

Hellroaring Creek Stressor Identification

Task Order 26
Contract 68-C-02-111

Prepared for:

U.S. Environmental Protection Agency
Region X
Seattle, WA

and

Idaho Department of Environmental Quality
Coeur d'Alene Regional Office
Coeur d'Alene, ID

Prepared by:

TerraGraphics Environmental Engineering
108 W. Idaho Avenue
Kellogg, ID 83837

Under contract to:

Parsons
10521 Rosehaven St
Fairfax, Virginia 22030

September 29, 2006

Table of Contents

Summary 1
Section 1.0 Scope of the Investigation..... 2
Section 2.0 Description of the Impairment 4
Section 3.0 Candidate Causes 5
Section 4.0 Existing Data..... 7
 4.1 Physical Habitat Data..... 7
 4.2 Biological Data 8
 4.3 Water Chemistry 9
Section 5.0 Analysis..... 10
 5.1 Stressor Refinement..... 10
 5.2 Candidate Cause Elimination..... 10
Section 6.0 Conclusions..... 12
Section 7.0 References..... 13

Table of Tables

Table 1 Index Scores for the Hellroaring Watershed..... 4
Table 2 Index Scoring Criteria..... 4
Table 3 Summary of Selected BURP Habitat Data for Hellroaring Creek..... 7
Table 4 Hellroaring Creek CWE Assessment Results..... 7
Table 5 Hellroaring Creek Adverse Conditions..... 7
Table 6 Summary of Individual Metric Scores for Hellroaring Creek 8
Table 7 Water Chemistry and Field Parameter Results from August 2006..... 9

Table of Figures

Figure 1 Hellroaring Creek Site Location Map 3
Figure 2 Hellroaring Creek Conceptual Model of Candidate Causes..... 6
Figure 3 Individual Metric Scores of Hellroaring Creek Compared to the Average Score of
 BURP sites with SMI scores >2 for the Pend Oreille Sub-basin..... 9

SUMMARY

TerraGraphics Environmental Engineering, Inc. (TerraGraphics) identified seven potential stressors or causes for fish, macroinvertebrate or habitat scores to be significantly different from established reference sites. The stressors include:

- Low nutrients resulting in low fish and macroinvertebrate abundance;
- Increased flood frequency and maximum stream flows with a concomitant decrease in base flows;
- Increased sediment delivery and percent fines;
- Reduction in riparian cover, shift in riparian plant species, lower quality shade;
- Increased metal concentrations;
- Increased nutrients; and
- Ineffective sampling or inappropriate reference stream reaches for comparison.

Increased nutrients and high metal concentrations were eliminated as potential stressors based on available information from investigation of current and historic land use practices. We concluded that the likely causes of impairment are from increased sediment delivery, low nutrients and, to a lesser extent, stream temperature.

We recommend that a sediment Total Maximum Daily Load (TMDL) be developed for the Hellroaring Creek Watershed.



SECTION 1.0 SCOPE OF THE INVESTIGATION

The following is taken from the Idaho Department of Lands (IDL) Cumulative Watershed Effects (CWE) investigation.

“Hellroaring Creek flows into the Pack River about 1/3 mile past the end of County Road 47 and approximately 6 ½ miles upstream from Colburn, Idaho. The Hellroaring Creek drainage contains 7,728 acres used primarily for forestry with a small area of rural residential. Land ownership is distributed among Industrial timber companies, the Idaho Panhandle National Forest, the Idaho Department of Lands (IDL), and small private owners.

Hellroaring Creek is a third order tributary to the Pack River. The drainage is oriented in an easterly direction with Hellroaring Creek generally flowing west to east. Elevation ranges from 2220 feet at the confluence with the Pack River to 5720 feet at the headwaters. The Hellroaring Creek watershed is underlain by Cretaceous granitics of the Kaniksu Batholith. In the very lower portion of the drainage, near the mouth of the creek, there are deposits of Pleistocene unconsolidated glacial debris and coarse alluvial materials.

Cool, dry summers and moderately cold winters characterize the area. Average annual precipitation ranges from 30 inches at the lower elevations to 50+ inches in the headwaters. The majority of precipitation occurs as winter snowfall and spring rain. High-volume runoff occurs during spring snowmelt and major rain-on-snow events.

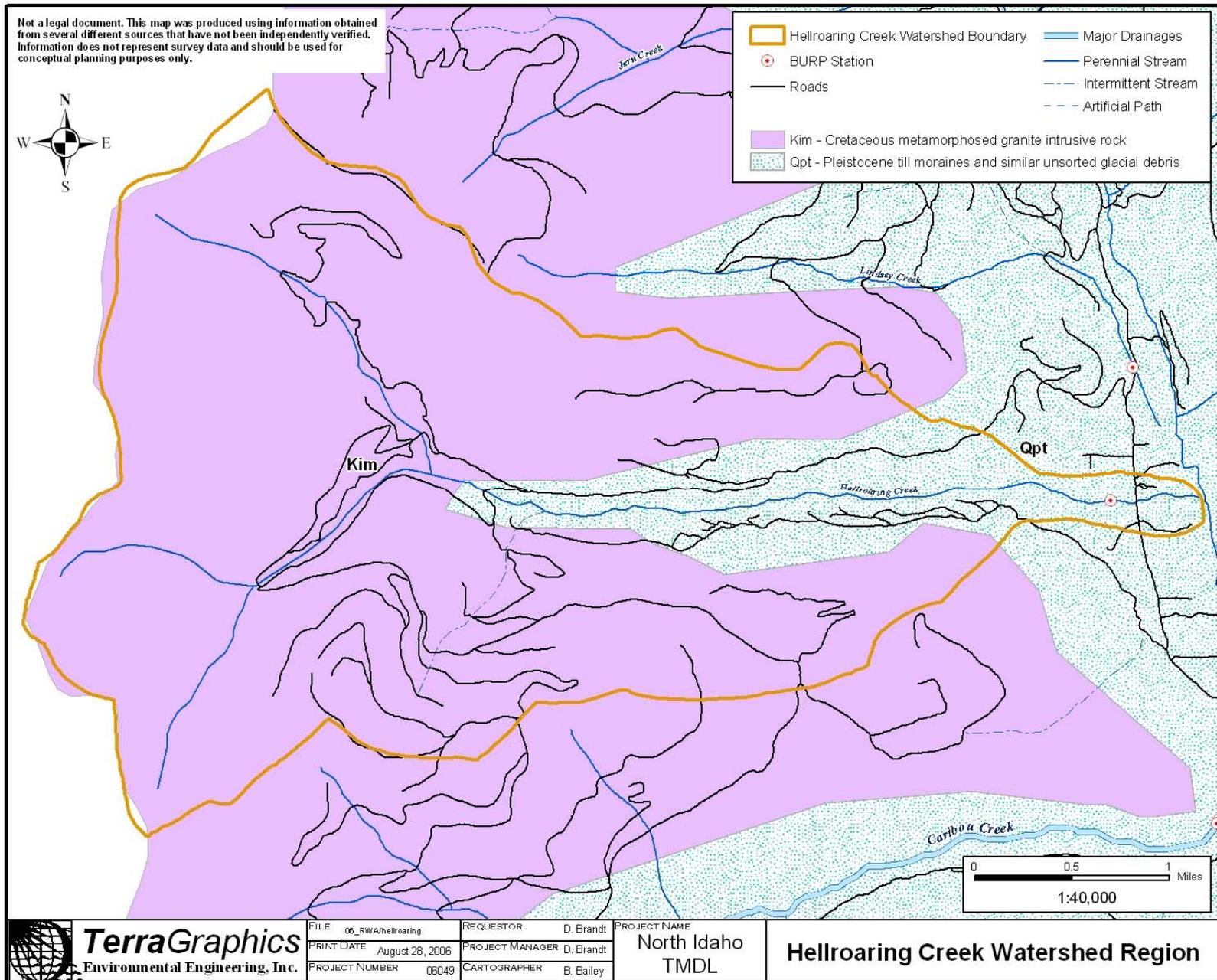
Vegetation varies with elevation, aspect, and landform. Lower elevations generally support Cedar-Hemlock habitat types. Uplands support a mixed conifer forest of Douglas fir, grand fir, red cedar, larch, hemlock, ponderosa pine, lodgepole pine, and western white pine with the more xeric species dominating south to west facing aspects. Higher elevation sites include subalpine fir, spruce, alder, alpine alder, willow and .

Very wet areas especially along riparian zones support alder, willow, and other water loving species” (IDL 2003).

The Stressor Identification was completed using existing biological data, water chemistry data, aerial photos, field notes from previous investigations, Idaho Department of Environmental Quality (IDEQ) BURP database and Pend Oreille Sub-basin TMDL, U.S. Forest Service (USFS) reports, interviews, and Geographic Information Systems (GIS) coverages (land use, geology).

A map of the drainage with some distinguishing features can be found in Figure 1.

Figure 1 Hellroaring Creek Site Location Map



SECTION 2.0 DESCRIPTION OF THE IMPAIRMENT

In 1998, the Coeur d'Alene office of IDEQ conducted a rapid bioassessment survey of Hellroaring Creek. The data were analyzed according to the Ecological Assessment Framework (Grafe 2002a) and the Water Body Assessment Guidance (WBAG) document (Grafe et al. 2002b). A status report was created in 2002. The Index Scores for Hellroaring Creek are located in Table 1. IDEQ determined that the Stream Macroinvertebrate Index (SMI) was significantly lower than expected for a stream within the Northern Rockies Ecoregion (Table 2). The Stream Fish Index (SFI) was also lower than expected. The Stream Habitat Index (SHI) was consistent with habitat conditions found in reference streams. The result of the assessment was the determination that Hellroaring Creek was not supporting its beneficial uses of cold water aquatic life and salmonid spawning. The pollutants identified as causing the impairment were “thermal modifications” and “unknown.” This stressor identification process will address the “unknown” pollutant and will not attempt to verify the validity of the “thermal modification” determination.

Table 1 Index Scores for the Hellroaring Watershed

Assessment Unit	Stream	BURP ID	Stream Macroinvertebrate Index (SMI)	Stream Fish Index (SFI)	Stream Habitat Index (SHI)
ID17010214PN044_02	Hellroaring Creek	1998SCDAB023	45.315	51.861	70

Table 2 Index Scoring Criteria

Condition Category	SMI (Northern Mountains)	SFI (Forest)	SHI (Northern Rockies)	Condition Rating
Above 25 th percentile of reference condition	≥65	≥81	≥66	3
10 th to 25 th percentile of reference condition	57-64	67-80	58-65	2
Minimum to 10 th percentile of reference condition	39-56	34-66	<58	1
Below minimum of reference condition	<39	<34	N/A	Minimum threshold

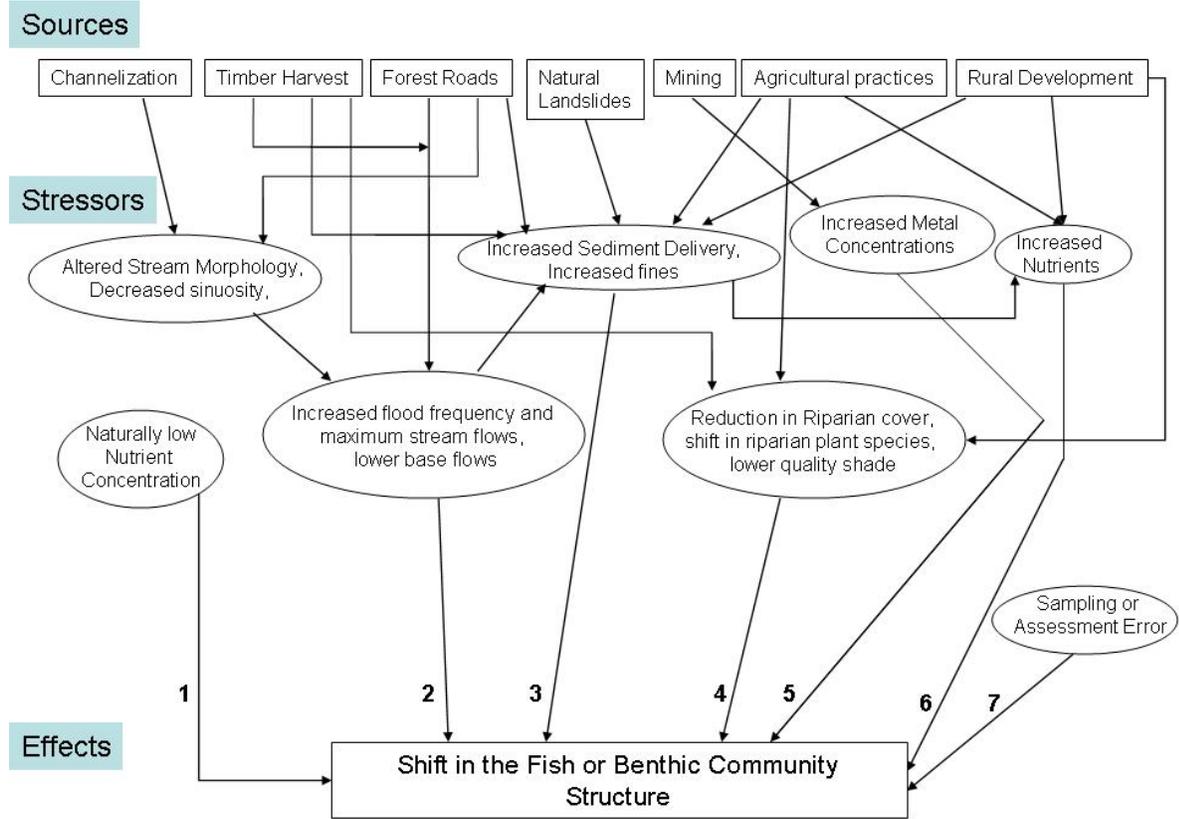
Note: N/A – Not available. SHI does not have a minimum threshold condition rating.

SECTION 3.0 CANDIDATE CAUSES

A conceptual model of candidate causes has been created for the Hellroaring Watershed (Figure 2). The conceptual model indicates seven potential causes for the low SMI and SFI scores for Hellroaring Creek. These seven causes include:

1. **Low nutrients resulting in low fish and macroinvertebrate abundance.** If low nutrients are the cause, one would expect low macroinvertebrate abundance and low species diversity due to limited periphyton biomass for the grazer and scraper guilds, low levels of detritus for shredder guilds and insufficient biomass to support macroinvertebrate predators. The low biomass of macroinvertebrates would result in low food for the fish community, resulting in low fish abundance.
2. **Increased flood frequency and maximum stream flows with a concomitant decrease in base flows.** If these were the causes, the stream flows during the time in which the BURP data were collected would be too low to support a viable aquatic community.
3. **Increased sediment delivery and percent fines.** Increased percent fines decreases both the amount of interstitial space for emerging fish fry as well as intergravel dissolved oxygen. This would result in a decreased survival rate of young of the year fish and a resultant reduction in the total fish abundance within the system. The higher percent fines would also result in a shift in the taxa of macroinvertebrates present in the stream. The sediment intolerant species would be suppressed and the sediment tolerant taxa would have higher abundance.
4. **Reduction in riparian cover, shift in riparian plant species, lower quality shade.** The loss of riparian cover and/or a shift to a lower shade canopy would result in increased stream temperatures. This would cause a shift in the aquatic macroinvertebrate community and the fish community. Fish species that require cold water, particularly for spawning and rearing areas, would have increased year class mortality and lower biomass than areas with more or higher quality shade.
5. **Increased metal concentrations.** Increased metal concentrations would result in a reduction in biomass and taxa richness.
6. **Increased nutrients.** Excessive nutrients would result in nuisance levels of periphyton, and lower scores on the Hillsenhoff Biotic Index (HBI).
7. **Ineffective sampling or inappropriate reference stream reaches for comparison.** The BURP protocol and the WBAG II were developed to assess beneficial use support conditions for a wide variety of streams. There is a sub-set of streams that are outside of the range of conditions used to develop the field protocols and the assessment model. These conditions could include things such as too little water, too large of stream, too large of substrate, or too steep of gradient. The result of applying the field techniques and assessment protocol to those streams outside the range of experience of the model would result in an erroneous assessment of not full support.

Figure 2 Hellroaring Creek Conceptual Model of Candidate Causes



SECTION 4.0 EXISTING DATA

4.1 Physical Habitat Data

Table 3 summarizes the habitat data collected during the Beneficial Use Reconnaissance Program (BURP) sampling event. The habitat data collected for Hellroaring Creek indicate that the creek exhibits similar characteristics as reference sites for the Northern Rockies.

Table 3 Summary of Selected BURP Habitat Data for Hellroaring Creek

BURP ID	Bank Cover Percentage	Bank Stability Percentage	Percent Canopy	Percent Fines	Embedded Score	Channel Shape Score	Pool/Riffle Ratio	Average Wet Depth (m)	Average Wet Width (m)	Width/Depth Ratio (wetted)	Discharge (cfs)
1998SCDAB023	97	100	67.5	29	19	7	N/A	0.41	3.53	25.54	19.5

Note: Percent fines was recalculated from BURP field sheets since the database values did not match up with values from the field sheets.

IDL conducted a Cumulative Watershed Effects (CWE) survey on the Hellroaring Watershed. Tables 4 and 5 contain the index scores and summary evaluations of the watershed. The CWE survey indicates that there are high risks of mass failure and total sediment delivery. The primary contributors to this determination are the watershed gradient and the soil type.

Table 4 Hellroaring Creek CWE Assessment Results

CWE Watersheds	Results	Channel Stability	Canopy Removal	Roads	Mass Failure	Total Sediment Delivery	Hydrologic Risk
Hellroaring Creek	<i>Score</i>	49	0.33	59.8	59.5	131.2	
Acres: 7728 FPA Acres: 7723	<i>Rating</i>	Moderate		High	High	High	Moderate

Notes: FPA=Forest Practices Act
Canopy Removal is expressed only as a score.
Hydrologic Risk is expressed only as a rating.

Table 5 Hellroaring Creek Adverse Conditions

CWE Watersheds	Temperature Adverse Condition	Nutrient Adverse Condition	Fine Sediment Adverse Condition	Hydrologic Adverse Condition
Hellroaring Creek	Yes	N/A	Yes	No

4.2 Biological Data

Table 6 summarizes the individual metric scores that are components to the SMI used in the WBAG process. Figure 3 is a graphical representation of the individual metric scores plotted with the average metric scores of streams assessed to be full-support within the Pend Oreille Sub-basin. The scores presented are not the raw metric scores but a conversion of the raw scores to a similar scale and scoring for this ecoregion. The full explanation of how these scores are derived can be found in the WBAG II document (Grafe et al. 2002b). For most metrics, Hellroaring Creek scores are significantly lower than the full support streams within the Pend Oreille Sub-basin. The only exception is HBI and percent dominance of the five most prevalent taxa. Most of these metrics within the SMI are abundance related; therefore, low abundance of macroinvertebrates is the defining characteristic for the low SMI score of Hellroaring Creek. The most pronounced metric reduction from reference is in the number of Trichoptera taxa. The basin average for full support streams is 62 whereas Hellroaring Creek scores 8.3. The only Trichoptera taxa found within the sample was Rhyacophila which is classified as an engulfer predator.

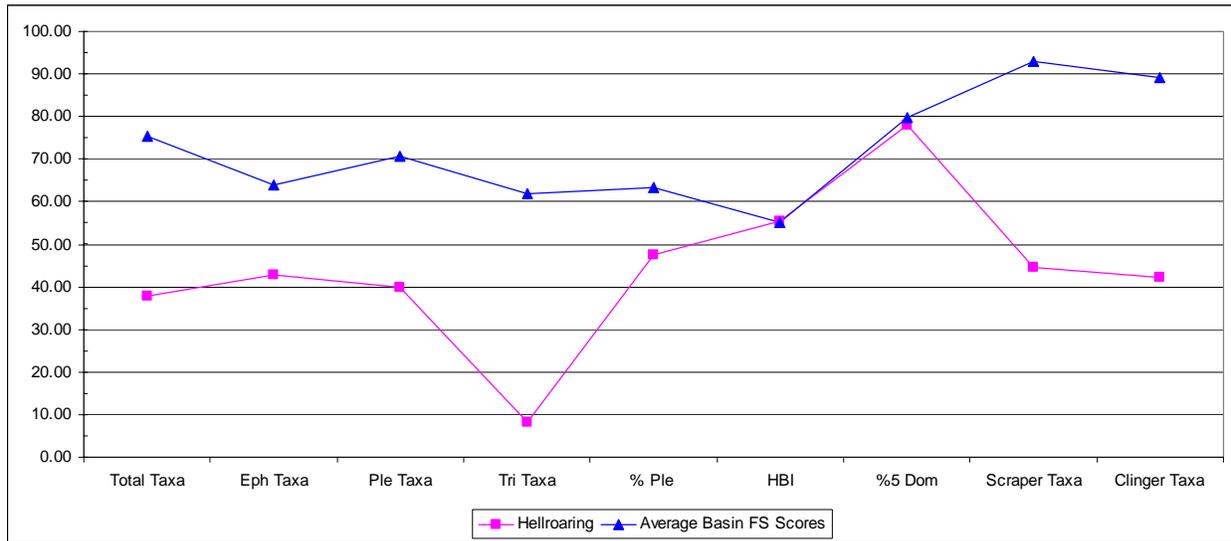
The BURP crew collected several sculpin and noted that there was a fish barrier downstream from the sample location.

Table 6 Summary of Individual Metric Scores for Hellroaring Creek

BURPID	Total Taxa	Ephemeroptera Taxa	Plecoptera Taxa	Trichoptera Taxa	% Plecoptera	HBI	% Dominance of top 5 taxa	Scraper Taxa	Clinger Taxa	SMI
1998SCDAB023	37.78	42.86	40.00	8.33	47.62	55.37	78.01	44.44	42.31	44.08
Average Basin Scores for Full Support Sites	75.4	63.8	70.6	62.0	63.4	55.1	79.9	93.1	89.2	72.5

Note: The scores range from 0 to 100 and are compared to reference streams within the Bioregion. They are not the raw metric scores.

Figure 3 Individual Metric Scores of Hellroaring Creek Compared to the Average Score of BURP sites with SMI scores >2 for the Pend Oreille Sub-basin



4.3 Water Chemistry

Total Phosphorus and Total Nitrogen concentrations were measured from Hellroaring Creek in August 2006. The water chemistry and field data from this monitoring effort can be found in Table 7. The water chemistry data do not indicate that excessive nutrients are a problem within Hellroaring Creek. The nutrient levels are extremely low for Hellroaring Creek. Phosphorus concentrations were found to be 5-6 µg/L and total nitrogen less than 0.1 mg/L. Specific conductance, another measure of anthropogenic impacts to a watershed, was low and indicative of a relatively unimpacted system.

Table 7 Water Chemistry and Field Parameter Results from August 2006

Date	Temperature (°C)	pH	Dissolved Oxygen (mg/L)	Dissolved Oxygen (% Saturation)	Specific Conductance (µs)	Total Nitrogen (mg/L)	Total Phosphorus (mg/L)
8/9/2006	18.93	6.94	8.31	98.4	24	<0.1	0.005
8/23/2006	16.56	6.95	8.39	95.5	24	<0.1	0.006

A review of the mine inventory for Hellroaring Creek does not indicate a history of mining activity within the watershed; therefore, it is unlikely that metal loading is a concern.

SECTION 5.0 ANALYSIS

This section investigates each potential cause to determine which ones are supported by the evidence found within the watershed and the current understanding of aquatic ecosystem function.

5.1 Stressor Refinement

Of the seven candidate stressors identified in Section 3.0, we have found sufficient evidence to remove excessive nutrients and high metal concentrations from the list of potential stressors. This decision was based on the extremely low nutrient concentrations found during the 2006 sample events as well as the lack of evidence of historical mining operations within the watershed.

5.2 Candidate Cause Elimination

Low nutrients resulting in low fish and macroinvertebrate abundance.

The nutrient values found in Hellroaring Creek are extremely low. The phosphorus concentrations would classify this stream as ultra-oligotrophic. It is likely that the nutrient levels found within Hellroaring Creek are limiting primary production and subsequent secondary production which results in low macroinvertebrate and fish densities. Since the SMI is very sensitive to changes in abundance and taxa richness, Hellroaring Creek would have a very poor score and would result in it being determined to be impaired. The evidence suggests that low nutrient values could be a significant stressor for the Hellroaring Creek aquatic community.

Increased flood frequency and maximum stream flows with a concomitant decrease in base flows.

There is not sufficient data to determine if there have been significant hydrological changes in the Hellroaring Creek Watershed. The stability of the channel, the percent of the bank that is covered and stable and the flows adequate to support aquatic life during the low flow period suggests that this is an unlikely cause of the impairment within the Hellroaring Creek Watershed.

Increased sediment delivery and percent fines.

The majority of the substrate was small to large cobble with a significant proportion of fines. The percent fines within the bank full zone is close to 30%. Many researchers have concluded that a value in excess of 25% is the point where the aquatic community becomes impaired (Relyea, personal communication, 2004). The CWE process indicates that the Hellroaring Creek watershed is susceptible to having high sediment delivery and mass failures. It is likely that sediment delivery is a cause for the low SMI scores.

Reduction in riparian cover, shift in riparian plant species, lower quality shade.

TerraGraphics was unable to locate historical information regarding the riparian shade within the Hellroaring Creek watershed. The BURP crew mentioned a significant amount of cover and they recorded that there was 68% canopy closure base on concave spherical densiometer readings. Temperature is a likely stressor to the system; however, we do not believe that it is the primary cause of the atypical aquatic community.

Ineffective sampling or inappropriate reference stream reaches for comparison.

The BURP protocol and the WBAG scoring systems were derived to deal with the most common stream types within Idaho. These are typically streams with gradients of 1-4% and with a gravel/cobble substrate. Hellroaring Creek is characteristic of the types of streams that BURP and WBAG were developed to assess.

Based on the conditions within Hellroaring Creek we have determined that the application of the BURP sampling protocol and the WBAG process was appropriate.

SECTION 6.0 CONCLUSIONS

Based on the analysis of existing biological, chemical, habitat, and watershed conditions, we have determined that there are two likely candidates for the low SMI and SFI scores for Hellroaring Creek. These are 1) excessive sediment and 2) low nutrients. A tertiary cause is increased stream temperature, but it is unlikely to be the primary factor for failing the WBAG process.

Based on our analysis, we believe that the development of a TMDL for sediment is appropriate at this time. The characteristics of the watershed make it very susceptible to adverse changes caused by changes within the watershed; therefore we suggest that care be taken by the land managers when contemplating activities within the Hellroaring Watershed.

SECTION 7.0 REFERENCES

Grafe, C.S. (editor), D. Brandt. 2002a. *Idaho river ecological assessment framework: an integrated approach*. Idaho Department of Environmental Quality. Boise, Idaho. 210 pp.

Grafe, C.S., C.A. Mebane, M.J. McIntyre, D.A. Essig, D.H. Brandt, and D.T. Mosier. 2002b. *The Idaho Department of Environmental Quality Water Body Assessment Guidance, Second Edition-Final*. Idaho Department of Environmental Quality; Boise, Idaho.

Idaho Department of Lands (IDL). 2003. Hellroaring Creek Cumulative Watershed Effects Assessment.