Metrics	Planform Dynamics	Ability for the river to naturally shift and adjust its planform when stressors (development, wildfire, flooding) in the watershed are present. The river's planform is its shape from above—its curves and bends. A natural planform creates diverse habitats and supports floodplain connection.
	Profile Dynamics	Ability for the river to naturally shift and adjust its profile when stressors (development, wildfire, flooding) in the watershed are present. The river's profile is its slope and elevation changes along its length. A healthy profile helps water flow smoothly, prevents erosion or buildup, and supports a stable, connected stream channel.
Project Influence	Both planform and profile dynamics are highly influenceable through stream restoration projects such as channel re-meandering and cross-sectional improvements (flow dynamics including width, depth, velocity) especially where the channel has been heavily altered.	

Aquatic Ecosystems		
Reflect overall stream health: the presence and diversity of aquatic life indicate how well the stream is functioning Support food webs and biodiversity: fish and insects play key roles in sustaining healthy ecosystems Respond to changes in flow, water quality, and habitat: valuable indicators for guiding restoration and management		
Metrics	Microhabitat for Macroinvertebrates	Stream bed composition, with substrate sizes to support diverse (and sensitive) aquatic insects at the base of the food web.
	Trout Spawning Habitat	Consists of well-oxygenated sections of stream with clean gravel beds where trout lay and incubate their eggs.
	Macroinvertebrates	Aquatic insects and other small organisms like mayflies and caddisflies are sensitive indicators of water quality and ecosystem health.
	Fish Communities	Reflect the availability of food, habitat, and connectivity. Fish presence and higher biomass signal a healthy, balanced stream.
Project Influence	Restoration projects can improve aquatic ecosystems by enhancing habitat, stabilizing flows, and improving water quality. For example, adding riffles and pools creates diverse microhabitats for insects and fish, while reducing fine sediment protects trout spawning areas.	