

BENEFICIAL USE RECONNAISSANCE  
MONITORING AND ASSESSMENT REPORT

Waterbody: Rock Creek Watershed: Green River

Hydrologic Unit Code: WYGR14040101 Segment: 194-1

Investigators: Glen Garton (WDEQ/WQD)

## INTRODUCTION

The entire reach of Rock Creek is classified by Chapter 1, Appendix A of the Water Quality Rules and Regulations (Unlisted Waters section) as a Class 2, coldwater stream (WDEQ/WQD, 1990). Designated uses for Rock Creek include: agriculture, protection and propagation of fish (coldwater game fish) and wildlife, industry, human consumption, recreation, and scenic value. Rock Creek originates on Deadline Ridge on the east side of the Wyoming Range in western Wyoming. The creek flows south before joining LaBarge Creek (Class 2, coldwater), a tributary to the Green River.

Rock Creek was included in the WDEQ/WQD Monitoring Program because inconclusive data suggested partial use support for aquatic life and cold water fish due to siltation and habitat loss from pastureland grazing and unknown sources (WDEQ/WQD, 1996). Rock Creek was also nominated for possible inclusion in the department's Reference Stream Project by the Bureau of Land Management (BLM) because of a least impacted condition.

One bioassessment station (MRW035) was established at the lower reaches of this segment on September 17, 1997. The pre-monitoring evaluation suggested that a single bioassessment station, located immediately above the county road crossing, would adequately assess this waterbody. This conclusion was based on the small watershed area and limited access to the upper watershed (contained within a BLM Wilderness Study Area). Water chemistry, biological (macroinvertebrates), and physical (habitat quality) data were collected at this site in accordance with the department's bioassessment sampling and analysis plan (King, 1993a), Nonpoint Source Program Quality Assurance Project Plan (WDEQ/WQD, 1993), and Surface Water Quality Assurance Project Plan (WDEQ/WQD, 1989).

The sampler noted no recent precipitation events (within the previous week) occurring at the station prior to sampling.

## DESCRIPTION OF BIOASSESSMENT STATIONS

The Rock Creek bioassessment station (MRW035) was established in the SE $\frac{1}{4}$ NE $\frac{1}{4}$  Sec. 36, T.27N., R.115W., Sublette County, Wyoming. Locational coordinates for the site are 42° 17' 19" north latitude and 110° 25' 43" west longitude. These coordinates were determined from the USGS topographic map. The station was located approximately 100 yards upstream of the road

crossing by Sublette County Road 315 at an elevation of approximately 7,300 feet. The station is found on the *Lake Mountain* USGS 7½' Quadrangle and the *Fontenelle Reservoir* 1:100,000 BLM Surface Management Status map.

## RESULTS AND DISCUSSION

### Physical Setting

The station is located in the foothills landform area of the Middle Rockies West Ecoregion. The predominate geology in the immediate area of the sample station was determined to be diamictite and sandstone of the Wasatch Formation (Twd). The predominant soil type (series or association) at the station has not been mapped and could not be determined. The state wide digital soils map of Wyoming (Munn and Arneson, 1998) lists the general soil taxonomy (order/suborder/great group/subgroup) at this station to be Typic Hapludolls and Typic Hapludalfs, loamy-skeletal, mixed, and frigid. Typic Hapludolls are minimal horizonation (hapl), moist (ud) mollisols (productive soils with a mollic epipedon) representing the central concept of the great group (typic). Typic Hapludalfs are minimal horizonation (hapl), moist (ud) alfisols (moist mineral soils having no mollic epipedon or oxic or spondic horizons) representing the central concept of the great group (typic).

There has been considerable natural gas development on Deadline Ridge immediately north of the Rock Creek watershed. The *Metalic and Industrial Minerals Map of Wyoming* map (Harris et al., 1985) identifies an outcropping of the Phosphoria Formation, a phosphate-bearing strata, along the Rock Creek watershed's northeast margin. That map does not identify any active or abandoned mines in the watershed. The Bureau of Land Management (1991) reports a mineral assessment for the Lake Mountain Wilderness Study Area was conducted by the United States Geological Survey and Bureau of Mines. The BLM reports there is currently no production of leasable minerals in the wilderness study area. There are a few expired phosphate claims but the potential for development is low and uneconomical.

Livestock grazing was determined to be the primary land use at the station. Recreation/wildlife habitat was determined to be the secondary land use. Beaver dams were identified upstream of the bioassessment station.

Discharge at the Rock Creek bioassessment station was visually estimated to be 3.6 cubic feet per second. The drainage area above the sample station was determined to be 6.6 square miles. The *Lake Mountain* USGS topographic map suggests that a significant portion of Rock Creek's flow is from a spring located in SW1/4 of Section 17, T.27N., R.114W. Rock Creek was determined to be an Order 3 stream at this location.

Rock Creek in the sample reach was determined to be an E4 stream type. This stream type is

slightly entrenched, exhibits a very low channel width/depth ratio, displays very high channel sinuosities, and contains a predominately gravel substrate. This stream type represents the developmental end-point of channel stability and fluvial process efficiency (Rosgen, 1996). Rock Creek most likely becomes a B stream type upstream of the station.

Photographs taken at the sampling station include: upstream, downstream, and panoramic views. These photographs can be found in the Rock Creek assessment file.

### Water Quality

Water quality samples at the single station were taken on September 17, 1997. Grab samples were collected, preserved, transported and analyzed in accordance with procedures outlined in the department's Surface Water Quality Assurance Project Plan (WDEQ/WQD, 1989). All water quality data were evaluated for quality assurance and quality control and met data quality objectives. Water quality parameters and results for the Rock Creek station are found in Table 1.

Table 1. Water Quality Parameters and Results, Rock Creek (MRW035),  
September 17, 1997, One station.

<b>Parameter (units)</b>	<b>Results, Stn. 1</b>
Time (hours)	1400
Temperature (°C)	12.7
pH (Standard Units)	8.55
Conductivity (µS/cm)	487
Dissolved Oxygen (mg/l)	7.70
Turbidity (NTU)	2.75
Total Suspended Solids (mg/l)	7
Alkalinity (mg/l)	195
Chlorides (mg/l)	< 5
Sulfate (mg/l)	99
Total Hardness (mg/l)	273
Total Phosphorus (mg/l)	< 0.1
Nitrate Nitrogen (mg/l)	< 0.1

The water temperature observed in Rock Creek (12.7° C) was well below the WDEQ/WQD (1990) maximum allowable stream temperature of 25.6° C for cold water fisheries.

The pH value observed in Rock Creek (8.55 standard units) was basic (greater than 7 standard units) but was below the WDEQ/WQD (1990) upper limit standard of 9.0 standard units. Rock Creek's early afternoon pH reading may have been somewhat elevated due to the response of increased plant photosynthesis (King, 1993a).

Conductivity is a field measurement used to evaluate the level of dissolved constituents in the water. The more dissolved substances present, the higher the conductivity measurement. There are no WDEQ/WQD surface water quality standards for conductivity, however King (1990) reported aquatic organism negative response when conductivities were greater than 6,900  $\mu\text{S}/\text{cm}$ . The conductivity of Rock Creek (487 $\mu\text{S}/\text{cm}$ ) is well below such a level and is not uncommon for waters flowing through a watershed with sedimentary rock geology and having a significant spring source in sedimentary geology.

Dissolved oxygen is the amount of free oxygen available to aquatic organisms. Dissolved oxygen levels observed in Rock Creek (7.70 mg/l) are greater than the 4.0 mg/l one day minimum coldwater criteria for non-early life stages (WDEQ/WQD, 1990).

Turbidity is an optical property of water where total suspended solids (TSS) and some dissolved material cause light to be scattered. An increase in turbidity and TSS has been shown to decrease the production and abundance of plant material, decrease abundance of fish food organisms, and decrease production and abundance of fish (Lloyd, 1987 and Newcombe and Jensen, 1996). The WDEQ/WQD (1990) numeric standard for turbidity deals with turbidity increases attributable to the activities of man. The WDEQ/WQD (1990) narrative standard for floating and suspended solids states that activities attributable to man shall not cause significant degradation of habitat for aquatic life or adversely affect plant life or wildlife. Lloyd's (1987) literature review of the effects of turbidity on salmonids suggested that turbidities in the 10-25 NTU range and TSS concentrations near 35 mg/l can have deleterious effects on fish. Newcombe and Jensen's (1996) literature review suggest TSS values between 18 and 35 mg/l can result in reduced feeding and abundance, and TSS values in the range of 50 to 66 mg/l can result in reduced rates of weight gain and avoidance behavior in adult rainbow and cutthroat trout. The instantaneous turbidity (2.75 NTU) and TSS (7 mg/l) of Rock Creek are quite low and do not suggest a negative effect on the aquatic life.

Alkalinity refers to the capacity of water to neutralize the addition of acid. Alkalinity is also important for primary production (bacteria and algae) in streams which directly affects the macroinvertebrate community. Generally, as alkalinity increases, stream production increases (King, 1993a). There is no numeric alkalinity standard in Wyoming, but a minimum limit of 20 mg/l has been set by the U.S. Environmental Protection Agency (1986). Rock Creek's alkalinity

level of 195 mg/l is well above this minimum threshold.

Chlorides and sulfates are the two principal dissolved components in water. Increased chloride or sulfate levels can have a negative effect on benthic macroinvertebrates. WDEQ/WQD (1990) water quality standards set aquatic life acute and chronic chloride standards of 860 mg/l and 230 mg/l, respectively. There is no surface water numeric standard for sulfates in Wyoming, however, King's (1993a) review suggests sulfate levels below 150 mg/l were optimal for macroinvertebrates. Acute chloride (<5 mg/l) and sulfate (99 mg/l) levels in Rock Creek suggest these dissolved constituents were not causing a negative impact to the aquatic life.

Total hardness in stream water is related to the concentration of metals (metallic ions). Common metallic ions that contribute to hardness include calcium and magnesium. Other metallic ions may include iron, strontium, and manganese. There is no total hardness water quality standard in Wyoming, however, if a large disparity between total hardness concentrations are observed between reference streams and the stream being assessed, sampling for specific metal should be conducted (King, 1993a). The total hardness of Rock Creek (273 mg/l) indicates "hard" water. Total hardness values for three reference streams in the "Overthrust" area of the Middle Rockies - West Ecoregion (Hams Fork - Campground, Fontenelle Creek - Upper, and Salt River) ranged from 156 to 213 mg/l with a mean of 178mg/l. The level of hardness in Rock Creek is higher than those at the reference sites but is not uncommon for waters flowing through a watershed comprised of sedimentary geology and may not suggest metallic ion problems.

Phosphorus is an essential element for plant growth and is considered one of two primary nutrients associated with human induced pollution. Even low levels of phosphorus (>0.2 mg/l) can stimulate growth of algae, periphyton, and bacteria. Naturally occurring phosphorus enters the stream primarily by soil erosion and sediment transport. Additional sources of phosphorus can include municipal and industrial effluents, and runoff from animal feeding areas and fertilized lands (King, 1993a). Wyoming has not established water quality standards for phosphorus, however, King's (1993a) literature review suggests total phosphorus levels should not exceed 0.05 mg/l in a stream that enters a lake or reservoir and suggests a target total phosphorus concentration of  $\leq 1.0$  mg/l for streams that do not directly enter lakes. The total phosphorus level in Rock Creek was <0.1 mg/l. Because Rock Creek does not directly enter a lake or reservoir, the total phosphorus level does not suggest a nutrient problem.

Several forms of nitrate nitrogen are present in nature. WDEQ bioassessments sample and analyze nitrate  $\rightarrow$  nitrite nitrogen. Nitrate is considered the other of the two primary nutrients associated with human induced pollution. Sources of human induced nitrate concentrations can be from municipal and industrial effluents, animal feeding operations, fertilizer use, and other human and animal waste runoff (King, 1993a). Wyoming does not have a nitrate standard for aquatic life, however, the human health standard for nitrate nitrogen is 10 mg/l (WDEQ/WQD, 1990). Nitrate nitrogen levels in Rock Creek were less than 0.1 mg/l.

Rock Creek exhibited no surface sheen, visible color, or odors at the time of the sampling. The water was slightly cloudy.

#### Macroinvertebrates and Biological Condition

Macroinvertebrate samples were taken from a 56-foot long riffle. Eight surber samples were randomly located at this site and a composite sample was obtained. Samples were collected and preserved according to WDEQ/WQD bioassessment protocols (King, 1993a).

Macroinvertebrate samples were sent to WDEQ/WQD's contract laboratory (Aquatic Biology Associates, Corvallis, OR) where they were processed and subsampled according to WDEQ/WQD protocol and standard taxonomic effort (King, 1993a). All biological data were evaluated for quality assurance and quality control and met data quality objectives.

Wyoming Department of Environmental Quality biological, water quality, and physical habitat data from 1992 to 1997 were analyzed to construct a regionally-calibrated multi-metric biotic index (Stribling et al., 1999). This analysis resulted in the delineation of four separate bioregions (areas with similar biological attributes). The Rock Creek site falls into the "Rockies" Bioregion. Ten core metrics with pronounced discrimination efficiency (degree of separation between metric value distributions of reference and degraded sites) were used to construct the multi-metric biological index. The metrics for Rock Creek and the resulting index scoring are presented in Table 2. Total scores above the 25<sup>th</sup> Percentile of the Rockies Bioregion "reference" index data were rated as "good" (70.7 - 85.4) or "very good" (> 85.4). Index score values below the 25<sup>th</sup> Percentile are rated as "fair" (47.1 - 70.6), "poor" (23.6 - 47.0), or "very poor" (< 23.6). A "good" or "very good" multi-metric rating suggests full support of aquatic life use. A "fair" multi-metric rating suggests partial support of aquatic life use, and "poor" and "very poor" ratings suggest non-support of aquatic life. Additional metrics assisting in the interpretation of the core metric scores are presented in Table 3.

The Index score for Rock Creek (70.6) is the upper limit value of the "fair" category (47.1 - 70.6) for the Rockies Bioregion. This value falls within the 90% confidence interval of  $\pm 3.3$  index units ( $p = 0.10$ ) bracketing the minimum "good" index score level of 70.7.

Taxa richness refers to the total number of taxa in the sample. The number of taxa generally increases with increasing water quality. An exception is for low productivity mountain streams with naturally low concentrations of dissolved constituents (King, 1993). Mountain streams in the "Overthrust" region of the Middle Rockies West Ecoregion generally would not fall into this "low productivity" streams. Taxa richness (41 taxa of insects and 3 non-insect taxa) for Rock Creek resulted in a metric score of 88, indicating a taxa richness fairly comparable with reference condition.

Table 2. Core Metric Values, Scores, and Rating at Rock Creek (MRW035).

Core Metric	Metric Value	Metric Score
Total Number Taxa	44	88
Ephemeroptera Taxa	5	42
Plecoptera Taxa	6	60
Trichoptera Taxa	9	82
% Diptera (non-chironomid)*	4.6	81
% Non-insects*	2.9	90
% Five Dominants*	64.9	70
HBI*	3.5	75
% Tolerants*	2.5	88
% Scrapers	17.6	31
Total Score		70.6
Rating		Fair

\* Metric where the trend increases with increasing stress (positive TwI).  
 Higher values indicate a negative response.

The percent of non-insects, commonly pollutant tolerant members of the Phyla Annelida (segmented worms) and Platyhelminthes (flatworms), in Rock Creek was low (2.9%) and resulted in a high metric score of 90. The low percentage of non-insects suggests the nutrient enriched, high sediment habitats where many of these species proliferate is absent. Additionally, the low percentage of pollutant-tolerant taxa in the sample (2.5% with a resulting metric score of 88) in the Rock Creek suggest general good water quality. These metrics show good comparability with reference condition.

The order Diptera (two-winged flies) contains a significant number of pollutant tolerant species such as the sewage fly, drone fly, rat-tailed maggot, and mosquito. A low percentage of Diptera taxa suggests a high water quality. The percent of non-chironomid Diptera in the Rock Creek sample was 4.6%. This percentage resulted in a scoring of 81, indicating good comparability with reference conditions.

The percent contribution of the dominant taxa is an indication of community balance. A community dominated by a single taxon or by relatively few taxa indicates environmental stress due to poor water quality or habitat quality (King, 1993). The numerically dominant taxon (Table 3) in the Rock Creek sample comprises 22.38% of the total. King (1993) assigns the highest biological score to samples where the dominant taxon comprises less than 20% of the total. The five dominant species in the Rock Creek sample comprised 64.9% of the total resulting in a metric scoring of 70. This scoring suggests a fair comparability with reference condition.

The modified Hilsenhoff Biotic Index (HBI) involves summation of the pollution tolerances of organisms into a single value. Tolerance values ranging from 0 to 10 are assigned to each organism contained in the sample. Organisms assigned higher values are more tolerant to organic and possibly nutrient and sediment pollutants. A high HBI value indicates that the macroinvertebrate community is comprised of organisms with greater tolerance to pollutants. King (1993) provides references and additional discussion on this index. A modified HBI for Rock Creek of 3.5 is low, suggesting a good representation of pollution intolerant taxa. The Rock Creek modified HBI received a scoring of 75, indicating fair comparability with reference condition.

Taxa in the Orders Plecoptera (stoneflies) and Trichoptera (caddis flies) are generally sensitive to water pollution. The Rock Creek sample contained 6 Plecoptera taxa and 9 Trichoptera taxa. These result in metric scorings of 60 and 82, respectively. The number of Plecoptera taxa is somewhat depressed than observed under reference condition, while the number of Trichoptera taxa indicates good comparability with reference condition.

Two metrics, number of Ephemeroptera taxa and percent scrapers, were primarily responsible for lowering the index score on Rock Creek to the cusp between “fair” and “good.” Ephemeroptera taxa (mayflies) are primarily scrapers, collector gatherers, and shredders and are generally associated with good to excellent water quality (King, 1993b). The number of Ephemeroptera taxa in the Rock Creek sample was 5, resulting in a metric score of 42. Scrapers are a functional feeding group of macroinvertebrates that scrape rock, twigs, and leaf surfaces for food such as periphyton (King, 1993b). Scrapers comprised 17.6% of the total abundance in the Rock Creek sample, resulting in a metric score of 31. The positive response of the other metrics suggest that the low number of Ephemeroptera and the low percentage of scrapers may be more of a function of stream type than of water quality. The E4 stream type at the sample location and its corresponding high percentage of gravels (49%) suggest depressed habitat availability for scrapers and Ephemeroptera.

Additional macroinvertebrate metrics were also analyzed as part of this assessment and are presented in Table 3. The ratio of scraper to filtering collectors reflects the macroinvertebrate food base used by these two feeding groups. Scrapers increase with an increase of diatoms and

decrease as filamentous algae (indicative of organic and nutrient enrichment) increases. Filtering  
 Table 3. Supplemental Metric Values, Rock Creek (MRW035).

Supplemental Metrics	Metric Value
Ratio Scrapper / Filtering Collector	7.93
Ratio EPT Taxa / Chironomidae Abundance	5.11
Percent Dominant Taxa	22.38
% Chironomidae Abundance	11.27
% <i>Cricotopus Nostoccladius</i> / Total Chironomidae	71.9
% Hydropsychidae / Total Trichoptera	0.00
Community Loss Index (Rock Cr. to Fontenelle Cr.)	0.61
% Multivoltine	22.66
% Univoltine	48.29
% Semivoltine	29.05

collectors increase due to the presence of filamentous algae and to an increased source of fine particulate organic matter used for food (King, 1993). The ratio of scrapper to filtering collectors in Rock Creek was 7.93. Even though this ratio is depressed due to the low percentage of scrapers, it still indicates a larger percentage of scrapper organisms than filtering collectors.

The ratio of EPT (Ephemeroptera, Plecoptera, and Trichoptera) to Chironomidae abundance is an assessment of community balance. EPT taxa are relatively sensitive to water pollution while Chironomidae (midges) are generally less sensitive and increase in abundance due to increases in organics and sediment. A balanced community will have a fairly even distribution of each of the four groups with a substantial representation of EPT taxa (King, 1993). A greater proportion of the generally tolerant Chironomidae to the more sensitive EPT taxa generally indicates effects due to water pollution. This ratio for the Rock Creek site was 5.11, indicating an even distribution and balanced community. An exception to this generality is the genus *Cricotopus Nostoccladius*, an indicator of good water quality (King 1993). The percent *C. Nostoccladius* to total Chironomidae was 71.9%, indicating that a larger percentage of the total Chironomidae were comprised of this indicator of good water quality.

Percent Hydropsychidae to total Trichoptera is a metric that measures the density of the generally mild pollution tolerant Hydropsychidae family (primarily filtering collectors) to the density of total Trichoptera (relatively sensitive to water pollution)(King, 1993). King (1993) assigns the

highest biological score to samples where density of Hydropsychidae is less than 20% of the total Trichoptera. Hydropsychidae were not identified in the Rock Creek sample, thereby giving this percentage a zero value. Reference streams in the “Overthrust” area also had zero values.

The Community Loss Index compares macroinvertebrate communities at two locations where at least one location represents a reference or control. The index measures the loss of taxa between the reference location and the comparison location with index values increasing as the degree of dissimilarity with the reference location increases. King (1993) provides additional discussion on the specifics of this index. The macroinvertebrate community in Rock Creek was compared with the community in Fontenelle Creek (Upper). Fontenelle Creek was chosen as the community loss comparison location because its metrics most represents a median of the three reference streams used in this report. Fontenelle Creek (46 total taxa) and Rock Creek (44 total taxa) had 19 common taxa. This results in a community loss index of 0.61. King (1993) reports a community loss index of <0.5 as having the highest biological scoring and a community loss index of 0.5 - 1.6 as having the second highest biological scoring. The community loss index for Rock Creek is slightly outside of the highest biological scoring category.

Community voltinism is a measure of the distribution of taxa with various life cycle requirements. Multivoltine taxa are those that exhibit several life cycles during a single year. Univoltine taxa are those requiring a year to complete a single life cycle, while semivoltine taxa are those that require several years to complete a life cycle. An even distribution of these three assemblages suggests a stable community. The dominance of multivoltine taxa suggest possible seasonal degradation of water quality or periodic pulses of pollutants through the system have limited the survival of univoltine and semivoltine taxa. The Rock Creek site exhibited 22.65% multivoltine taxa, 48.29% univoltine taxa, and 29.05% semivoltine taxa. This suggest a stable community with respect to life cycle assemblages.

The investigator made the following biosurvey observations on Rock Creek: filamentous algae was not observed; floating macrophytes were commonly observed; rooted macrophytes were commonly observed; periphyton was abundant; slimes were not observed; and, fish were not observed.

### Habitat Quality

Physical (habitat quality) data were collected and analyzed according to WDEQ/WQD bioassessment protocols (King, 1993). All data were evaluated for quality assurance and quality control and met data quality objectives.

Substrate composition and silt cover (embeddedness) were recorded at eight, one square foot sample points within the riffle where macroinvertebrates were collected. Water velocity was also

recorded at each of these points. A summary of these data are presented in Table 4.

Table 4. Mean Substrate Composition, Weighted Embeddedness, and Water Velocity at the Rock Creek Sample Riffle.

Mean Percent Substrate (Eight 1 ft. <sup>2</sup> Quadrats)							
Cobble (2.5-10")	Coarse Gravel (1 - 2.5")	Fine Gravel (0.3 - 1")	Sand (<0.3", gritty)	Silt* (<0.3", fine)	Clay (Hard Pack)	Organic (fine, black)	Precipitate (Oil, WWTF)
39	21	28	11	1	0	0	0
<b>Weighted Embeddedness - Silt Coverage</b> (Range 20 to 100) Eight 1 ft. <sup>2</sup> Quadrats				<b>Mean Water Velocity (ft./sec.)</b> Eight Quadrat Locations			
62.6				1.85			

\* Silt substrate is where the silt covering is greater than 1/4 inch deep

The most common substrate component in the Rock Creek sample riffle was cobble (39%). Cobble was also the most common substrate component at the three “Overthrust” reference streams, where the mean cobble composition was 68% (Table 5). The lower percentage of cobble and higher percentages of fine gravel and sand at Rock Creek is likely a factor of the stream’s E4 Rosgen stream type, but may also reflect increased erosion and sediment transport in the Rock Creek watershed. The Rock Creek sample riffle is composed primarily of cobble and gravels (88%). Fines were comprised primarily of sand (11%) with a minor amount of silt (1%) substrate being noted. The presence of rock and gravel in flowing streams is generally considered the most desirable habitat (Plafkin et al., 1989).

Table 5. Substrate Composition and Weighted Embeddedness at Three “Overthrust” Area Reference Streams.

Stream	Cobble (%)	Coarse Gravel (%)	Fine Gravel (%)	Sand (%)	Silt (%)	Weighted Embeddedness
Hams Fork River - Campground	66	22	8	0	3	47.8
Fontenelle Creek - Upper	57	18	15	8	2	77.4
LaBarge Creek	80	10	8	2	0	56.6

The most common embeddedness (silt covering) category observed on the cobble and gravels in the Rock Creek sample riffle was where less than 5% of the surface was covered by silt (44% of the non-fines substrate). The weighted embeddedness rating of 62.6 (weighted embeddedness ranges from 20 to 100 with a rating of 100 being relatively sediment free) indicates moderate embeddedness. This moderate silt covering may be a direct function of wildlife and livestock disturbances in the non-roaded watershed and recreational pressures adjacent to the stream. However, much of this silt covering component likely is a result of the erosive “overthrust” geology of the watershed coupled with the fact that the sample location, an E4 stream type, likely represents the sediment loading area from the steeper watershed above.

The qualitative habitat quality assessment for Rock Creek covered a segment approximately 200 yards upstream and 200 yards downstream of the sampling station. Thirteen assessment parameters were evaluated. Evaluation of these parameters allow for a total habitat score ranging from zero to 200 points. High total point scores equate to high quality habitat. Specifics of the individual habitat parameters are contained in King (1993) and the department’s procedures paper *Beneficial Use Reconnaissance Project - Wadable Stream Monitoring Methodology* (WDEQ/WQD, 1998).

Habitat Scores for Rock Creek and three reference streams located within the “Overthrust” region of the Middle Rockies West Ecoregion are contained in Table 6.

Rock Creek had a total habitat score of 143 points. This score is 97% the mean score for the three reference streams and 93% of the highest scoring reference stream (Hams Fork - Campground). King (1993) suggests streams with  $\geq 90\%$  comparability with reference streams are assessed as comparable and fully supporting.

Table 6. Habitat Scores for Rock Creek as Compared with Three “Overthrust” Reference Streams.

	<b>Rock Creek</b>	<b>Hams Fork - Campground</b>	<b>Fontenelle Cr. - Upper</b>	<b>LaBarge Creek</b>
Total Score	143	153	152	138

Historical and Ancillary Information

The Wyoming Game and Fish database reports Rock Creek (edit date 07/24/97) having Colorado River cutthroat and mottled sculpin present in Sec. 36, T.27N., R.115W.).

The United States Forest Service (Young et. al, 1996) reports Rock Creek to be a stream with

genetically pure Colorado River cutthroat trout. The Rock Creek population is listed in that publication as a conservation population (believed to be indigenous, genetically pure, allopathic above a barrier; and not believed to be in a recently stocked watershed). The ecology of the Colorado River cutthroat trout has rarely been studied but it is believed this subspecies is similar to other cutthroat trout. Colorado River cutthroat trout generally occupy headwater streams characterized by cold, clear, well oxygenated water (Speas et al., 1994).

The Rock Creek watershed is contained almost entirely within the boundaries of the Bureau of Land Management’s Lake Mountain Wilderness Study Area. The BLM is managing this area under Interim Wilderness Study Area Policy to protect wilderness values until a congressional decision on wilderness designation is made. The Rock Creek watershed is also managed by the Bureau of Land Management as an Area of Critical Environmental Concern for the protection of the genetically pure strain of Colorado River cutthroat trout (USDI, BLM. 1991).

Water quality samples were collected by the Bureau of Land Management in 1975, 1977, 1978, 1985-87, and 1989 in Section 29, T.27N., R.114W and Section 36, T.27N., R.115W . Water quality samples were also collected by the Wyoming Game and Fish in 1973 from Section 29, T.27N., R.114W. Data from these sample events were obtained electronically from the University of Wyoming, College of Engineering *Water Resources Data System (WRDS)*. The specific sampling procedures, analysis methods, and quality assurance/quality control on these data are not known, and therefore these are considered as “evaluated” information only. The age of these data make them “historic” information. A summary of these data along with a comparison with WQD’s September 17, 1997 data are presented in Table 6.

Table 6. Historic BLM and Wyoming Game and Fish Evaluated Water Quality Data from Rock Creek as compared with the WQD’s September 17, 1997 data.

Parameter	Mean ( $\bar{x}$ )	No. (n)	Minimum	Maximum	WQD Results
Temp. ( C)	12.5	26	6	21	12.7
Field pH	8.3	21	7.1	9.0	8.55
Conductivity (uS/cm)	401	26	295	550	487
Alkalinity (mg/l)	188	21	166	239.7	195
Chlorides (mg/l)	2.75	18	< 1	9.0	< 5
Sulfates (mg/l)	87	19	5.9	170	99
T. Hardness (mg/l)	246	19	169.71	323.33	273
T. Phosphorus (mg/l)	1.17	8	0.04	8.05	< 0.01
T. Phosphorus* (mg/l)	0.19	7	0.04	0.62	

Nitrate N (mg/l)	0.47	8	< 0.1	1.34	<0.01
Discharge (cfs)	3.56	22	0.8	17.76	3.6

\* Outlier value of 8.05 removed from mean determination.

The general summary of historical, evaluated data from Rock Creek is very comparable with that taken by the WQD during the assessment (Table 1), with the exception of nutrients (total phosphorus and nitrate nitrogen). One total historical phosphorus value (8.05 mg/l) was an extreme outlier and was questioned for validity. The higher total phosphorus values observed in the historical data could be explained by water samples with higher levels of suspended solids being collected during runoff periods. The presence of the Phosphoria formation in the watershed may be a source of this nutrient. The higher, historical nitrate - nitrogen values may be the result of invalid samples or possibly reflect a flush of nutrients from wildlife and livestock during runoff periods. The complete lack of filamentous algae and the low percentage of non-insect taxa at the sample locations does not support the notion of a long-term nutrient problem. Some of the BLM samples exhibited concentrations of metals (zinc, lead, silver, and chromium) above detection limits, but below water quality standards. The presence of these metals in a stream within a sedimentary geology with no mining activity appears unusual. It is believed the presence of these metals reflect sample contamination from the use of galvanized and/or soldered metal sampling equipment and not water quality conditions.

## SUMMARY AND CONCLUSIONS

### Classification

Rock Creek is correctly classified as a Class 2, Coldwater game fish stream. This conclusion is based on this assessment and on data from the Wyoming Game and Fish database, Bureau of Land Management, and United States Forest Service indicating the presence of Colorado River cutthroat trout.

### Water Quality

Water quality data collected from Rock Creek on September 17, 1997 do not identify any water quality standards exceedences or conditions that would suggest nutrient, sediment, or toxicant problems. The basic pH observed at the Rock Creek site may be primarily a function of increased plant photosynthesis during the mid-afternoon sampling.

### Macroinvertebrates and Biological Condition

Bioassessment core metrics indicate that Rock Creek's macroinvertebrate community is generally comparable to that in reference streams, although a decrease in percent scrapers and the number of Ephemeroptera taxa was noted. The secondary metrics examined suggest the borderline "fair/good" rating arrived at via the core metrics may be more a function of stream

type than water quality. These metrics suggest a higher degree of similarity between Rock Creek and reference condition than observed solely through the core metrics.

Physical and Habitat Quality

The substrate composition and moderate amount of silt coverage (embeddedness) at the Rock Creek site suggest good habitat for macroinvertebrates and fish spawning and rearing. The lower percentage of cobble substrate and higher percentages of fine gravel and sand at the Rock Creek site may be the result of the lower gradient and velocity exhibited by its “E” stream type. Erosion and sediment transport at a level somewhat higher than other “Overthrust” area reference sites may be occurring in the Rock Creek watershed. Habitat parameters taken at the Rock Creek sample location indicate the physical habitat is comparable with that of the three reference streams examined.

FINAL ASSESSMENT AND SIGNATURES

Review of the chemical, biological, and physical data collected on Rock Creek on September 17, 1997 indicates that Rock Creek, a tributary of LaBarge Creek, is a Class 2 (cold water) waterbody. Rock Creek may be slightly impacted by natural or man-induced activities but is fully supporting of all its designated beneficial uses.

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