Little Malad Subbasin Water Quality Monitoring Report

Amy Jenkins
Idaho Association of Soil Conservation Districts

Technical Report Summary
ARJ-LM-07

January, 2007
Pocatello, Idaho

Introduction

The Idaho Association of Soil Conservation Districts (IASCD) recently completed a water quality monitoring project in the Little Malad subbasin in southeastern Idaho. The Little Malad River is a tributary to the Malad River and ultimately to the Bear River. The tributaries included in this report are within the Daniels subwatershed, draining to the Daniels Reservoir before entering the Little Malad River. The one exception is Elkhorn Creek which drains directly to the Little Malad River below Daniels Reservoir. The Daniels subwatershed is comprised of 66,618 acres of private and public land. The tributaries discussed in this report originate from the Bannock Range and are located within the Oneida Soil and Water Conservation District (SWCD). IASCD monitored six tributaries; Wright, Dairy, Elkhorn, Hill, Little Malad Spring, and Indian Mill creeks.

The Bear River TMDL was written by the Idaho Department of Environmental Quality (DEQ) and approved by the Environmental Protection Agency (EPA) in June 2006. They identified sediment and phosphorus (Table 1) as the major pollutants of concern in the Bear Basin (DEQ 2006). Most of the streams included in this report are on the state of Idaho §303(d) list for having water quality limited segments. Specifically, Wright, Dairy, Elkhorn, Little Malad Spring and Mill creeks are considered impaired. DEQ developed sediment and nutrient TMDLs for Wright, Little Malad Spring and Elkhorn creeks. TMDLs were not written for Dairy Creek due to a lack of water quality data. No TMDLs were completed for Indian Mill Creek because this stream was not added to the §303(d) until after DEQ's subbasin assessment was completed. Hill Creek, which flows into Daniels Reservoir, is not a listed stream, but was chosen for monitoring due to the lack of data and potential impacts from agricultural practices. The beneficial uses designated for these streams are cold water aquatic life (CWAL) and secondary contact recreation (SCR). Wrights Creek is additionally designated for salmonid spawning (SS).

Table 1. Pollutant targets for stream segments in the Little Malad subbasin (DEQ 2006).

Pollutant of Concern	Pollutant Targets for the Little Malad Subbasin
Suspended Sediment Concentration (SSC)	Not to exceed 68 mg/L
Total Phosphorus (TP)	Not to exceed 0.075 mg/L
Total Nitrate + Nitrite	Not to exceed 0.85 mg/L (not specified in TMDL)

This monitoring project was initiated at the request of the Oneida Soil and Water Conservation District (OSWCD). The OSWCD has actively participated in conservation efforts in the watershed for the last 25+

years. In the 1980s, the district received multiple State Agricultural Water Quality Implementation Project (SAWQP) funds to improve water quality in the Little Malad subbasin. Best management practices (BMPs) that were implemented included terraces, sediment basins, and conservation tillage. More recently, the SWCD has worked with landowners to implement BMPs such as riparian habitat improvements, exclusion fencing, and off-site watering.

Agriculture is the dominant land use in the watershed and includes non-irrigated cropland and rangeland. Additionally, Wrights Creek is impacted by pumice and perlite mining operations from the headwaters to the confluence with Dairy Creek.

The goal of this monitoring project was to provide water quality data to the district to allow for identification of potential pollutant sources and to quantify pollutant concentrations in the tributaries. Efforts were made to assess the impacts that agricultural and mining activities have on water quality in the watershed. The water quality monitoring data presented here complement stream assessment work by IASCD and the Soil Conservation Commission (SCC). The data will be used to plan and evaluate agricultural best management practices (BMPs) in the Little Malad subbasin. IASCD has worked cooperatively with the Idaho State Department of Agriculture (ISDA) and Oneida SWCD to implement this project.

Site Descriptions and Monitoring Schedule

Water quality monitoring began at eight sites in March of 2005 and continued through November 2006. Wrights Creek is the largest tributary to Daniels Reservoir and was monitored at three locations (Figure 1). The downstream monitoring site on Wrights Creek (Wrights 1) was located above Wide Hollow Road, the middle site (Wrights 2) was upstream of the confluence with Dairy Creek and the upper Wrights Creek site (WC3) was upstream of Perlite Road. Additionally, Wrights 2 was below an active pumice mining operation and Wrights 3 was upstream of the operation.

Little Malad Spring creek is only about 1.5 miles long from the spring to the reservoir and was monitored upstream of Wide Hollow Road. Hill Creek is approximately 6 miles long and was monitored upstream of Daniels Road, just before it enters Daniels Reservoir. Indian Mill Creek was monitored upstream of East Daniels Road. Dairy Creek was monitored upstream of the confluence with Wrights Creek. Elkhorn Creek was the only stream in this project that was not a tributary to Daniels Reservoir. Elkhorn Creek drains directly to the Little Malad River approximately 4 miles below Daniels Reservoir and was monitored upstream of Elkhorn Road.

IASCD monitored twice a month from March through November. During each visit, samples were collected and analyzed for suspended sediment concentration (SSC), total phosphorous (TP), orthophosphorus, nitrate + nitrite and ammonia. Stream discharge, temperature, dissolved oxygen, pH and conductivity were monitored in the field.

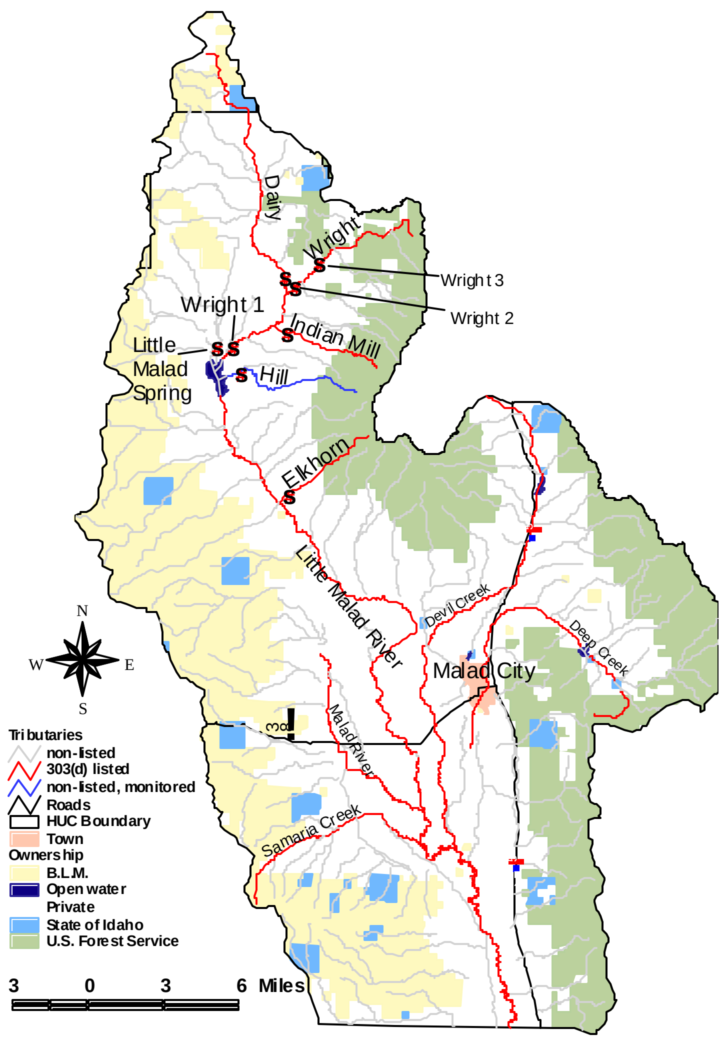

Figure 1. IASCD monitoring locations in the Little Malad subbasin.

Results

Discharge

Discharge rates in many of the streams fluctuated seasonally as is common in systems that are largely influenced by snow melt (Figure 2). Stream flow peaked during spring months and declined to base flows for the remainder of the year. The one exception to this was the Little Malad spring where flows remained relatively constant throughout the year.

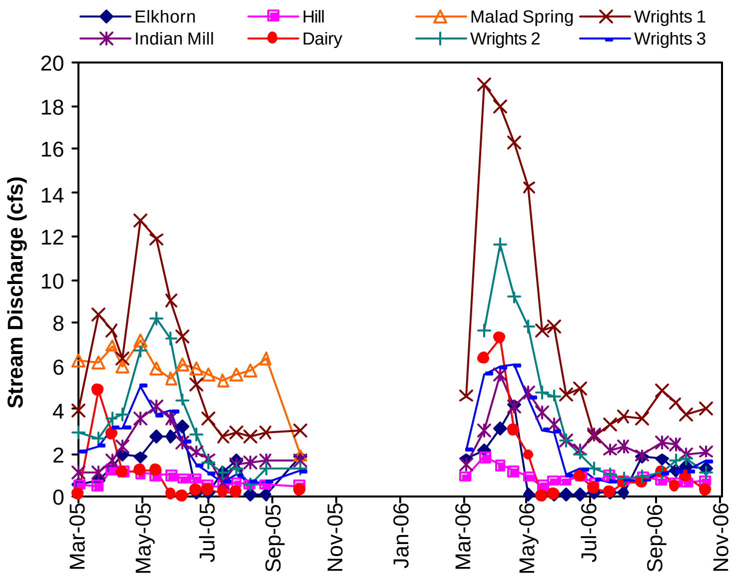

Figure 2. Stream discharge (cfs) at the eight monitoring sites in the Little Malad subbasin.

Average discharge rates were highest at the downstream Wrights 1 site, followed by the Little Malad Spring (Figure 3). Stream flows in Hill and Elkhorn creeks were significantly lower than the other sites ($p = 0.005$).

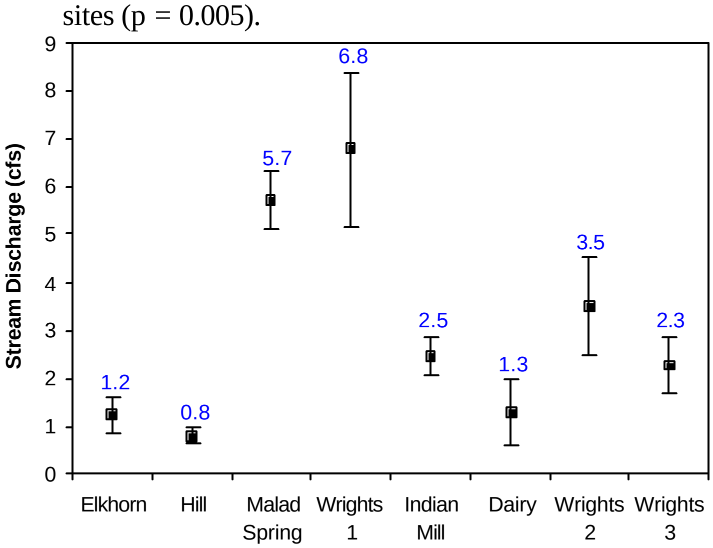

Figure 2. Mean stream discharge (± 95% confidence interval) measured from March 2005 to November 2006.

Suspended Sediment Concentration

Suspended sediment concentrations (SSC) in the streams fluctuated throughout the year. Elkhorn and two of the Wrights Creek sites experienced SSC variations that are typical of snowmelt dependent systems (Figure 4). At these sites, SSC levels increased during spring runoff events and declined to low levels throughout the rest of the year. Conversely, Indian Mill, Hill, Wrights 2, and Dairy creeks exhibited atypical sediment trends with no obvious pattern (Hill, Indian Mill, Dairy creeks) or where sediment peaked during summer months (Wrights 2).

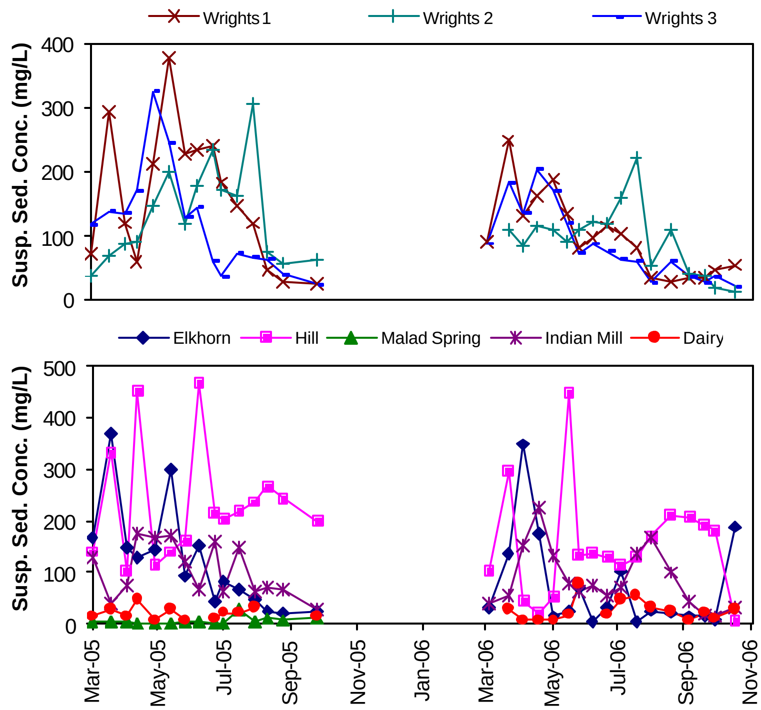

Figure 4. Suspended sediment concentration at the eight monitoring sites in the Little Malad subbasin.

The difference in SSC trends between Wrights 2 and 3 is important because these sites are situated within a mile of each other, with a mining operation and dirt road in between. At the upper site (Wrights 3), SSC was significantly related to stream discharge ($p < 0.005$) and peaked during spring runoff (Figure 4). During upper basin runoff (March-April, DEQ 2006), SSC was significantly higher in Wrights 3 compared to Wrights 2 ($p = 0.011$). It is likely that water quality at Wrights 3 was impacted by large scale erosion of mined materials during runoff events in the upper watershed (Appendix A). The significant reduction in SSC concentrations at the Wrights 2 site maybe due to capture of sediments by inactive beaver dams and dilution by runoff from the east side of the watershed. Conversely, at the downstream site (Wrights 2) SSC peaks during the summer and is significantly higher than the Wrights 3 site during summer base flow periods (August-October, p = 0.053). This suggests that road and/or mining activities introduce sediment to the stream during summer months.

Mean SSC concentrations in all streams except the Little Malad Spring and Dairy Creek were above the DEQ target of 68 mg/L (Figure 3). SSC levels in Hill Creek were significantly higher than any other site we monitored (p = 0.02). Sediment basins were installed in the 1980s to limit sediment inputs to Hill Creek from the adjacent cropland, but these have filled and are no longer functioning (Appendix B). Over the entire study period, average SSC levels did not differ significantly between the three Wrights Creek sites. However, as mentioned above, Wrights 2 and 3 did experience significant seasonal differences in SSC.

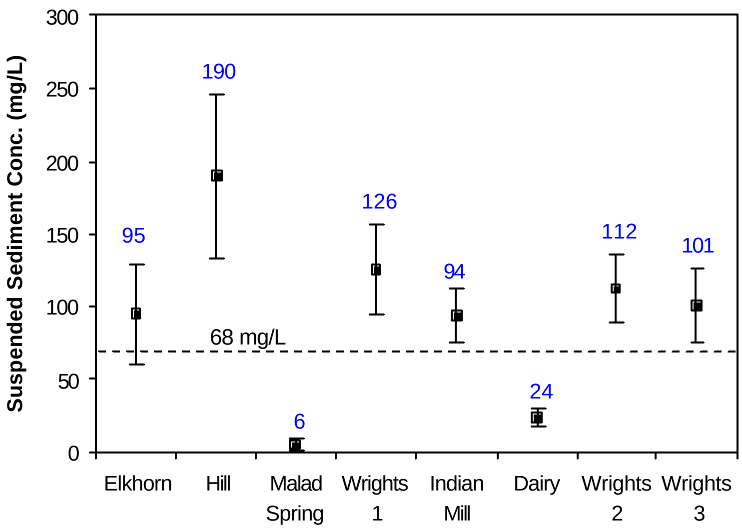

Figure 5. Suspended sediment concentration (mg/L, ± 95% CI) measured at the eight monitoring sites from March 2005 to November 2006. The horizontal dashed lines represent the DEQ target of 68 mg/L.

Additionally, sites were evaluated based on average daily SSC loads (lbs/day) that were calculated using sediment concentrations and stream discharge rates (Table 2). Wrights Creek experienced the highest SSC loads with the downstream site (Wrights 1) having significantly higher loads than any other site (p = 0.049). Despite the elevated sediment concentrations measured, Hill Creek did not experience high sediment loads because of its relatively low flows.

Table 2. Mean daily load (lbs/day) of pollutants at each site (± 95% confidence interval).

Site	SSC Load	TP Load	N Load
Dairy	112 (±113)	0.68 (±0.84)	2.91 (±2.89)
Elkhorn	847 (±567)	0.63 (±0.48)	5.03 (±1.71)
Hill	689 (±217)	0.71 (±0.16)	6.87 (±1.30)
Indian Mill	1186 (±657)	1.19 (±0.51)	5.74 (±2.10)
Malad Spring	143 (±87)	0.76 (±0.20)	24.51 (±5.78)
Wrights 1	4873 (±3394)	6.81 (±4.43)	16.53 (±9.61)
Wrights 2	1709 (±1090)	3.21 (±1.72)	8.28 (±4.83)
Wrights 3	1503 (±1253)	2.00 (±1.03)	5.46 (±3.18)

Total phosphorus

Total phosphorus (TP) concentrations at the eight sites fluctuated throughout the year. TP levels at Wrights 1, Dairy (2005 only), and Elkhorn creeks exhibited typical seasonal trends (Figure 6). At these sites, TP concentrations peaked during spring runoff and decreased during base flow. TP levels at Wrights 2 paralleled suspended sediment concentrations and were highest during summer months. TP at the remainder of the sites varied, but in no distinct pattern.

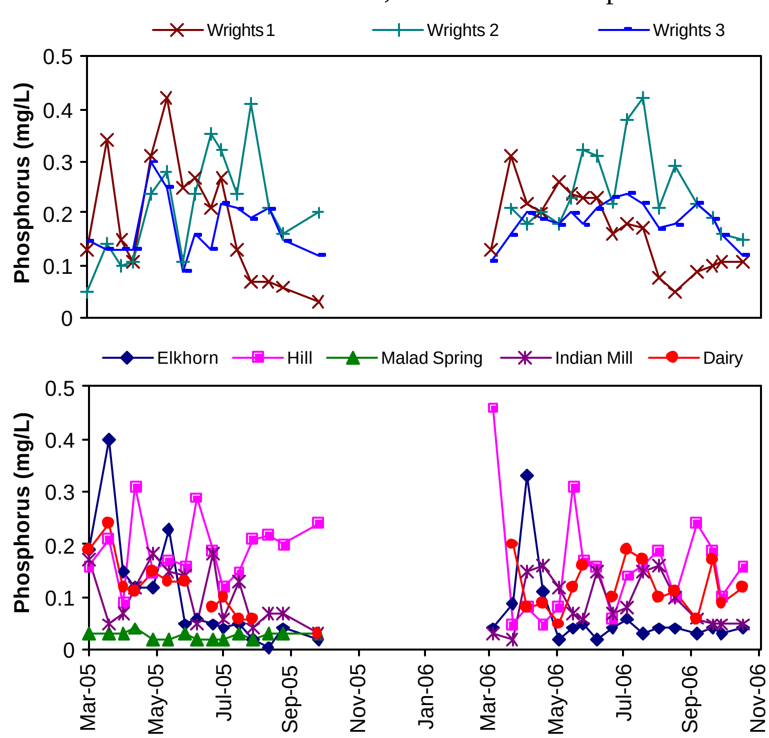

Figure 6. Total phosphorus concentrations (mg/L) at the eight sites in the Little Malad subbasin.

On average, TP concentrations at all sites except the Little Malad Spring exceeded the target of 0.075 mg/L (Figure 4). Concentrations were significantly higher in Wrights and Hill creeks than in Elkhorn, Indian Mill and Dairy creeks (p = 0.006). Phosphorus is likely entering these streams attached to sediment particles and efforts to decrease sediment inputs may reduce TP levels in these systems.

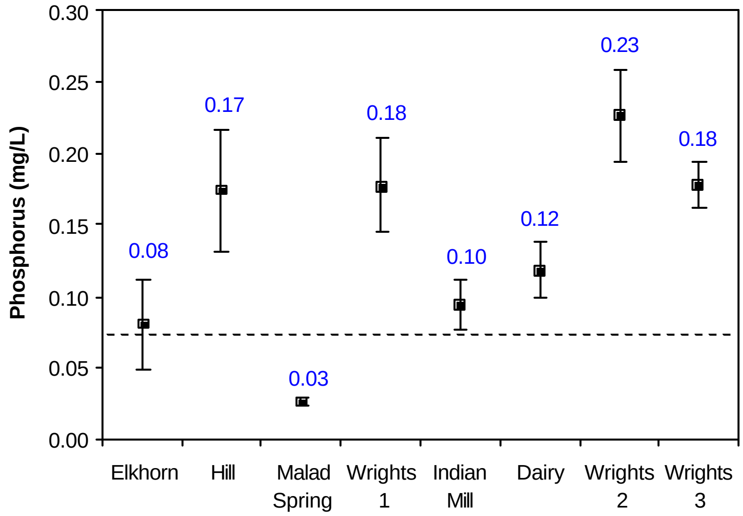

Figure 7. Total phosphorus (mg/L, ± 95% CI) measured at the eight sites from March 2005 to November 2006. The horizontal dashed line represents the DEQ target of 0.075 mg/L.

Phosphorus loads (lbs/day) were highest in Wrights Creek and increased significantly from the upstream (Wrights 3) to downstream (Wrights 1) sites (p = 0.012, Table 2). TP loads were significantly higher at the WC1 site than in any other stream we monitored (p = 0.004). Again, the low flows in Hill Creek resulted in relatively minor loading of TP, despite the high concentrations of TP observed in that stream.

Nitrogen

Nitrogen (nitrate + nitrite, mg/L) was not specified by IDEQ as being a pollutant of concern in the watershed. However, we chose to monitor nitrogen at these sites because of the known impacts of excess nutrients in streams (EPA 2005). We used a target of 0.85 mg/L to evaluate nitrogen concentrations in this report. This target was applied to the Thomas Fork, a tributary to the Bear River (DEQ 2006). Additionally, this is similar to the target for the Portneuf River (0.8 mg/L), a phosphorus limited watershed in southeastern Idaho (DEQ 2001).

Nitrogen at the eight monitoring sites fluctuated throughout the year, but most streams did not follow a seasonal pattern (Figure 8). Exceptions to this were Wrights (2006 only) and Elkhorn creeks. In 2006, the Wrights Creek sites increased during spring runoff and remained elevated for three months. In Elkhorn Creek nitrogen concentrations were highest 2-4 weeks after peak stream flow and TP concentrations.

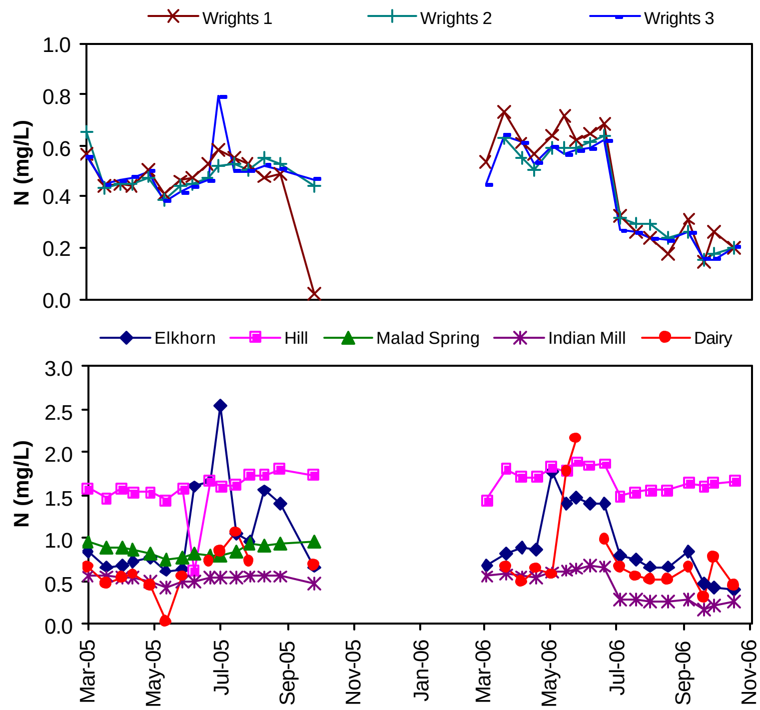

Figure 8. Nitrogen levels (nitrate + nitrite, mg/L) measured at the eight sites from March 2005 to November 2006.

Average nitrogen concentrations in Hill, Elkhorn and Little Malad Spring creeks exceeded the 0.85 mg/L target (Figure 9). Hill Creek experienced higher nitrogen levels than any other stream (p = 0.0001). There were only three days when the highest nitrogen levels were from a stream other than Hill Creek. Nitrogen concentrations in Elkhorn and Little Malad Spring creeks were not significantly different, but were higher than the other streams (p =0.015). Nitrogen concentrations were similar at the Wrights and Indian Mill sites and were significantly lower than in Dairy Creek (p = 0.006). Sources of nitrogen in the watershed are likely from fertilizer application on cropland and animal wastes on rangeland. Nitrates move readily in groundwater and may be entering surface waters via groundwater springs.

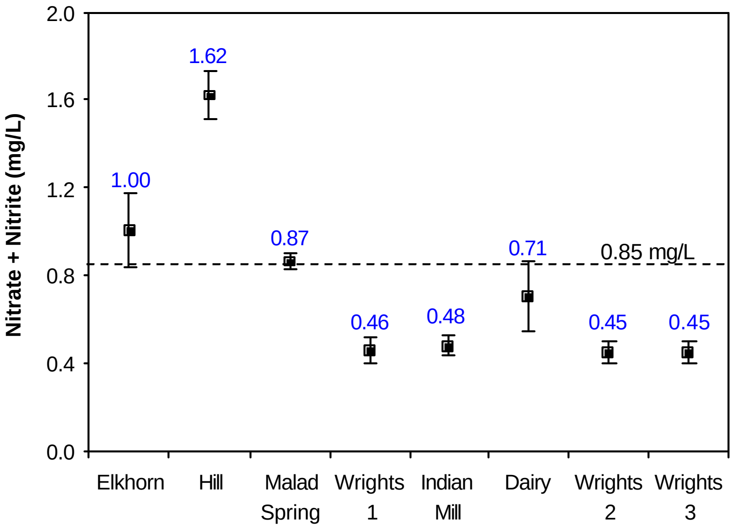

Figure 9. Average nitrogen levels (nitrate + nitrite, mg/L) measured at the eight sites (± 95% CI).

Nitrogen loads (lbs/day) were highest in the Little Malad Spring ($p = 0.005$, Table 2). This was the result of moderate nitrogen concentrations combined with relatively high flows in the spring. The lower Wrights Creek site (WC1) had the second highest nitrogen load, followed by the middle Wrights Creek site (WC2).

Qualitative Data

In addition to the water chemistry data presented in this report, IASCD and the Soil Conservation Commission (SCC) conducted comprehensive assessments of many of the streams in the watershed. In 2005, Wrights, Indian Mill, Little Malad Spring, and Dairy creeks were evaluated using the Stream Visual Assessment Protocol (SVAP). SVAP uses physical and biotic characteristics to assess stream health and function. The SVAP results indicated that many of the assessed reaches were in fair to good condition, but some were highly degraded (ISCC 2007). ISCC (2007) estimated that 75% of streambank erosion was coming from four of 23 reaches in the watershed; one on Dairy Creek and three on Wrights Creek. On Wrights Creek, the reaches with the poorest SVAP scores were upstream of the Wrights 1 monitoring site which experienced the poorest water quality. In these reaches streambank stability and lack of riparian habitat were among the chief concerns (ISCC 2007).

Conclusions

Water quality impairments were common in the streams we monitored in the Little Malad subbasin. Many of the streams in this project did not exhibit typical seasonal water quality trends. Instead, they tended to vary unpredictably and often exceeded water quality targets for SSC, TP, and nitrogen.

When streams were ranked based on their pollutant concentrations (mg/L) it was clear that Hill Creek had the poorest water quality, followed by Wrights Creek. However, when streams were ranked by their daily pollutant loads (lbs/day), Wrights Creek was found to carry the highest loads of SSC and TP. Therefore it is recommended that Hill and Wrights creeks be considered priority areas for water quality improvement projects in the watershed.

While agriculture is the dominant land use in the Little Malad subbasin, Wrights Creek may also be impacted by mining activities. The upper reaches of the stream have experienced massive influxes of sediment due to gully erosion and escapement of mined materials from sediment basins. It appears that road maintenance has included application of mined materials to the road surface. During summer months this material is frequently airborne due to the heavy mining traffic on the roads (personal observation) and may explain the inputs of sediment during low flow, summer months. During precipitation events, this material is easily eroded from the road surface.

Recommendations

The results of this monitoring project helped to identify water quality limited streams in the subbasin. While many of the streams indicated water quality concerns, efforts should be focused on Hill and Wrights creeks as they had the poorest water quality in the subbasin. While a lower priority, Elkhorn, Indian Mill, and Dairy creeks did experience elevated SSC, TP, and/or nitrogen levels. Implementation of BMPs aimed at reducing sediment and nutrients in these streams would help to support beneficial uses in the subbasin. Efforts should include restoring function to previously installed BMPs and implementation of new BMPs where needed.

Hill Creek was identified as having some of the highest concentrations of pollutants in the subbasin. In the past, BMPs such as sediment basins were installed to reduce sediment inputs to Hill Creek. Many of the BMPs have exceeded their lifespan and are no longer functioning properly. Non functioning sediment basins should be cleaned out and repaired to restore their effectiveness. Additionally, Hill Creek is surrounded by cropland and many of the fields slope towards the stream. It is recommended that the riparian buffer be enlarged to allow for entrapment of sediment (and subsequently phosphorus) before it reaches the stream.

Wrights Creek had high concentrations of pollutants as well as the highest SSC and TP loads in the subbasin. While the upper reaches are influenced by mining activities, the lower reaches are impacted by agricultural practices. Idaho Department of Lands (IDL) and mine operators are responsible for mining activities in Wrights Creek. Water quality in upper Wrights Creek may be improved by modifications to sediment basins and altering road maintenance practices. In the lower reaches of the Wrights Creek watershed, agriculture is the dominant landuse. As previously mentioned, the Wrights 1 site was located below the most degraded reaches on Wrights Creek. It is recommended that attention be focused on those reaches of the stream that were assessed to be in poor condition. Implementation of BMPs on the most degraded reaches will likely have the most significant impact on water quality in lower Wrights Creek. Specifically, use exclusion, riparian buffer, filter strips, tree/shrub planting and prescribed grazing are among the recommended BMPs for Wrights Creek.

Acknowledgements

I would especially like to thank Linda Daniels and Ben Evans for their help in choosing site locations and obtaining landowner permission for the sampling. I appreciate the assistance given by Kirk Campbell in drafting this document and for the comments of Gary Bahr and Ken Clark. Thanks to the Oneida Soil and Water Conservation Districts for providing insight and information regarding the Little Malad subbasin.

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Appendix A: Mining Impacts on Sediment Recruitment by Wrights Creek

Photo 1. Evidence of runoff from lower mine to Wrights Creek.

Photo 2 and 3. Evidence of sediment basin failure and runoff from mining activities in the upper Wrights Creek watershed during spring 2006.

Photo 4 and 5. Mining material on roads. This material often washes to the stream during precipitation events.

Appendix B: Agricultural Impacts on Hill Creek

Figure 1. Sediment basin in cropland that is no longer functioning.