Complete Methodology

Flow data was gathered for the last ten water years (2007-2016) and compared to available historic data on the river. We took data from three different USGS gauge locations on the river and averaged the recent flow data and compared it to averaged historic flow data to conclude the percentage that the flow on the river has changed. Flow data is recorded in cfs.

Water Quality is a combination of multiple factors that, when combined, provide an overall snapshot of the water quality on the river. Data was taken from the same USGS locations on the river where flow data was taken, with the exception of nutrients, where conclusions were drawn from the DWR Regulation 85. There are many factors that contribute to water quality, and this assessment is not a comprehensive review.

Nutrients are nitrogen and phosphorus. They are a part of all aquatic ecosystems and are necessary to support the growth of the algae and aquatic plants that provide food and habitat for fish and smaller aquatic organisms. However, excess nitrogen and phosphorus can result in serious water quality problems. It impairs drinking water, endangers aquatic life, and threatens recreational uses. Nutrient pollution can also pose serious risks to human and animal health and damage to the economy. Too much nitrogen and phosphorus in the water causes algae to grow faster than ecosystems can handle.

Temperature impacts the rates of metabolism and growth of aquatic organisms, rate of plants' photosynthesis, solubility of oxygen in river water, and organisms' sensitivity to disease, parasites, and toxic materials. We used temperature data from the last 3 years to determine the average overall temperature, and compared, when possible, to historic data to determine if the water temperature has changed over time. We also analyzed the number of times that each river exceeded the Daily Maximum (DM) temperature standard in the last three water years. Temperature standards are determined by the State of Colorado Water Quality Control Division (Regulation 31).

Specific Conductance is a measure of the concentration of ions in the water, and is an excellent way to determine the overall water quality of a river. Fluctuations in conductance are an early indicator of change in a water system. We used specific conductance data from the last 3 water years to determine the average overall specific conductance of each river. The lower the specific conductance, the higher the quality of the water. Normal acceptable concentrations range from 200 ug/L to 1000 ug/L for freshwater; the lower the concentration the better.

Dissolved Oxygen (DO) is the amount of oxygen (O2) dissolved in the water. Dissolved oxygen is one of the best indicators of water quality. Aquatic species, including fish, macroinvertebrates, and plant life depend on DO for survival, just like we depend on the oxygen in the air we breathe. DO is directly correlated to temperature; cold water can

hold more DO than warm water. DO data was not available on every river; lack of DO data had no impact on grade determination, and was only factored into the score when data was available.

pH is a chemical measure of the acidity of water. It is measured on a scale of 1-14, where seven is neutral, below seven is acidic and above seven is alkaline (basic). Pollution can change a water's pH, which in turn can harm animals and plants living in the water. For instance, water coming out of an abandoned coal mine can have a pH of two, which would be detrimental to fish health. The state of Colorado Water Quality Control Division defines the acceptable range for pH between 6.5 and 9 (Regulation 31). The USGS defines the normal range for pH between 6 and 8.

Major Dams is a way to quantify how impounded each river is. Dams and reservoirs and their management can deeply impact flows, and have negative implications for fish populations and recreation activity. This metric was determined through an assessment of the number and size of dams and reservoirs on the river, scoring only those with storage capacity greater than 15,000 AF. Also taken into consideration was how much water in the basin is diverted for storage purposes, and how severely the impoundments have impacted the river.

Water Diverted out of Basin is a measure of how many AFY are exported from the basin via transmountain diversions, excluding diversions and water compacts that send water outside of the state. The more water that is exported from the basin, the more flow is negatively impacted. Export data is courtesy of the DWR, and is an average of annual transmountain exports from 2011-2015.

Water Use is a measure of how much water is consumed by certain sectors within each basin. We included municipal and commercial, industrial, agriculture, recreation and fishery, and minimum streamflow sectors. The percentages are an average of annual use from 2011-2015. This category was not factored into the grades for each river, given the complexity of water use and the uniqueness of each river, but rather talked about qualitatively with respect to how water is used and managed in the region. Water use is calculated in acre-feet, which is the amount of water required to cover one acre to a depth of one foot. An acre is about the size of a football field, including both end zones.

A*griculture* is a combination of irrigation (water applied to crop vegetation) and stock (livestock watering) augmentation (replacement supply) and recharge (released underground and delivered to a recharge structure for later use).

Municipal & Commercial use is a combination of urban use by a municipality or entity responsible for distributing water, and non-manufacturing businesses such as hotels and restaurants.

Recreation and Fishery are generally non-consumptive uses for aesthetics and acoustical purposes, and the production of fish.

Minimum Stream Flow is defined in statute and used in decrees granted to the CWCB.

Industrial water use is used for manufacturing, mining, steam production and other industrial activities.

*Data for water use and exports from basin is not river-specific, it refers to the basin as a whole

**Limited water quality data is available for the North Platte River, so we included qualitative sources such as news articles and the North Platte Basin Implementation Plan, and expert opinion to determine the appropriate grade for the North Platte with regards to water quality. Similarly, there is no distinct data for water use in the North Platte basin, it was included in the Yampa/White River Basin data. We used this data along with expert opinion and qualitative sources of information to make conclusions and determine the grade for water use. We find the North Platte basin to have a severe lack of available data with regards to water use and water quality, and call for an increase in monitoring and data collection to ensure that this river and the basin as a whole is properly managed, used and conserved.

***Limited flow data is available on the Rio Grande River within Colorado, so in order to make reasonable and informed conclusions about flow, we collected data from one USGS station in northern New Mexico

****The State of Colorado Division of Water Resources does not recognize the North Platte as an individual basin; instead it is combined with the Yampa/White Basin. For this reason, there is no water use chart for the North Platte because data is not available. Because the Yampa basin is larger, the water use chart is more reflective of that basin than it is of the North Platte.

Grading Rubric

	Flow	Quality	Quality	Quality	Quality	Dams	Dams	Exports
	Flow*	Specific Conductance (ug/L)	pH	DO (mg/L)	Temp (°C)	Dam size (AF)	# of Dams[+]	Exports (avg AFY)
A	No change - 5% decrease	0-400	7-8.5	>9.5	0 - 0.1 degree change	15,000 - 25,000	none	0-5,000
B	5%-15% decrease	400-600		8.5-9.5	0.1-0.5 degree change	25,000-75,000	1-2	5,000-40,000
C	15%- 25% decrease	600-800	6.5-7 & 8.5-9	7.5-8.5	0.5-0.9 degree change	75,000 - 150,000	3-4	40,000-80,000
D	25%-35% decrease	800-1000		6.5-7.5	0.9- 1.3 degree change	150,000 -300,000	5-6	80,000-120,000
F	35% and greater decrease	>1000	<6.5 or >9	<6.5	>1.3 degree change	>300,000	>6	>120,000

*Exceptions for South Platte and Colorado where flows have been severely altered due to diversions.
+Exception for the Colorado, where tributary dams are included due to the extent of transmountain exports sourced from the reservoirs on the upper tributaries, as well as the unique status of the Colorado River as a primary water source for millions of people across the West.