MPERG Report 2006-2

Pilot Scale Erosion Control Using Bioengineering Techniques at Gold Run Creek, 2005

By

Laberge Environmental Services

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EXECUTIVE SUMMARY

Disturbance of frozen ground, through placer mining activities, may lead to slope failure. A stockpile of frozen overburden has recently begun eroding from the formation of a runoff channel. A large cut, approximately 300 metres long and up to 50 metres deep has been created adjacent to Gold Run Creek, a heavily mined area southeast of Dawson City.

This stockpiled overburden has been in place for several years and has revegetated with several species of mature willows (age dated to 15 years). Either due to heavy rainfall or climate change, melting has commenced in the stockpile resulting in the formation of a runoff channel. This has increased in size and slope failure continues to enlarge the cut.

Laberge Environmental Services conducted a reconnaissance survey of the site in July 2003, to assess the site with the purpose of exploring ways of halting the slope failure and stabilizing the disturbed section of overburden. In the fall of 2005, several bioengineering structures were installed to assist in controlling the erosion. Retaining walls were installed on the side walls and the face of the cut, and a live willow flume was built to direct and reduce the velocity of the water entering the cut.

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1.0 INTRODUCTION

Placer mining has been an important industry in the Yukon for over one hundred years with this activity typically taking place in the Klondike Region near Dawson City. To access gold-bearing gravels, the removal of extensive quantities of overburden is usually required. The majority of placer mining has taken place in the zone of discontinuous permafrost where vegetated valley flats and north-facing slopes are generally underlain with permafrost. With the removal of the insulating overburden, the thermal equilibrium of permafrost is disrupted and thawing occurs. The stability of soils and vegetation is affected and slope failure may occur. As melting progresses, the potential for mass movement of soil increases.

Laberge Environmental Services investigated such a site adjacent to Gold Run Creek near Dawson City, Yukon, on July 14th, 2003. Slope failure had occurred on the southwest-facing incline of an overburden stockpile, and a runoff channel had subsequently eroded through the overburden, increasing the sediment loading of the creek during snowmelt and rainfall events.

The 2003 survey was carried out with the purpose of exploring ways of halting the slope failure and stabilizing the disturbed section of overburden. It was anticipated that the use of bioengineering techniques could provide at least part of the solution to this problem. In May 2005, during the Northern Latitudes Mining Reclamation Workshop held in Dawson City, another reconnaissance trip to the site was made. Very little change had occurred during the previous two years, and David Polster of Polster Environmental Services, indicated there was great potential for the effective use of bioengineering structures to curb the erosional activity.

In September 2005, Stu Withers and Bonnie Burns of Laberge Environmental Services, spent seven days at the site constructing several bioengineering structures, consisting of retaining walls and a live willow flume.

1.1 History of the Site

A large volume of frozen overburden had been stockpiled to the east of the Gold Run Road and has since revegetated. The current owners and operators of these claims have not added to or altered the stockpile. It is not clear exactly when the slope failure first occurred; however, melting permafrost has created a runoff channel that continues to erode through the overburden and increases the sediment loading in Gold Run Creek. Initially, the previous owners installed a gravel plug at the base of the erosion channel to inhibit the flow and slope failure. This was unsuccessful and settling ponds have been built to decrease the amount of sediment reaching the creek.

Attempts to contact previous owners to ascertain the time frame and the volumes of overburden stacked here have been unsuccessful. An examination of air photos shows that stockpiling of the overburden had been underway, but not completed, in 1989.

2.0 STUDY AREA

The study site is located approximately 52 kilometres southeast of Dawson City. The site is on the left bank (east side) of Gold Run Creek, about seven kilometres upstream from its confluence with Dominion Creek. It is located at UTM 614343 easting and 7069344 northing, zone 7V, NAD 83, and can be sited on the NTS Map 115-O/10.

The study area is located in the Yukon ecoregion known as Klondike Plateau. This unglaciated ecoregion consists of rolling terrain with black and white spruce forests. Sedge tussocks, lichens and sphagnum are common where drainage is poor or permafrost lies near the surface.

3.0 RESULTS OF RECONNAISSANCE SURVEY, 2003

It is unclear just when the slope failure first occurred. By July 2003, soil had slumped back to a point about 300 metres from the creek bank (see Figure 1). The width of the slumped-in area ranged from about 4 metres at its apex to about 60 metres at its centre. The maximum depth was estimated to be about 50 metres. The walls of the gully were nearly vertical in places.

Vertical cracks in the soil about one metre deep had formed up to 20 metres back from the sidewalls at various locations, indicating the instability of the thawed overburden. The depth to frost in mid-July ranged from 20 cm near the apex of the slope failure to about one metre at the top of the overburden stockpile. Water was discharging from the base of the erosion cut at a rate of about 0.1 litres / second.

The overburden stockpile has overgrown with a dense stand of willows (mostly *Salix arbusculoides* and *S. planifolia*). These willows were aged to be about 15 years.

A strip of land, 15 to 20 metres wide, running parallel to the creek and behind the overburden pile, had also been cleared at some point. A pure stand of water horsetail (*Equisetum fluviatile*) covered a small wet, level area at the apex of the slope failure. The cleared zone has revegetated with willows (*Salix planifolia*), dwarf birch (*Betula glandulosa*) and other shrub species along with forbs, sedges and grasses. The area behind this cleared strip is undisturbed black spruce forest.

Photographs of the site and further details are available in MERG Report 2004-3 (Laberge Environmental Services, 2004).

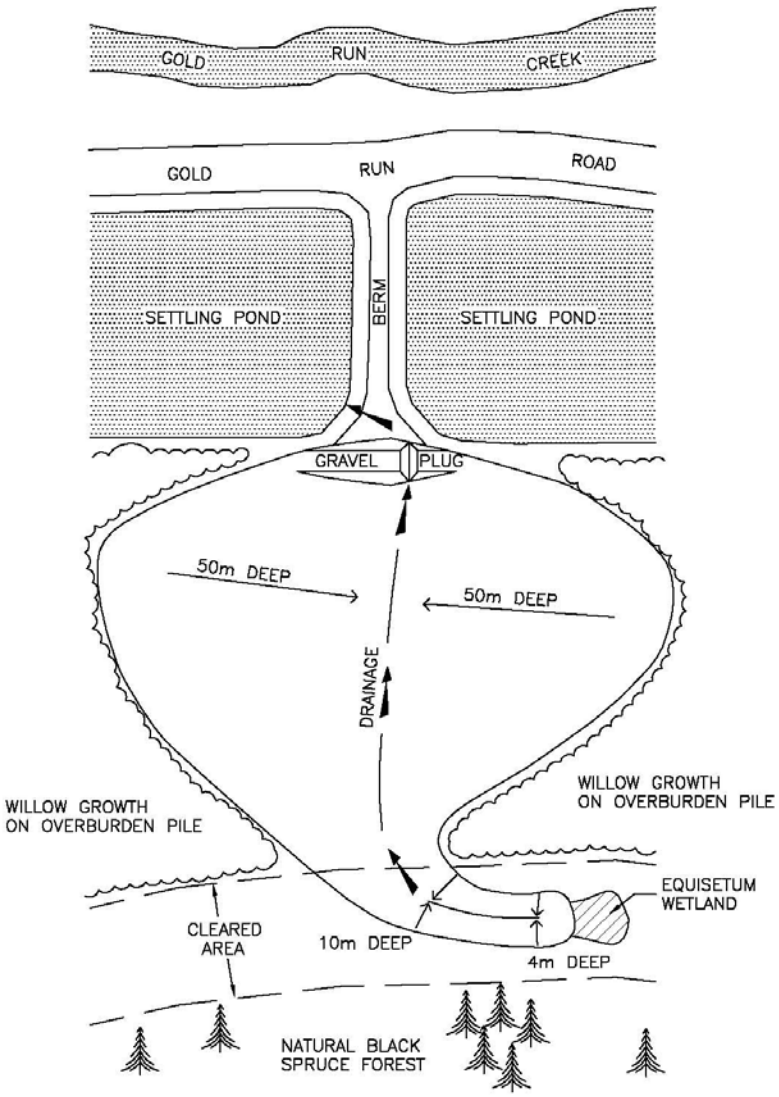


Figure 1 – Slope Failure Near Gold Run Creek
(Not To Scale)

4.0 FIELD TRIALS CARRIED OUT IN 2005

Some sections of the cut had stabilized since 2003, whereas erosion in other areas had intensified. Documentation during the reconnaissance survey in 2003, showed that slumping of the actively eroding north-west facing wall of the slope failure, induced mature willow trees to fall onto the surface of the gully wall. It was noted during 2005 that these willow trees were sending up shoots from their prone position and in effect, assisting in the stabilization of the slope. Slumping in other sections had caused the slope walls to reach their angle of repose and were gradually revegetating on their own with grasses. However, an increase in the volume of water reporting through the cut during the summer of 2005 had created tunneling and deep holes throughout the upper section.

The cut had eroded approximately seven additional metres into the bench since the earlier visit in May 2005. The summer season in the Dawson area had been very wet (personal communication, L. Millar) and the resulting increase in flow had contributed to the expansion in erosion. In addition, a hole approximately 10 metres deep had been created at the apex of the cut during this short time period. The water flowing into the cut was estimated at three to four litres per second. In comparison, the estimated rate of flow during the reconnaissance trip in July 2003 was only 0.1 litres per second.

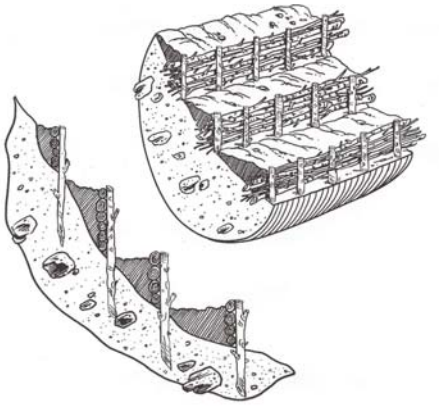
The most effective use of time and personnel for restoration work, necessitated the focus on the upper section of the gully to control further back-cutting into the bench.

Prior to the construction of any restoration work, the steep walls of the upper section of the cut had to be recontoured. Due to limited access to the site, and the fact that any further disturbance is undesirable, this was accomplished with hand tools. The recently created deep hole and eroded tunneling had to be backfilled prior to work on the rear wall. Large woody debris lying near the site, as well as all trimmings from the willows, were placed into these undermined areas. Existing slumping soils were also added as fill.

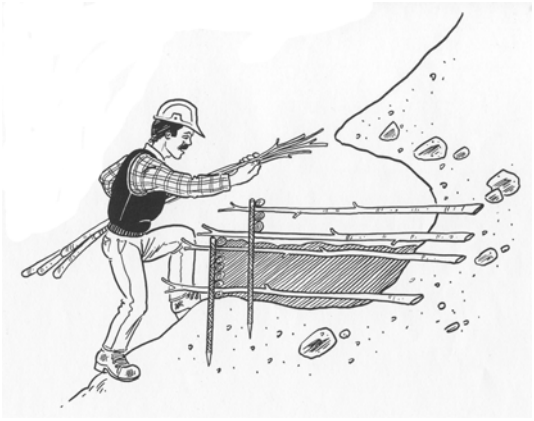
All live plant material was harvested on site. The overburden stockpile, with its dense

growth of willows, provided a convenient donor site. Willows were cut down using Swede saws, and de-limbed using pruning shears.

Once the side walls were adequately sloped, wattle fences/live reinforced earth walls were constructed. Sketches of these structures are presented in the figures below.



Wattle fences (D. Polster)



Live reinforced earth walls (D. Polster)

Starting on the flattened gully floor, a series of three ‘steps’ was installed up each gully wall. Larger diameter willows (10 to 13 cm) were pounded vertically into floor of the gully. Long cuttings of numerous smaller diameter (2 to 7 cm) willows were laid horizontally against the vertical posts. Earth from the gully wall was backfilled to the willows. Once the height of the horizontal willows reached approximately 30 cm, horizontal posts were inserted perpendicular into the face of the gully. These were tied to the vertical posts and provided added stability. Several additional willows were laid against the vertical posts on top of the horizontal posts, and backfilled. This constructed ‘step’ then provided the work space for construction of the next wattle fence/reinforced earth wall.

Three ‘steps’ or wattle fences/live reinforced earth walls were built on each of the east and west sides of the upper gully.

Prior to work on the rear wall, the flow had to be diverted. Rigid rubber hose, diameter four inches, was donated by a local placer miner, Norm Ross. A small earth dam was fabricated upstream of the cut, the pipe inserted and laid along the lowest bench of the

east wall. The diverted flow reported below the structures. The hole could now be filled and the retaining walls constructed. Two wattle fences/reinforced earth walls were constructed along the rear face of the cut and back filled. Numerous long cuttings of trimmed willows were laid on top of this slope from the edge of the cut to the floor of the gully. The butt ends of the willows were placed upstream, with the tapered ends angled down into the gully. The purpose of this 'live willow flume' was to direct the flow in a gentle manner to the base of the gully and decrease further erosion. Untrimmed willows were placed perpendicular across the willows to encourage further slowing of water flow. As the water velocity decreases, the erosion potential is reduced.

Live willow staking was done upstream of the cut in the flow path to aid in decreasing the water velocity.

Due to the high rate of flow entering the cut during the field trials, a decision was made to leave the pipe in place to allow the structures an opportunity to stabilize. A 50 foot length of perforated "Big O" pipe was attached to the end of the rubber pipe, to diffuse the flow over a longer expanse of the gully floor. This should help to control erosion resulting from water action.

Bioengineering tends to be labour intensive. On several occasions during the week, additional labour was provided by Lorraine Millar of Client Services in Dawson City, by Karen Pelletier of Mineral Development in Whitehorse, and by David Polster, who also provided technical guidance on the various structures.

Photos of the site and the structures are presented in Appendix A.

5.0 RECOMMENDATIONS

To adequately determine if these structures prove successful, a follow up assessment should be completed next summer. At that time, it will be ascertained whether the installments are stable enough to allow removal of the diversion pipes.

6.0 ACKNOWLEDGMENTS

Laberge Environmental Services would like to thank the Mining Environmental Research Group for providing the funding for this project. We also appreciate the assistance of Lorraine Millar, Client Services Officer, Energy Mines and Resources, YTG, who assisted with physical labour at the site and was instrumental in acquiring piping materials. We are grateful to Client Services, Dawson Office, for providing a travel trailer for our use as accommodation at the site.

We appreciate the advice and labour provided by David Polster of Polster Environmental Services, and the manual labour provided by Karen Pelletier of Mineral Development from Whitehorse who happened to be in the vicinity on one of the afternoons.

We also thank Alberta Gold Diggers for allowing us access to the site, which is located on their property.

And without the donation of the rubber pipe from Ross Mining Ltd, it would have been very difficult to complete the installation of the bioengineered structures. Thank you Norm Ross.

7.0 REFERENCES

Laberge Environmental Services. 2004. *Reconnaissance Survey of Erosion Site at Gold Run Creek*. Prepared for Mining Environmental Research Group (MERG). Report No. 2004-3.

Millar, Lorraine. Chief Mining Inspector, Client Services and Inspections, Dawson City, Yukon. Personal Communication, September 8th, 2005.

Polster, David F. 2005. *Soil Bioengineering for Land Restoration and Slope Stabilization*. Polster Environmental Services, Duncan, BC.

APPENDIX A

PHOTOGRAPHS

Willow shoots growing from slumped willows on north west facing wall. September 9, 2005.

The cut has receded back from “A” since May 24th, 2005. Photo taken on September 6th, 2005.

Top of cut prior to any restoration work, September 6th, 2006

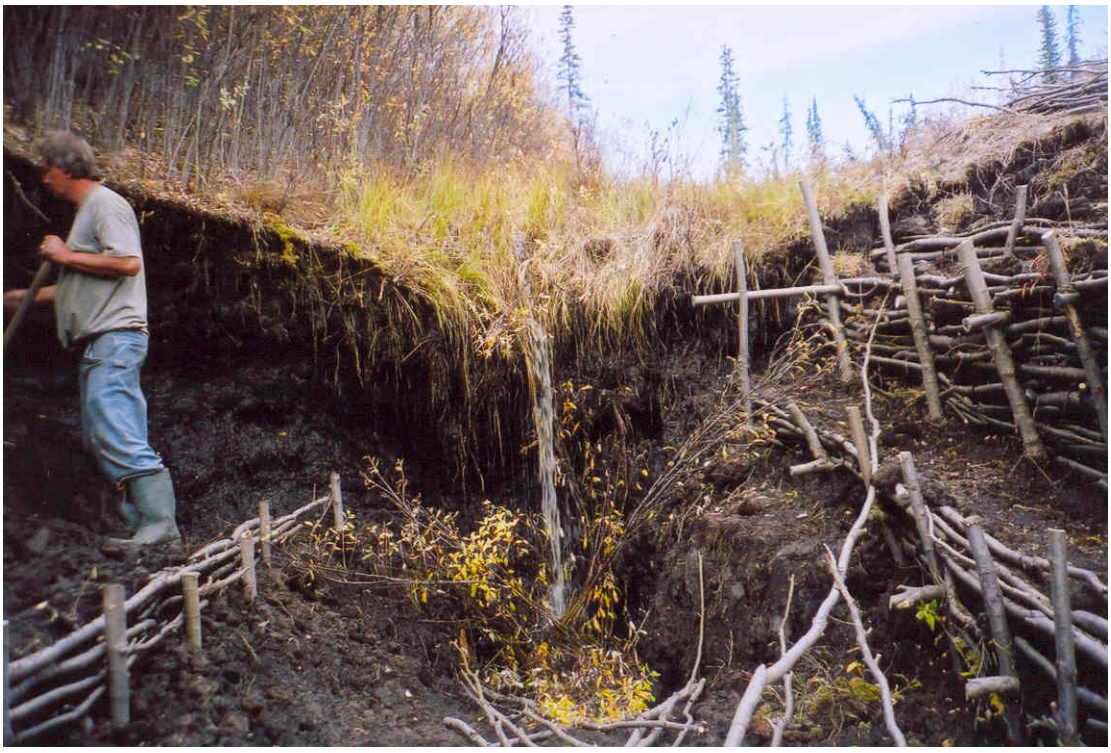
Top of cut prior to any construction, flow estimated at 3 to 4 litres/second, Sept 6th, 2006

Constructing second tier on the east wall. September 6th, 2005.

East wall completed, looking down the cut. September 7th, 2005.

Aerial view of the upper portion of the cut. The completed structures on the east wall can be seen in the upper right. Stabilized section in the foreground. September 7, 2005.

Aerial view looking back along the cut. Work is commencing on the west wall. Sept. 7/05



West wall construction, September 7th, 2005.

Working on final tier on the west wall, September 8th, 2005.

First retaining wattle fence completed on rear wall, September 9th, 2005.

The two tiers of retaining walls have been backfilled in readiness for the installation of the live willow flume. September 9th, 2005.

Live willow flume prior to the placement of cross willows. pipes installed. September 9th, 2005.

Completed live willow flume and retaining walls, with both September 9th, 2005.