Sand Creek Stressor Identification

Task Order 26
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Prepared for:

U.S. Environmental Protection Agency
Region X
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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

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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.

Low nutrients was eliminated as a potential stressor based on available information from investigation of current and historic land use practices. The remaining six potential causal agents were evaluated. We determined that high percent fines was a likely stressor but we were unable to determine if this was a natural condition or human induced. We recommend that the watershed be modeled to allow comparison of natural load to current load.

We recommend the collection of additional temperature and nutrient data. These two candidate causes could be contributing factors, but sufficient data do not exist to determine this with any degree of certainty.

SECTION 1.0 SCOPE OF THE INVESTIGATION

Sand Creek flows into Lake Pend Oreille near the southeast corner of Sandpoint. The Sand Creek drainage contains 10,048 acres, with 59.7% of the area covered by forest. Land ownership is primarily private (USGS).

The drainage is oriented in a southerly direction with Sand Creek generally flowing north to south. Elevation ranges from 2,120 feet at the drainage into Lake Pend Oreille to 5,710 feet at the headwaters, with an average elevation of 2,730 feet. Approximately 20% of the area within the drainage contains slopes greater than 30%. Less than 3% of the drainage contains slope greater than 30% and faces north (USGS).

Cool, dry summers and moderately cold winters characterize the area. Average annual precipitation is 31.5 inches (USGS). The majority of precipitation occurs as winter snowfall and spring rain. High-volume runoff occurs during spring snowmelt and major rain-on-snow events (IDL 2003).

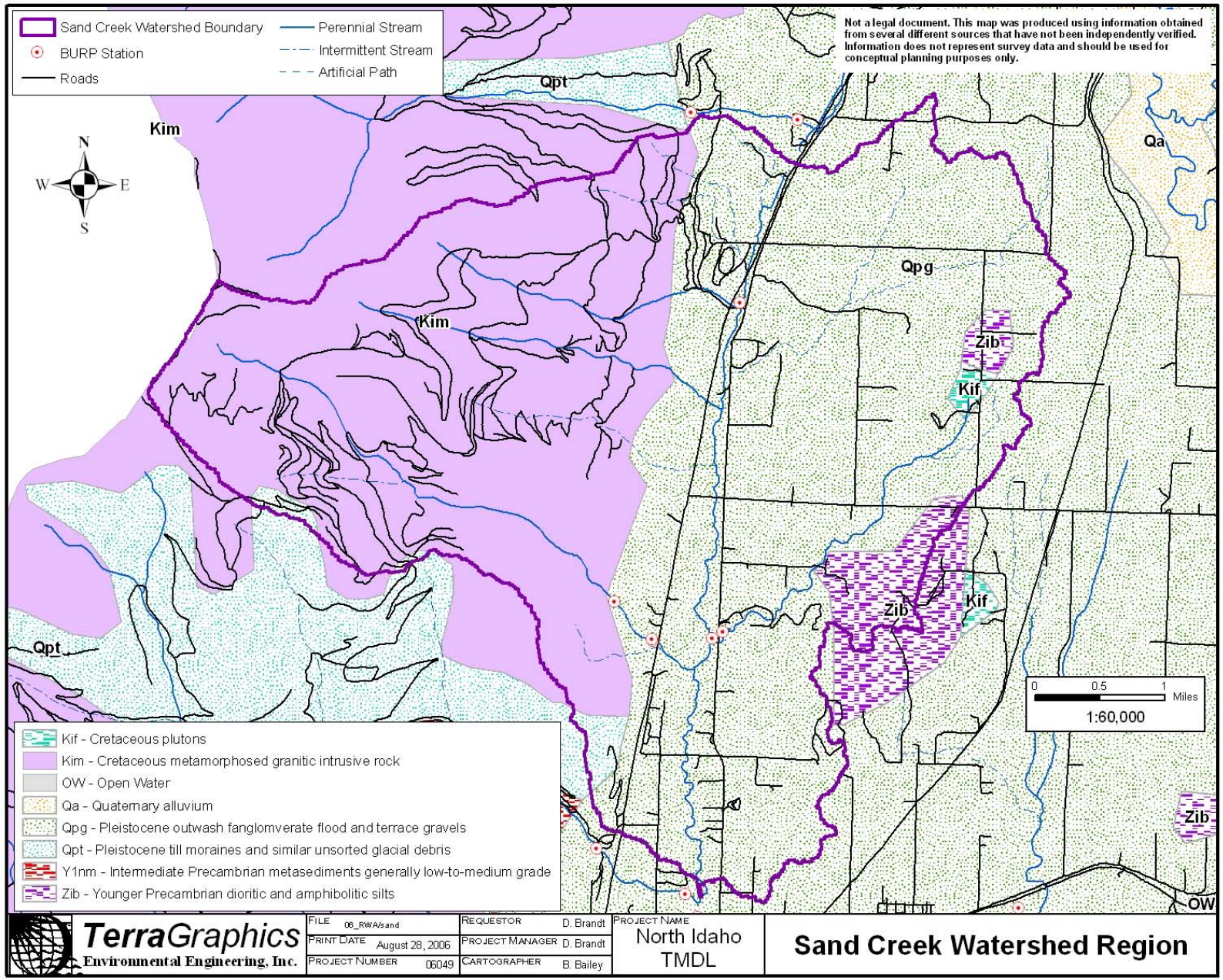
Vegetation varies with elevation, aspect, and landform. Lower elevations generally support Cedar-Hemlock habitat types. Uplands support a mixed conifer forest of Douglas fir, grand fir, red cedar, larch, hemlock, ponderosa pine, lodgepole pine, and western white pine with the more xeric species dominating south to west facing aspects. Higher elevation sites include subalpine fir, and spruce. Very wet areas especially along riparian zones support alder, willow, and other water loving species (IDL 2003).

There is considerable residential development occurring within the Sand Creek Watershed. In addition to residential areas, there are agricultural and light industrial activities within the watershed.

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 Sand Creek Site Location Map



SECTION 2.0 DESCRIPTION OF THE IMPAIRMENT

In 1997 and 1998, the Coeur d'Alene office of IDEQ conducted a rapid bioassessment survey of Sand 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 Sand Creek are located in Table 1. IDEQ determined that the Stream Macroinvertebrate Index (SMI) and the Stream Habitat Index (SHI) for both reaches of Sand Creek were significantly lower than expected for a stream within the Northern Rockies Ecoregion (Table 2). The Stream Fish Index (SFI) was also lower than the ecoregion reference streams.

The result of the assessment was the determination that Sand 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 but will not attempt to determine the validity of the "thermal modification" determination.

Table 1 Index Scores for the Sand Creek Watershed

Assessment Unit	Stream	BURP ID	Stream Macroinvertebrate Index (SMI)	Steam Fish Index (SFI)	Stream Habitat Index (SHI)
ID17010214PN049_03	Sand Creek	1998SCDAB016	29.387	63.807	42
ID17010214PN049_03	Sand Creek (Upper)	1997SCDAA017	40.228	N/T	51

Note: N/T – Fish data were not collected.

Table 2 Index Scoring Criteria

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

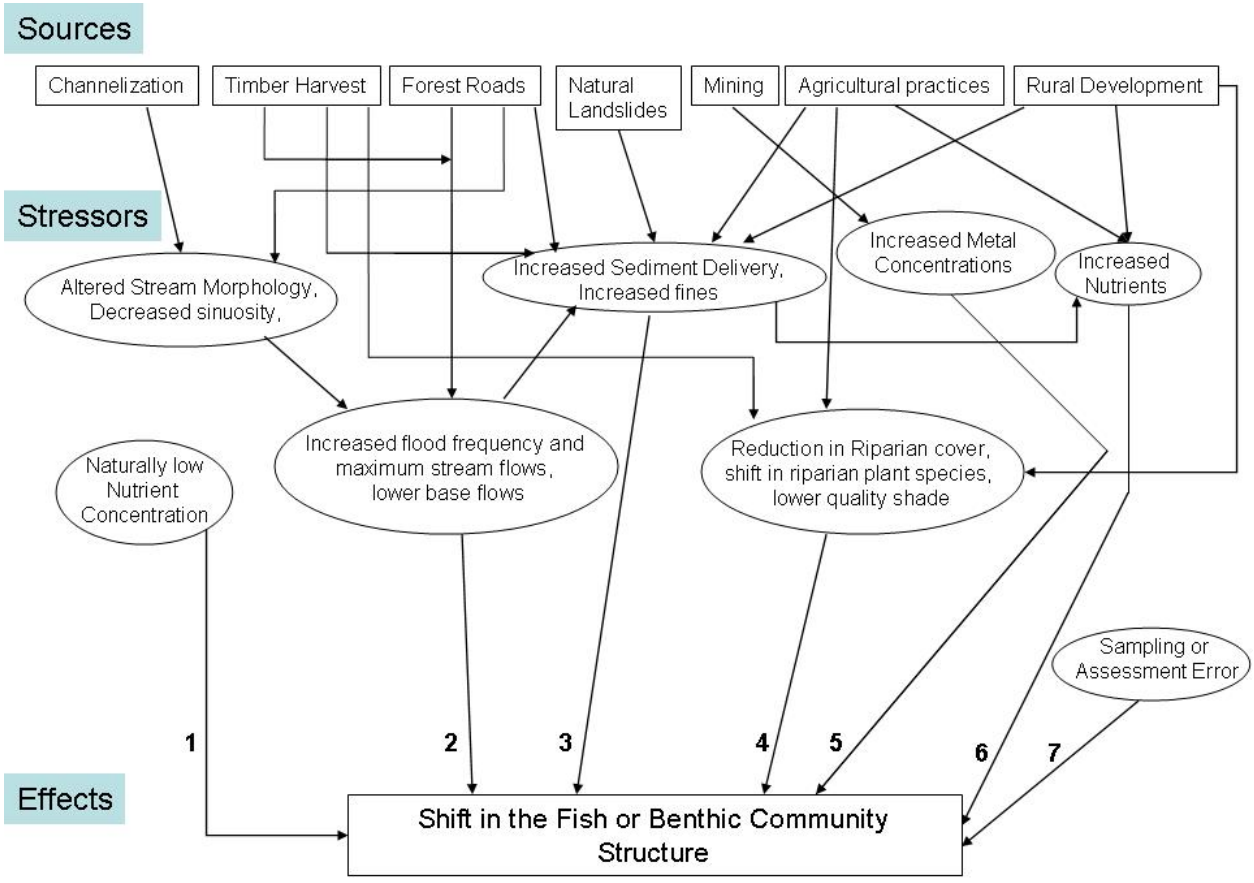
Note: N/A – Not available. SHI does not have a minimum threshold condition rating.

SECTION 3.0 CANDIDATE CAUSES

A conceptual model of candidate causes has been created for the Sand Creek Watershed (Figure 2). The conceptual model indicates seven potential causes for the low SMI and SFI scores for Sand 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 Sand 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 data collected for Sand Creek at the upper reach show very poor habitat. The lower site scored significantly better but was slightly degraded from conditions found in reference streams. Notes from the BURP event indicate that the lower BURP site (1997SCDAA016) was too deep to perform a Wolman pebble count but that a visual estimate of percent fines was nearly 100%.

Table 3 Summary of Selected BURP Habitat Data for Sand 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)
1998SCDAB016 (Sand Creek)	95	100	34.5	N/A	N/A	3	0.471	0.98	5.43	16.63	1.4
1997SCDAA017 (Sand Creek, Upper)	98	90	30	77	1	7	0.398	0.99	4.80	9.70	6.9

Notes: Percent fines and Embeddedness for 1997SCDAA017 were recalculated from BURP field sheets since the database values did not match up with values from the field sheets. Percent fines and Embeddedness data were not collected for 1998SCDAB016, but the BURP crew made a qualitative estimate that the stream was mostly sand and silt with some small pebbles.

4.2 Biological Data

Table 4 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. For all metrics used in determining the SMI scores, Sand Creek scores are significantly lower than the full support streams within the Pend Oreille Sub-basin. 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 Sand Creek. The most pronounced metric reduction from reference is in the number of Plecoptera taxa in the lower reach and the low number of Trichoptera taxa in the upper reach.

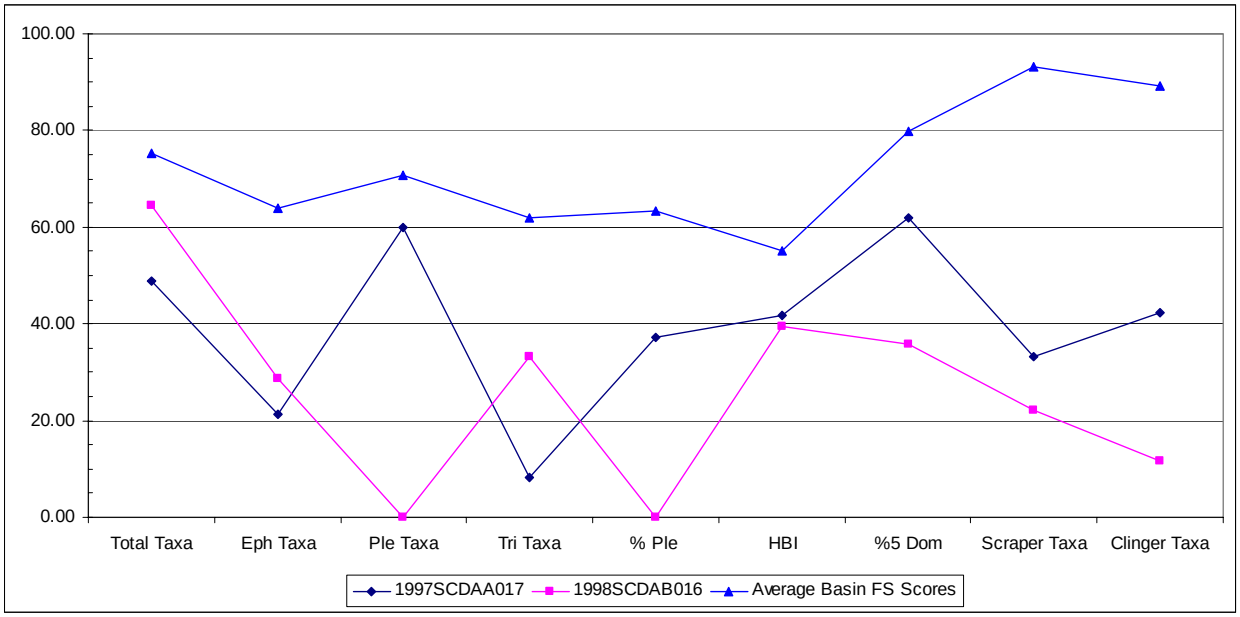
The BURP crew performed electrofishing on the lower reach of Sand Creek. They collected 33 brook trout from 3 different age classes, 40 sculpin and 1 sunfish. The SFI scores were not calculated for this stream.

Table 4 Summary of Individual Metric Scores for Sand Creek

BURPID	Total Taxa	Ephemeroptera Taxa	Plecoptera Taxa	Trichoptera Taxa	% Plecoptera	HBI	% Dominance of top 5 taxa	Scraper Taxa	Clinger Taxa	SMI
1998SCDAB016 (Sand Creek)	64.44	28.57	0.00	33.33	0.00	39.61	35.87	22.22	11.54	26.18
1997SCDAA017 (Sand Creek, Upper)	48.89	21.43	60.00	8.33	37.33	41.76	62.01	33.33	42.31	39.49
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 Sand Creek Compared to the Average Score of BURP sites with SMI scores >2 for the Pend Oreille Sub-basin



4.3 Water Chemistry

TerraGraphics was not able to locate any water chemistry data taken on Sand Creek.

A review of the mine inventory for Sand Creek indicates that there are two sand and gravel mines located on an unnamed tributary of Sand Creek. The tributary drains into Sand Creek on the extreme downstream end of the area of interest.

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 low nutrients from the list of potential stressors. This decision was based on the land use practices within the area and the low HBI scores for this stream.

5.2 Candidate Cause Elimination

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

There is not sufficient data on this watershed to determine if there have been significant hydrological changes in the Sand Creek Watershed. The stability of the channel, percent of the bank that is covered and stable, and the flows adequate to support aquatic life during the low flow period suggest that this is an unlikely cause of the impairment within the Sand Creek Watershed. The physical characteristics of the watershed also support this conclusion. The watershed is relatively low gradient with a low percentage of the watershed within the rain on snow zone. Due to the low gradient of the valley bottom, the energy during a flood would be unlikely to permanently alter the stream channel.

Increased sediment delivery and percent fines.

The majority of the substrate is sand. The percent fines within the flood prone zone is between 80% and 100%. Many researchers have concluded that a value in excess of 25% is the point where the aquatic community becomes impaired (Relyea, personal communication, 2004). It is likely that the high percent fines is a cause for the low macroinvertebrate scores and, to some degree, the poor habitat scores. Based on the soil types within the area, this may be a natural condition and not a result of anthropogenic activities. We recommend that the watershed be modeled to allow comparison of natural load to current load. If the model indicates a large increase in sediment delivery, then a sediment TMDL should be developed.

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 Sand Creek watershed. The BURP crew measured low percent canopy closure. They also documented a lack of a large intact riparian zone and collected a warm water species in the fish survey. This information points to a creek with stream temperatures warmer than most streams in north Idaho. TerraGraphics concludes that temperature is a contributing factor to the low SMI scores within Sand Creek.

Increased nutrients.

We were not able to locate any instream nutrient values for Sand Creek. The HBI scores are lower than the average scores for the sub-basin, indicating the potential that nutrients are adversely impacting the system. The BURP crews did not make any observations regarding excessive periphyton or epiphytes growth. The number of brook trout and sculpin found in the stream indicates that diel dissolved oxygen depletion is not a significant problem.

We recommend that nutrient data be collected on Sand Creek to confirm that excessive nutrients are not impairing the beneficial uses.

Increased metal concentrations.

We did not find any instream metal data for Sand Creek. The mines located within the Sand Creek drainage are very small sand and gravel pits. Based on this information, we do not believe that high metal concentrations are a contributing factor to the low SMI scores.

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 a gravel/cobble substrate. Sand Creek gradient and stream size are within the range of streams that BURP and WBAG were designed to assess. The BURP and WBAG process would result in poor scores for naturally sandy bottom streams. In this case the BURP and WBAG process worked as it was designed. The problem is not with the protocol but with determination of the natural conditions within Sand Creek.

SECTION 6.0 CONCLUSIONS

Based on the analysis of existing biological, chemical, habitat, and watershed conditions, we have determined that the most likely candidate for causing the low SMI scores for Sand Creek is a preponderance of fine grain sediment. We were not able to determine if this was due to natural or anthropogenic sources. We recommend that the watershed be modeled and then reevaluated to determine if a sediment TMDL is warranted. We also concluded that it is likely that the stream temperature is elevated from natural levels and is contributing to the low SMI scores. We recommend that IDEQ collect temperature logger data and if this supposition is confirmed then a temperature TMDL should be developed. Finally, we recommend that nutrient data be collected within Sand Creek to determine if there are excessive nutrients present in the system.

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.

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