Spring Creek Project: Dairy Street Landslide Rehabilitation

November, 1998

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Acknowledgments

We would like to thank the following people for their valuable advice and input on this project:

Rob Heibein, Barry Peters, Ken Downs, Alan Gilchrist, Ralph Ottens, David Sahlstrom, David Polster, Lloyd Hodges.

We would also like to thank Bell Pole Co. Ltd for the donation of cedar logs, the City of Terrace for assistance with the project, and the Department of Fisheries and Oceans and Northwest Community College for lending out equipment used on the project.

Funding for this project was provided by the Terrace -Kitimat Partnership for Salmonids (Fisheries Renewal BC) and the Department of Fisheries and Oceans Habitat Restoration and Salmonid Enhancement Program.

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1. INTRODUCTION

In the summer of 1998 Triton Environmental Consultants Ltd. formed a partnership with Northwest Community College (NWCC) and the Department of Fisheries and Oceans (DFO) to conduct rehabilitation assessments and works in the Spring Creek Watershed. The project is funded by DFO's Habitat Restoration and Salmon Enhancement Program (HR-SEP) and is planned as a multi-year restoration program with a focus on:

- training (primarily NWCC natural resources program students),
- restoration of fisheries values, and
- community stewardship.

Spring Creek is a tributary to the Kalum River. Fish species found in Spring Creek include chinook salmon, coho salmon, cutthroat trout, rainbow trout, Dolly Varden, threespine stickleback and sculpins.

At the outset of the Spring Creek Project, students from NWCC conducting field assessments discovered a small landslide at the west end of Dairy Street in Terrace. The landslide flowed directly into the creek and was a potential barrier to upstream migration of coho salmon. Input of fine sediments from the slide was also a concern for fish. The slide became the focus of rehabilitation works in the Fall of 1998. Funding for the rehabilitation of the Dairy Street Slide was provided jointly by HR-SEP and the Terrace Kitimat Partnership for Salmonids (Fisheries Renewal BC).

This report outlines rehabilitation planning and work conducted on the Dairy Street slide. Photos of the project area before and after rehabilitation work are provided at the end of the report.

2. SLIDE DESCRIPTION AND ASSESSMENT

The slide, located on the left bank of Spring Creek at the west end of Dairy Street, was initially discovered by NWCC students in July 1998. The slump most likely occurred in the Spring of 1998. The slide is approximately 90m in length and 25m in width at the headscarp. The width of the slide ranges from 8m in the transport zone to 30m at the deposition zone in Spring Creek. The slope of the face of the slide ranges from 11% - 59% gradient. The original slope was probably around the 30% gradient range.

The initiation of the slide appears to be the result of a combination of factors. The soils in the vicinity of the slide have a high content of glaciomarine clays, which can become highly unstable when saturated. A municipal drainage ditch at the top and center of the slide caused added water volume to the slope. Evidence of dumping debris from the road onto the slope was found; this overloading of the top of the slope may have contributed to the initiation of the slide. A continuous seepage zone approximately 15m down from the top of slide is also evident, which contributes to soil saturation.

The base or toe of the slide has three aspects. One side faces upstream, one side faces directly across the stream(depositing debris in the creek) and one side faces downstream. The downstream side of the toe was of primary concern for stabilization because of its near vertical angle. This side was originally about 2m in height and was subject to undercutting by the creek. A large volume of slide material was being held back by this side of the toe. Destabilization by undercutting on this side could cause another failure, with the material landing directly in the creek.

The front face of the toe was also of major concern because debris deposited in the channel was a potential barrier to adult coho migration. Also, the debris jam acted to increase water velocities along the front of the slide causing undercutting and toe destabilization. The upstream side of the toe was of less risk of undercutting because a backwatered area had formed upstream and water velocities in this area were low, with minimal erosive power.

An unstable headscarp was at the initiation zone of the slide during the initial assessment. The narrow transport zone appeared to be relatively stable, however the side walls were oversteepened and failing. Some vegetation was established on the slide, primarily horsetail (*equisetum sp.*) and seedling alder (*alnus sp.*)

2.1 Impacts to Fisheries Values

The primary concern with the slide was passage of adult coho into spawning habitats upstream. At the time of the discovery of the slide, water was flowing beneath the debris pile which had come to rest in the creek. Juvenile fish could migrate upstream and downstream of the slide but adult passage was suspect.

Another concern for fish populations in Spring Creek was the input of suspended sediments from the slide. Elevated suspended sediment concentrations can adversely affect fish by causing mortalities, reducing growth rate and/or resistance to disease. Impacts are dependent on background water quality, fish species, fish life history stage (eggs, alevins, fry, juvenile, adult), water temperature and water chemistry. For adult fish migrating to spawn, suspended sediment may halt migration, increasing energy consuption during the total migration and possibly reducing reproductive success. Gill lamallae in fish of all ages may be abraded or clogged by suspended sediment, decreasing respiratory efficiency and subsequent growth, survival and reproductive success. Suspended sediment may increase susceptibility to infection, particularly form pathogenic bacteria which invade at the abrasion sites (Redding et al. 1987, Goldes et al. 1988). Adult and juvenile feeding may be impaired by suspended sediment, by decreasing the visibility of prey or stimulation a hiding behavior (Berg and Northcote, 1985). For eggs incubating within the substrate, sediment may smother eggs preventing oxygen and waste exchange, or trap alevins in the gravel.

Fish can survive high concentrations of suspended sediments for short periods, however, prolonged exposure in most species results in mortalities and a reduction in overall productivity. Salmonids are typically more sensitive to suspended sediments than other fish.

2.2 Instream Works Planning

Instream works were planned and supervised by Rob Heibein of DFO in discussion with Triton. The goals of the instream works at the base of the slide were to:

- provide adult fish passage,
- improve fish habitat,
- prevent massive erosion of the toe of the slide by the creek,
- prevent constant saturation of the toe of the slide, and
- reduce suspended sediment input into the creek from the slide.

In order to achieve these goals a plan was developed to re-direct the main flow of the creek away from the toe of the slide into a new channel. At the same time a plan was developed to strategically place large woody debris (LWD) in order to coax the stream away from the slide and scour the new channel deeper than the original channel. LWD placements were designed to serve a dual function of coaxing the stream flow to the right bank(away from the slide) and improving fish habitat by creating deep pools, undercut banks and LWD cover.

3. Slide Rehabilitation Planning

Numerous individuals were invited to visit the slide and provide input as to rehabilitation options. These included: Ralph Ottens (MoF, WRP), David Sahlstrom (Terrasol), Ken Downs (NWCC), Alan Gilchrist (NWCC) and Rob Heibein (DFO). Advice and input from these individuals was greatly appreciated and contributed to the formation and/or modification of a rehabilitation plan for the slide. The goals set out for rehabilitation of the slide were to

- provide initial stabilization of the headscarp,
- manage water transport away from the slide,
- manage water transport on the slide,
- provide structural stabilization of the initiation and transport zones through bioengineeering,
- provide stabilization of the toe of the slide,
- increase the rate of successional reclamation of the site by establishing initial vegetation on the slope (grasses and native trees and shrubs),
- reduce surface erosion on the slide, and
- provide training for installation of a variety of bioengineering structures.

Bioengineering techniques involve using plants and structures made from plants which can provide support, catchment areas, erosion control and soil and structural stability on slides. Bioengineering plans for the slide included the following structures:

- live pole drains
- live gully breaks
- live 'smiles'(modified wattle fencing)
- modified brush layers
- wattle fencing
- live staking
- live silt fencing

The initial plan for rehabilitation of the slide included placing drainage structures from the seepage zone through the transport zone and off of the toe of the slide. Drainage structures were to include a combination of french drains and live pole drains. Both systems are designed to intercept water sources on the slide and to transport the water down and off the slide, thus preventing saturation. Bioengineering structures were planned for the entire slope once drainage structures were in place.

Installing these structures required the collection of willow and cottonwood cuttings or 'whips'. Approximately 2000 whips were required to complete the bioengineering plan for the slide. Whips are best collected during the dormant stage (after leaf production has stopped in the fall, or prior to leaf production in the early spring). Cuttings taken during the dormant stage have the best potential for growth. Carbohydrate stores in the plant are highest immediately following the summer growth season. These stores of carbohydrates in the cuttings allow fresh growth to begin in the spring without photosynthesis. Rooting in willow occurs only during the dormant period, prior to budding and after leaves have fallen. Theoretically, some rooting should occur soon after whips are installed. Successful rooting and plant growth is key in providing increased stability through bioengineering on the slope. Supervision of installation is also important, as cuttings installed 'upside down' or with insufficient soil coverage will not root and grow.

It is important that cuttings be stored in a cool, wet, environment prior to use. Soaking overnight is recommended where practical. Whip collection was planned to occur immediately prior to site rehabilitation so that cuttings would not dry out in storage. Whips were collected on three occasions for this project. Bundles were stored in the pool at the base of the slide overnight prior to use.

4. Slide Rehabilitation

Rehabilitation works were conducted from September 15, 1998 to October 10, 1998. A crew of 4 - 8 persons worked on the slide throughout this period. A heavy rain event in early October changed the bioengineering and drainage plans for the slide. The heavy rain caused a slump at the top of the slide and a large amount of material flowed into the transport zone. As a result of the slump, the transport and initiation zones were deemed unsafe to work on and rehabilitation plans for these areas were canceled. Rehabilitation was focused on completing instream work and stabilization of the toe of the slope.

4.1 Initial Stabilization

The headscarp or initiation zone of the slide required immediate stabilization. A large volume of unstable material remained at the headscarp when the slide was discovered. The City of Terrace removed the majority of this material prior to the commencement of rehabilitation works. This action increased the stability of the slide and made the work site more safe.

4.2 Instream Work

Instream work involved creating a new channel on the opposite bank from the slide to direct the main portion of flow away from the toe of the slide.

Slide debris was removed and brush was cleared on the right bank of the creek in order to create a route for the channel diversion. A small trench was dug in order to get water flowing into the new channel. A large log was angled under an existing log across the stream in the new channel. This placement caused intensive scouring beneath the placed log and deepened the new channel. After a significant rain event the pool underneath the log had scoured to over 1m deep, providing excellent fish holding and rearing habitat. The banks downstream of the log placement were undercut by the flow, creating additional fish cover. Flow was also directed away from the downstream toe by the channel diversion. Juvenile fish were observed using habitat in the new channel immediately. An adult coho was observed in the undercut downstream of the log placement. The new channel not only provides passage for adult coho migrating upstream to spawn, but also provides holding and rearing habitats.

LWD were placed upstream of the new channel to encourage scouring on the right bank (opposite the slide) and direct water flow towards the new channel. These placements were attached to large trees on the banks with cable.

Instream work was completed entirely by manual labour LWD placements were completed by using a combination of techniques including hand winching with a come-a long, peavey and man-power. Three log placements were made in total.

Photos 3 and 4 show the channel prior to instream work. Photos 5-7 and 14 show the new stream channel.

4.3 Toe Stabilization

A log crib-wall structure was built to stabilize the downstream toe of the slide (Photos 8 and 11). Cedar logs donated by Bell Pole Co. were transported to the base of the slide using a cable suspension system. The crib wall was constructed at a 1/1 slope, two log-tiers in height and was stabilized by rebar pounded into the substrate through holes drilled into the logs. Deadman logs were placed and attached to the structure with rebar to provide additional strength in each level. The structure was backfilled and willow whips were planted throughout. The base of the structure was armoured with cobbles.

The debris pile at the front of the slide was partially removed. A live wattle fence was built from willow and cottonwood whips along the front of the toe, curving to cover a portion of the upstream toe. The wattle fence was built to provide some initial toe stabilization and to minimize erosion of the toe by flowing water. If the whips take, the fence will provide additional toe support and erosion control in the form of live willows with a root system.

4.3.1 Bioengineering

Bioengineering structures were built from the bottom of the transport zone over the entire depositional zone to the creek (Photos 9-14).

Live pole drains were installed on both sides of the gully (transport zone) and were directed off of the toe and into the forest on either side of the slide. The placement of the pole drains was intended to direct water flow away from the toe of the slide. In this way the large volume of material in the depositional zone could dry out and saturation (and subsequent movement) of this material could be prevented. Live pole drains were installed with the intention of being connected with french drains from the top portion of the slide. The slump made installation of french drains unsafe and impractical. Live pole drains were left installed for demonstration purposes and to direct water away from the toe.

A combination of live 'smiles' and modified brush layers were used to stabilize and revegetate the depositional zone and to prevent mud from flowing into the creek (Photo 9). Live silt fencing was placed at the outlet of one of the live pole drains to intercept sediment headed towards the creek (Photo 12).

4.3.2 Revegetation

Live staking of cuttings was done throughout the depositional zone to provide increased cover and root stability from willow plants. Cedar seedlings and trees (approximately 1m high) were planted along the right bank of the creek.

Hand seeding of the slope was done as a final revegetation method to help reduce surface erosion and provide some increased soil stability. Hand seeding occurred late in the fall and may not have been successful. Hand-seeding is planned again for early spring 1999.

5. MONITORING AND MAINTENANCE

The Dairy Street Slide will be monitored as part of the ongoing Spring Creek Project. Revegetation plans for 1999 include grass seeding and planting of native shrubs and conifers. Instream works will be monitored by the Spring Creek Project as well. Instream work and bioengineering structures installed on this project will serve as demonstration sites for future work on Spring Creek as well as for NWCC Natural Resources Program training.

6. REFERENCES

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PHOTOGRAPHS

Photo 1: Depositional zone (toe), view towards creek, prior to rehabilitation work.

Photo 2: Lower end of transport zone, upper end of depositional zone prior to rehabilitation work.

Photo 3: Debris in stream channel prior to instream work.

Photo 4: Slide material blocking stream channel prior to instream work.

Photo 5:New channel showing LWD placement beneath log to encourage scour.

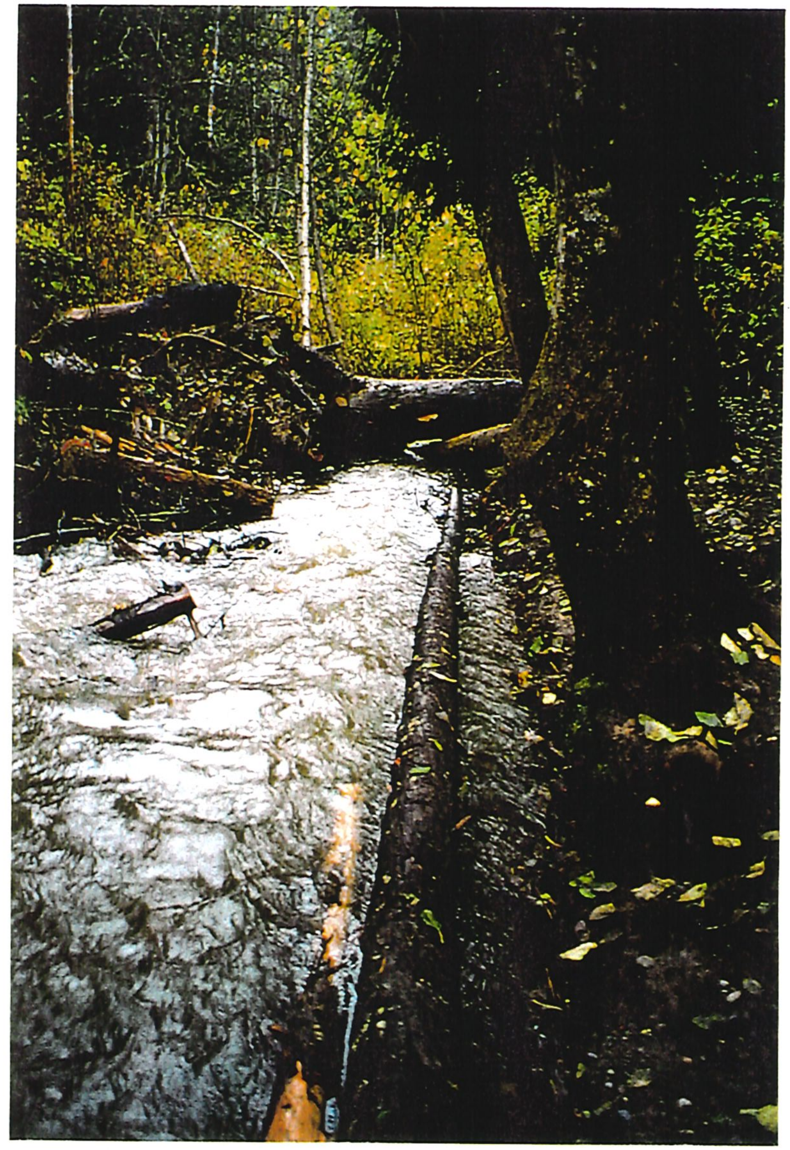

Photo 6: New channel showing LWD placements on right bank.

Photo 7: Instream work showing LWD placement beneath log, undercut banks and pool formed immediately downstream.

Photo 8: Crib wall structure constructed to stablize toe of slope.

Photo 9: Bioengineering structures: live smiles (bottom and right) and modified brush layer(left).

Photo 10: View of depositional zone, showing bioengineering structures.

Photo 11: View from downstream of crib wall with live staking and bioengineering structures.

Photo 12: Live pole drain exit with live silt fencing downstream.

Photo 13: View of slide from right bank showing wattle fencing and bioengineering.

Photo 14: View of new channel showing LWD placements on right bank, modified brush layer (foreground).

Photo 15: High water event in October showing crib wall structure protecting toe of slide.

Photo 16: High water event showing new channel and LWD placement on right bank.

Photo 17: High water event showing water energy concentrated under LWD placement, scouring substrate.