MPERG Report 2010-3

Alternative Methods for the Reclamation of an Exploration Trail off the Dempster Highway, Yukon

By

Laberge Environmental Services

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Alternative Methods for the Reclamation of an Exploration Trail off the Dempster Highway

Prepared for:

Mining and Petroleum Environment Research Group

Submitted by:

Laberge ENVIRONMENTAL SERVICES

March 2010

Summary

In 2004 and 2005, methods for restoring the damage done to the permafrost layer of an exploration trail was investigated using natural and bioengineered techniques rather than mechanical means. The impacted trail was created in November 2002 and is located off Kilometer 159 of the Dempster Highway. The methods included backfilling the impacted areas with adjacent vegetated material and transplanting plugs or islands of vegetation from donor areas in the immediate vicinity. Hand collections of seeds of various species growing on site were dispersed over some of the mitigated areas. Live willow staking was conducted at a stream crossing.

The exploration track was 1.2 km in length. Approximately half of the access trail required remediation of some form, the remainder having minimal or no disturbance. The techniques of using native material to backfill the impacted areas, and willow staking to channelize the stream flow at the lower crossing has been effective in controlling erosion and restoring the site. The hand-spread grass and sedge seeds hastened colonization on the applied areas. Although these techniques are labor intensive they definitely are effective and inexpensive, especially on a small scale.

The trail appears to be largely restored by July 2009 with some sections of the trail virtually indiscernible from the surrounding environment. It is doubtful that had the application of gravels and peat moss using dump trucks (the initial recommendation) been undertaken in 2004, the final result would not have been as successful.

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1.0 Project Background

In late 2002, an exploration company, Canadian Empire Exploration Corp, hired a drilling company to create a 1.2 km access trail off of Kilometer 159 on the Dempster Highway to conduct a drilling program. Contrary to their permit, which only allowed one pass, repeated passes over the trail with heavy equipment had created significant rutting and gouging of the active permafrost layer. A routine inspection by Energy Mines and Resources (EMR) personnel in the spring of 2003 discovered significant water erosion and disturbance to the ground cover, and instructed the exploration company to repair the trail before their permit expired the coming October.

No action was taken so EMR used a wide track bulldozer to remove snow from the access trail in February and again in April of 2004, to allow greater frost penetration into the ground. The bill was sent to the exploration company. EMR proposed to the company that later in 2004, gravel should be hauled in by dump trucks and spread in a thin layer with a loader along the trail. This would provide the trucks with some traction and provide some initial insulation. Subsequently peat moss would be spread along the trail with trucks driving all the way up to the drill site, and the loader working back toward the highway (Allan Rothwell, letter dated April 27th, 2004). The exploration company decided to pursue alternate methods and contracted Laberge Environmental Services (LES) in 2004 to investigate the use of bioengineering techniques in rehabilitating the site. In September of 2004, LES assessed the trail and performed some initial backfilling and leveling with hand tools. Extensive live willow staking at the lower creek crossing was also conducted in attempts to control and confine the flow.

A more intensive restoration program was undertaken in the summer of 2005 (July 11th to 15th) to compliment the initial efforts. The live willow staking was performing well and no additional work was done at the creek crossing. Some of the initial remediated sites required no further work, however the deeper ruts were still presenting problems. A stockpile of peat, located a short distance away, was accessed as fill material for the deeper ruts throughout the lower section of the trail. The peat moss was carried to the site on tarps by foot to reduce any further impact to the trail that would have occurred if an all terrain vehicle (ATV) was used. This proved to be very labor intensive for the crew of five, and other methods were then employed. This consisted of filling in the ruts and wetter spots with donor clumps of peat moss and tussocks removed from the immediate environment, as well as making use of the soil and peat that had been pushed aside by the heavy tracked vehicles. It was anticipated that the removal of the donor clumps should not impact the original environment as great care was taken during the retrieval process. Additionally the donor sites used were distributed over a generous area.

In July 2006, LES was in the vicinity on another project and voluntarily inspected the site to assess how the mitigation methods had withstood the current spring melt. No active erosion was taking place and the disturbed areas were healing.

The current project entailed revisiting the site to assess the success of the rehabilitated areas after a period of four and five years since the work was accomplished. As far as could be determined, no one had been to the study area, including the regulatory agencies, since the voluntary inspection conducted by LES in the summer of 2006. All mitigated sites had been well documented and surveyed in 2004 and 2005, ensuring that each area was easily relocated when visited in 2009.

1.1 Project Objective

The objective of the 2009 project was to determine whether the use of organic cover to remediate disturbed permafrost sites continues to be successful at a site that was treated four and five years previously.

The project objective was achieved through the following methods:

- Each of the remediated sites was revisited and assessed.
- Photographs were taken from the same designated locations and compared with those taken in 2004, 2005 and 2006.
- Several of the sites were reseeded in 2004 with hand-collected seeds from native plants growing in adjacent areas. These areas were assessed to determine the success of this seeding method.
- The donor sites were assessed to determine if they have recovered.

2.0 Study Area

The study area is located adjacent to the Dempster Highway in northern Yukon, approximately 125 kilometers by air from Dawson City. It falls within the ecoregion North Ogilvie Mountains, characterized by modest mountains with unvegetated summits and rubble covered slopes separated by wide valleys. The ecoregion was largely unglaciated and has continuous permafrost which is sometimes absent close to watercourses. Mean annual temperatures range from -7°C to -10°C with extreme winter temperatures in the lower valleys of -50 °C to -60 °C (Yukon Ecoregions Working Group, 2006).

During the 2002 fall drilling program at the Yukon Olympic Property, an exploration trail was established to the west of Km 159 on the Dempster Highway. The trail head is located across a dry river bed (part of the Engineer Creek drainage) and is impossible to detect from the highway. The trail itself is approximately 1.2 km long from the trailhead to the drilling site, and rises in elevation approximately 55 m representing a slope of 0.45%. Several sections of the trail are level and there are no steep sections. However, the disturbance of the permafrost active layer in 2002 had subsequently created areas of erosion. During the initial inspection conducted by LES on September 13th and 14th, 2004, specific sites requiring remediation were surveyed and plotted (Figure 1). A full description of each of these sites is detailed below in Table 1.

TABLE 1 Site Locations and Descriptions from Top of Trail to Dempster Highway

Site #	Easting	Northing	Date Established	Description
1	623169	7219964	September 13, 2004	Uppermost section, start of disturbance
2	623161	7219982	September 13, 2004	Curved rutted section
3	623147	7219957	September 13, 2004	Turn-around area
4	623129	7219950	September 13, 2004	First sump
5	623120	7219961	September 13, 2004	Second sump
6	623080	7220004	September 13, 2004	Upper creek crossing
7	623060	7220050	September 13, 2004	First set of ruts below upper creek crossing. Section between Site 7 and Site 8 is fine
8	623070	7220257	September 13, 2004	Top of next rutted section - minor
9	623081	7220326	September 13, 2004	Bottom of this rutted section. The stretch between Sites 9 and 10 is fine.
10	623147	7220364	September 13, 2004	Lower stream crossing.
11	623231	7220453	September 13, 2004	Beginning of rutted section below lower creek crossing.
12	623276	7220491	July 13, 2005	End of rutted section - section mitigated in July 2005
13	623384	7220541	July 12, 2005	Top of wet rutted section mitigated in July 2005
14	623448	7220553	July 12, 2005	Section of dry ruts mitigated in July 2005
15	623499	7220559	September 14, 2004	Wet area, lots of infilling done throughout this section which goes to Site 16, in Sept '04 and July '05
16	623544	7220592	September 14, 2004	Deep set of ruts. Between Sites 16 and 17 is fine.
17	623696	7220649	September 14, 2004	Trail head. The area between Sites 17 and 18 is the large, usually dry, overflow channel of Engineer Creek.
18	623929	7220542	September 14, 2004	Dempster Highway km 159.

Notes: Datum: NAD 83
Zone: 7W
Topo Map: 116G01

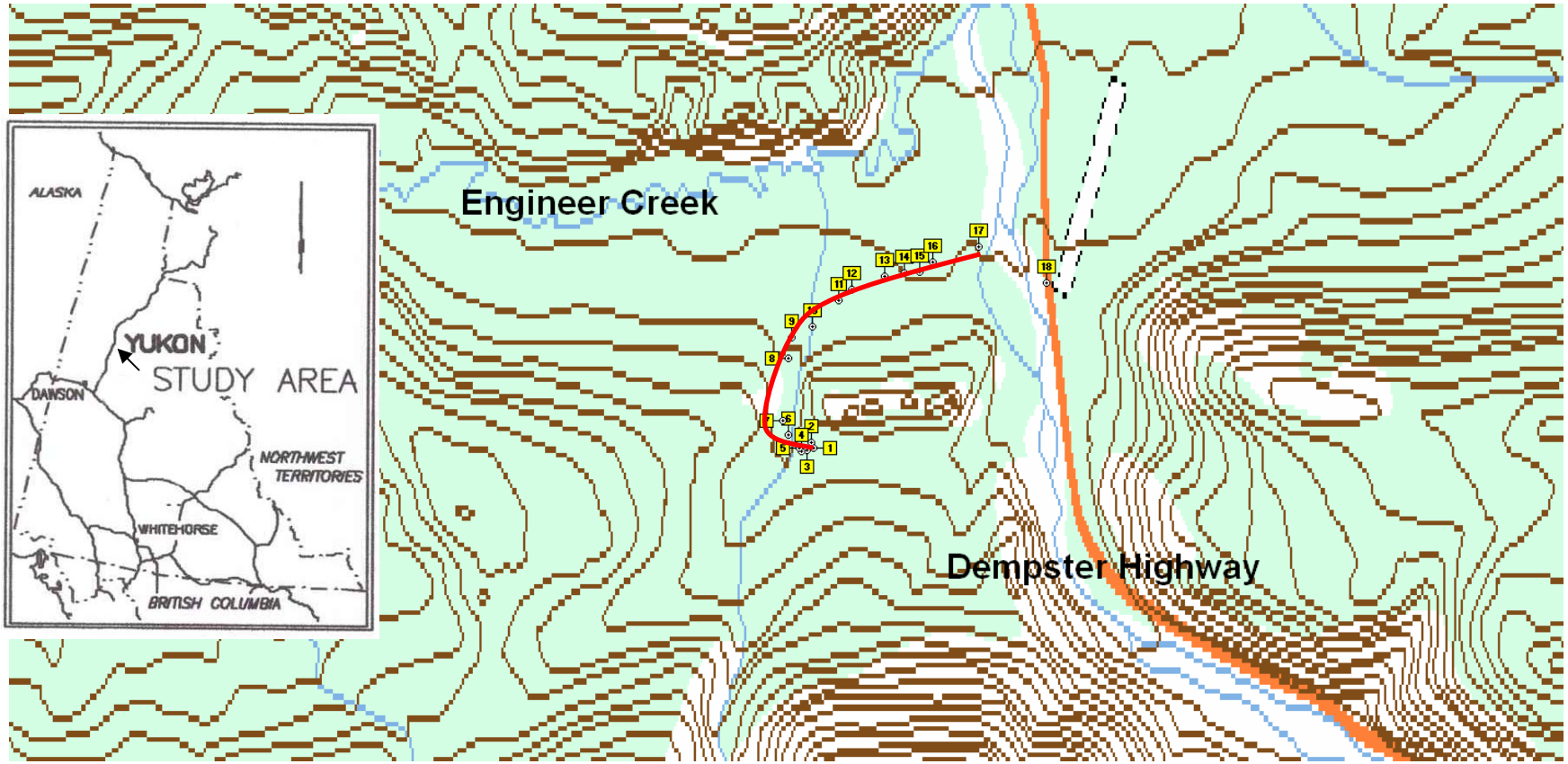

Figure 1 Location of Trail and Sites at Km 159 Dempster Highway

3.0 Remediation Descriptions and Results

3.1 The Uppermost Section

This section encompasses Sites 1 through 7. During the inspection conducted by Energy, Mines and Resources in May 2003, deep ruts were filled with water from the commencement of spring melt (Photo #1, Appendix A) at the top of the trail, Site 1. The damage to the trail had occurred in November 2002, so this represents the first melt following the impact. The water was running in the ruts and continued intermittently down to the upper creek crossing (Site 6), a small tributary to Engineer Creek. This runoff had eroded several sections down to the underlying gravels within this segment.

During the inspection by LES on September 13th, 2004, the ruts contained frozen water (Photo #2). These trenches were filled in with local material from the sides using hand picks (Photo #3). Inspections of Site 1 during July 2005, July 2006 and July 2009, showed that grasses were growing within the ruts, with the presence of a small amount of standing water (Photos # 4 to # 6) and no evidence of flowing water. No further treatments were applied after the initial effort in 2004.

Site 2 is approximately 20 m below Site 1 where the trail curves south. The runoff in 2003 had eroded the groundcover here down to the underlying gravels. As well as using side material for filling in the ruts, some small plugs of vegetation from the adjacent forest were used. This area was revegetating nicely and no standing or running water was present in 2005, 2006 or 2009 (Photos 7 to 9).

Rougher areas of the turnaround/drill site area, Site 3, were levelled with hand tools in Sept 2004 and in July 2005. In addition, blue-joint reed-grass seeds (*Calamagrostis canadensis*) were collected by hand from a nearby stand and spread over these disturbed sites on September 13th, 2004. Although this site still presented bare portions during ensuing inspections, no further treatments were deemed necessary. Natural revegetation would continue over time.

There were two existing sumps at the drill site, both of which were frozen during the September 2004 inspection. Remediation work was carried out in July 2005. The first sump (Site 4) was shallow and small, and contained some standing water. Efforts were concentrated on the second larger and deeper sump (Site 5). Local ground material that had been ripped up by the equipment, as well as dead vegetation, were used as fill. As of 2009, the surface of the sump was revegetating efficiently and contained small quantities of standing water, but no erosion had occurred since the remediation work in 2005 (Photos 10 to 14).

During the September 2004 inspection, the trail between the second sump and the upper creek crossing was rutted and flowing water had previously eroded some sections, but was frozen at the time. These ruts were backfilled with soil and peat that had been pushed aside by the heavy tracked vehicles, and blue-joint reed-grass seeds (*Calamagrostis canadensis*) were also scattered on September 13th, 2004. No further treatments were applied in 2005. Photos 15 to 19 show how the area has recovered over time. By 2009, the colonizing bluegrass documented in 2006 has become well established. Appendix B lists the species that were colonizing the various mitigated areas.

The channel of the upper creek crossing (Site 6) appeared stable during the September 2004 visit, however both approaches had suffered damaged, notably the upslope portion. The repeated

traversing of equipment accessing this slope had exposed some of the underlying material and this was further exacerbated following the spring melts. Ground material that had been scraped aside during the mechanical activities was placed over the exposed roots and gravels on September 13th, 2004. This procedure was effective at reducing and eliminating erosion and no further work was required in July 2005. Photos 20 through 23 show the initial problem, the site following the treatment and the recovery in the ensuing years.

Some levelling of the downslope approach was conducted with hand tools on July 21st, 2005, which has increased the stability and enhanced the return to original conditions. (Photos 24 and 25).

The trail was relatively unaffected for approximately 50m from the upper creek crossing to a set of fairly deep ruts (Site 7). The standing water within the ruts was frozen on September 14th and as the terrain was level no action was taken. During July, some time was spent in backfilling these ruts to ensure that they would not create a problem in the future (Photos 26 to 30).

The section of the trail from here to the lower creek crossing was in good shape for much of the route. In July 2005 some of the more rutted spots were backfilled, but little remediation was required.

3.2 The Lower Creek Crossing (Site 10)

The drilling company appeared to have had problems with the lower creek crossing as there were two separate areas where fords had been created. The original creek channel here is very narrow with willows (predominantly *Salix arbusculoide* and *Salix pulchra*) growing immediately on the banks (Photo). Both fords had created wide shallow areas with the potential for flooding. A great deal of energy was spent live-willow staking along these two fords on September 14th, 2004. Dormant willow cuttings were collected from the streamside and immediate area, and staked along both banks at both of the lower crossings. The intention was that the live cuttings would produce new roots and shoots during the following growing seasons, leading to the re-establishment of a riparian band of willows at these sites. This would confine the channel to control the flow.

The live staking was very successful and no further stabilization work was conducted at Site 10 when assessed in July 2005. Subsequent inspections in 2006 and 2009 showed a high success rate of survival. No evidence of flooding or erosion was apparent (Photos 32 to 34).

3.3 The Bottom Section

This section encompasses Sites 11 through to 16. There were a couple of dry and wetted rutted segments of the trail below the lower creek crossing. These ruts were backfilled with adjacent material including dead portions of spruce trees in July 2005 (Photos 35 and 36).

A very wet boggy problem area commenced at Site 15 through to a set of very deep ruts at Site 16. It appears that this large boggy area presented difficulties for vehicles as quite a wide section was disturbed. In September 2004, portions of the surface layer that had been scrapped off that previous winter were placed onto the wetter sections. Sedge seeds (*Carex ssp*) were collected from the immediate vicinity and scattered over the mitigated portions.

In July 2005 a great deal of standing water was present and efforts were concentrated throughout this area. Following recommendations by EMR, loads of peat collected from a stockpile at Km 187, were brought in on July 24th to assist in the absorption of the moisture and hopefully build up the insulation layer again. This method had been used the previous day to fill in the deep ruts at Site 16, described in detail below. It was becoming apparent that this method was far too labor intensive and time consuming and would not permit completion of the mitigation project within the given budget and time constraints. Alternatively, clumps of moss and vegetation were harvested from the undisturbed areas nearby and placed into the disturbed area. This had the added advantage of introducing mature plants to the site that could then spread over time. During the July 21st 2006 visit, areas of standing water were still present, but is typical of this vicinity and pockets of standing water exist in the undisturbed areas adjacent to the trail. Lush areas of sedges were colonizing portions of the treated areas. Increased growth was observed in July 2009. Photos 37 through to 42 display the site before any mitigation methods were employed plus the site over time.

The very deep set of ruts, Site 16, was frozen during the initial inspection in September 2004 (Photo 43). The only mitigation that could be preformed at this time was the placing of dead trees on top of the ice to help absorb and slow down flow during the following spring melt. This was the first site where the application of peat to aid in the absorption of the standing water was employed as a mitigation method that had been recommended by EMR. Truckloads of peat were hauled as close to the trailhead as possible over the rocky dry riverbed. The peat was shoveled onto tarps and then carried to the site by four people with one at each corner (Photo 44). After approximately 25 tarp loads, the set of ruts appeared to be covered (Photos 45 and 46). However, this process took one full day and only one impacted site had been repaired. It was important not to introduce any mechanical disturbance to this sensitive area, and the use of all terrain vehicles for moving the peat was rejected. It is interested to note, that the numerous trips made by foot were creating an impact from the trailhead to Site 16.

A year later, the applied loads of peat were not sufficient to absorb the water and the presence of pooling was observed (Photo 47). Clumps of vegetation had not been added to this area as they had been at Site 15, but it is probable that if this had been done, some invasion of plants may have commenced. By 2009 significant colonization had occurred however the site was still soft and spongy (Photo 48).

3.4 Donor Sites

Most of the vegetation that was used as infill was obtained from the material that had been inadvertently scrapped aside by the grader EMR had hired in late winter of 2004 to remove snow and thus encourage freezing of the disturbed trail. Other vegetation was collected from the natural surrounding areas by digging up small sections of tussocks present throughout the vicinity of Site 15.

Attempts were made in 2009 to locate these donor sites to determine if they had recovered over the ensuing years. Some of the donor sites were not obvious and others were slower to recover. It appeared that those removed from the wetter areas recovered faster than those collected from drier zones (Photos 49 and 50).

4.0 Acknowledgements

Laberge Environmental Services would like to thank the Mining and Petroleum Environmental Research Group for providing the funding which allowed us to conduct an updated inspection of the site in 2009, resulting in this report. The initial inspection and all of the field work was funded by Canadian Empire Exploration Corporation, a division of Western Prospector Group Ltd.

5.0 References

Allan Rothwell. April 27, 2004. Letter to the president of Western Prospector Group Ltd. EMR files, Dawson City, Yukon.

Yukon Ecoregions Working Group. 2006. Ecoregions of the Yukon Territory Biophysical Properties of Yukon Landscapes. Editors C.A.S. Smith, J.C. Meikle and C.R. Roots. Agriculture and Agri-Food Canada, Research Branch, PARC Technical Bulletin 04-01.

APPENDIX A

PHOTOGRAPHS

Photo #1: Site #1, in May 2003 snowmelt is actively flowing in the ruts that were created by tracked equipment in November 2002. Photo credit: Al Rothwell, EMR, YG, Dawson City.

Photo #2: Site #1; on September 13th, 2004, water within the ruts was frozen.

Photo #3: Site #1; the ruts are backfilled with local material, September 2004.

Photo #4: Site #1; grass is growing within the ruts creating stability by July 2005. There are localized spots of standing water but no evidence of running water.

Photo #5: Site #1; grass growth is thicker in the ruts by July 2006. Some standing water remains.

Photo #6: Site #1; grass and plant growth continues to populate the ruts in July 2009. No standing water present.

Photo #7: Site #2; the eroded and rutted corner has been backfilled with local material, Sept 13, 2004.

Photo #8: Site #2; the section remains stable with new grass growth sprouting on the exposed soils, July 2005.

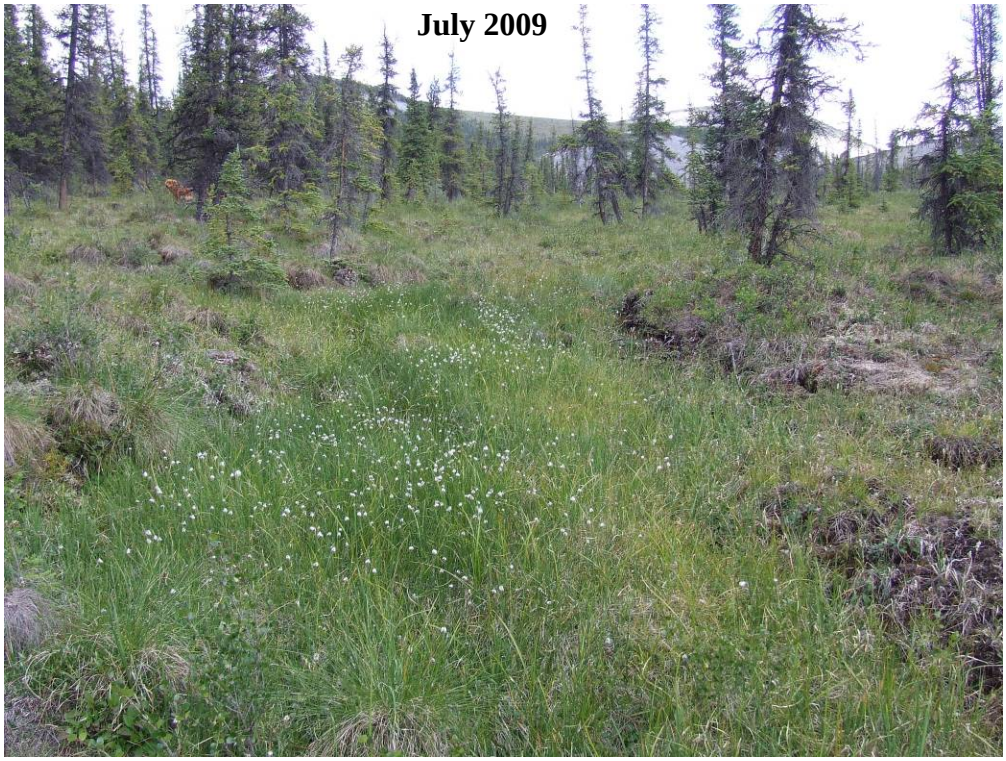

Photo # 9: Sedges and grasses have colonized Site #2 by July 2009.

Photo #10: Site #5; the standing water in the second sump was frozen on September 13th,2004.

Photo #11: Site #5; prior to any treatments, July 2005.

Photo # 12: Site #5; following backfilling with local material, July 2005.

Photo #13: Site #5; the organic material had absorbed the water with some standing water present over the northern half, however no water movement or erosion was evident, July 21, 2006.

Photo #14: Site #5; plant growth has increased by July 2009 and little standing water is evident.

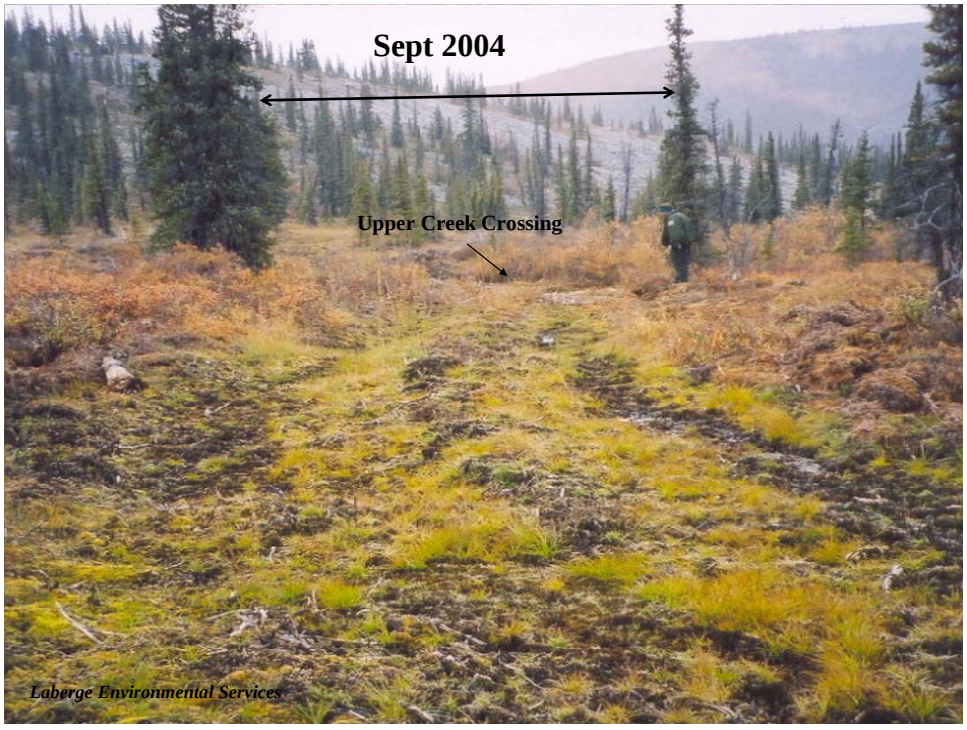

Photo #15: The section of trail from the second sump (Site 5) to the upper creek crossing (Site 6) required backfilling, September 2004.

Photo #16: Completion of backfilling the problem areas, September 13th, 2004.

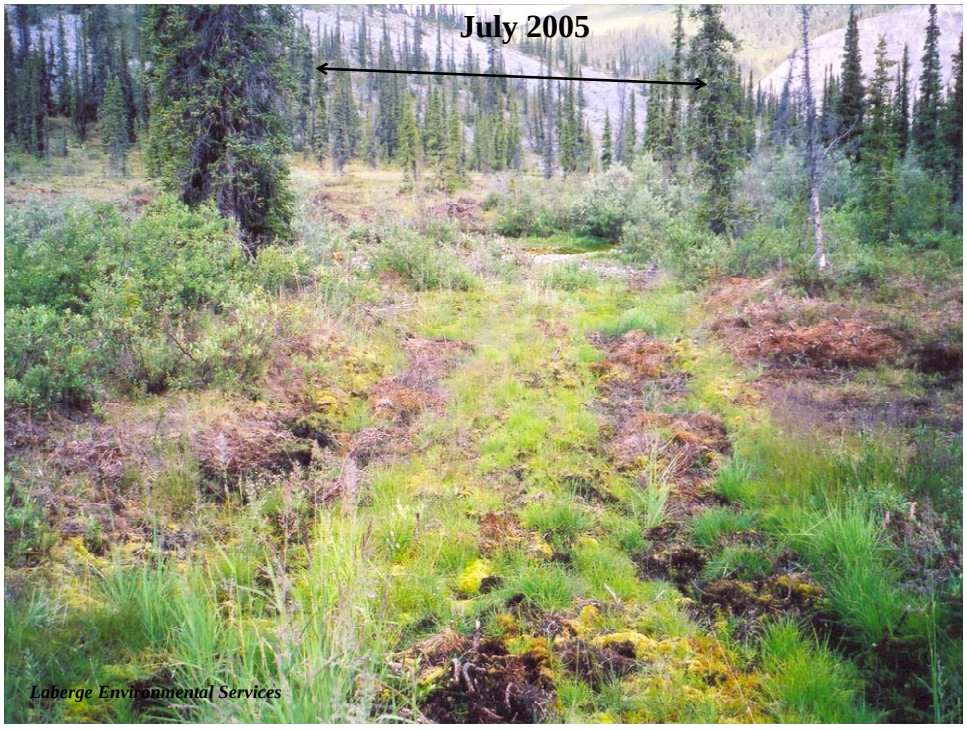

Photo #17: By July 2005 grass is growing within the rutted areas and no water, standing or flowing is evident.

Photo #18: By July 2006, a robust growth of *Calamagrostis canadensis* is apparent.

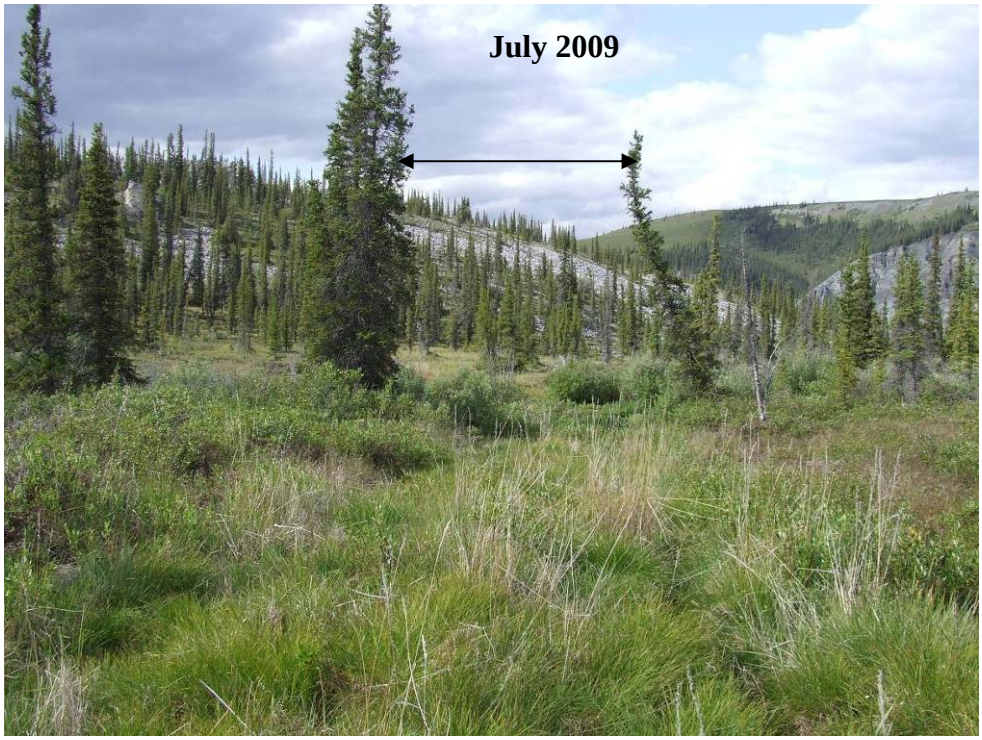

Photo #19: By July 2009, vegetation has continued to invade and propagate, and the ruts are barely perceptible.

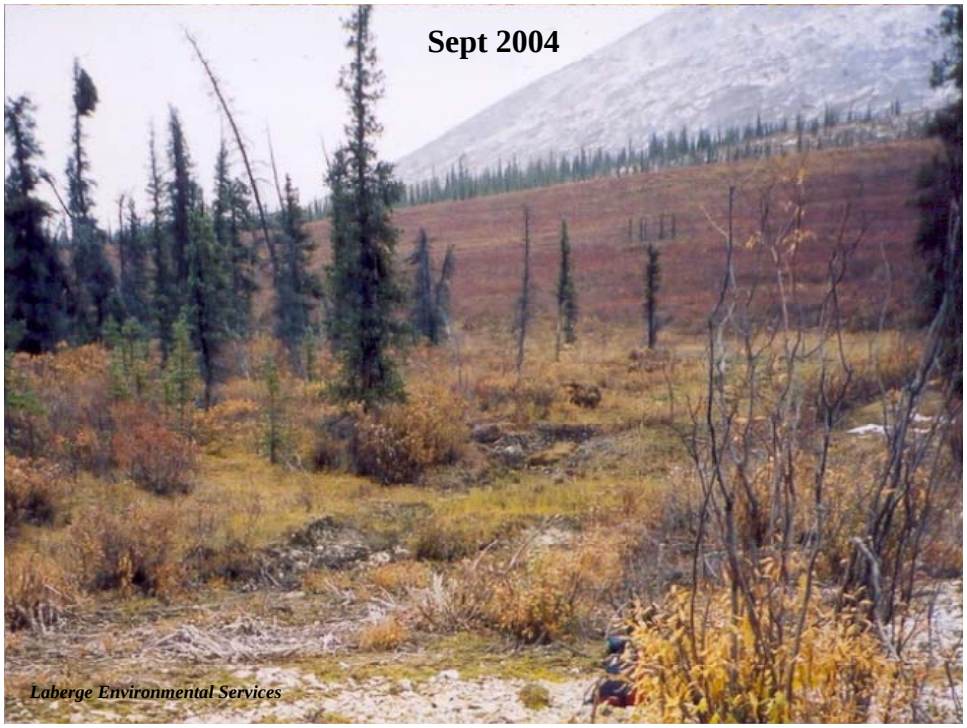

Photo #20: Site 6; the upper approach of the upper creek crossing had been damaged with most of the ground layer having been removed and/or worn down by the action of the tracked equipment, September 13th, 2004.

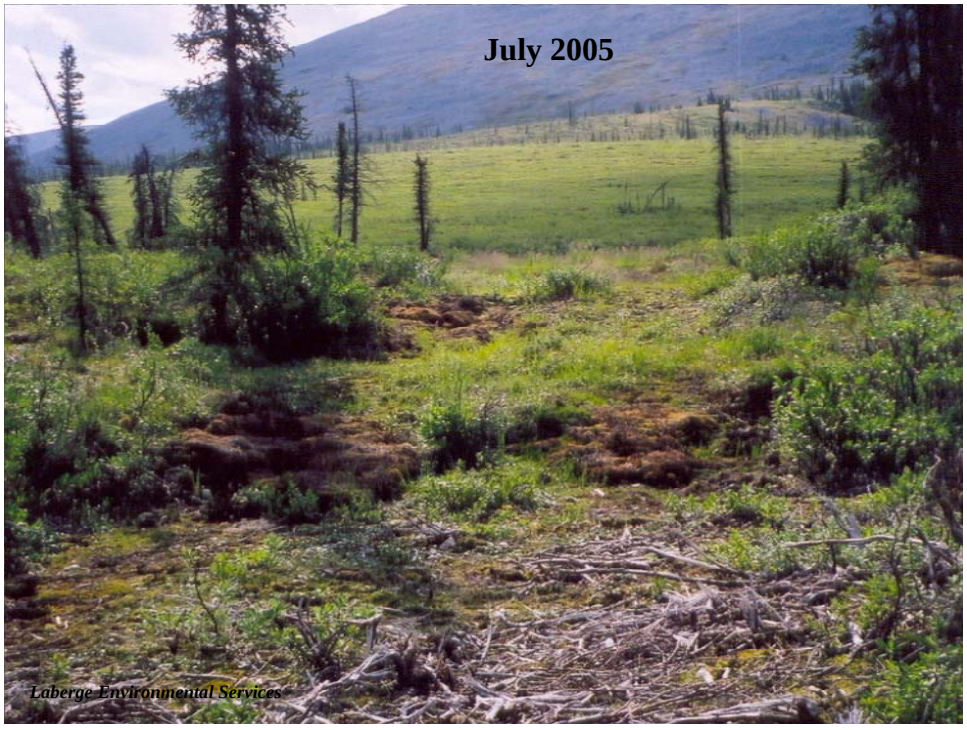

Photo #21: Site 6; less than one year later no erosion has occurred on the upslope approach, gravels remained covered with material laid down in 2004 and grasses have begun to grow in some areas, July 21, 2005.

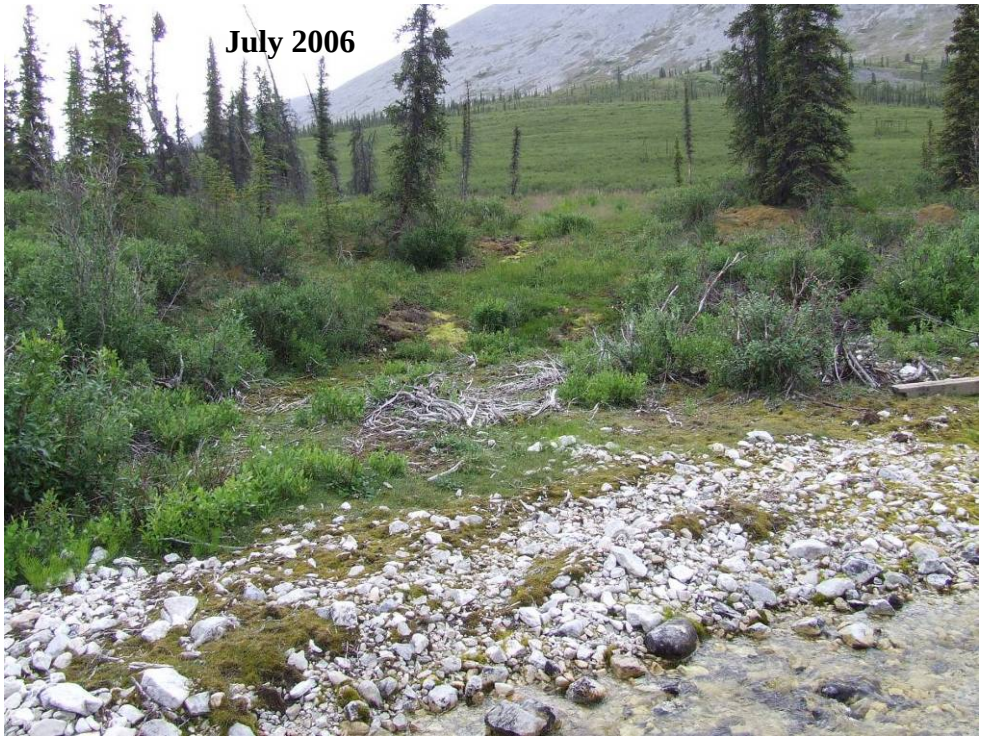

Photo #22: Site 6; on July 21, 2006, increased growth appears to be creating more stability. No signs of any erosion.

Photo #23: Site 6; The remediated site has well established plant growth and the upper approach is stable, July 24, 2009.

Photo # 24:Site 6; grasses are becoming established on the lower approach to the upper creek crossing on July 12th, 2006.

Photo # 25: Site #6; the lower approach continues to revegetate naturally, July 24, 2009.

Photo # 26: Site 7 prior to any amendments, July 13, 2005.

Photo # 27: Leveling and backfilling Site 7, July 13, 2005.

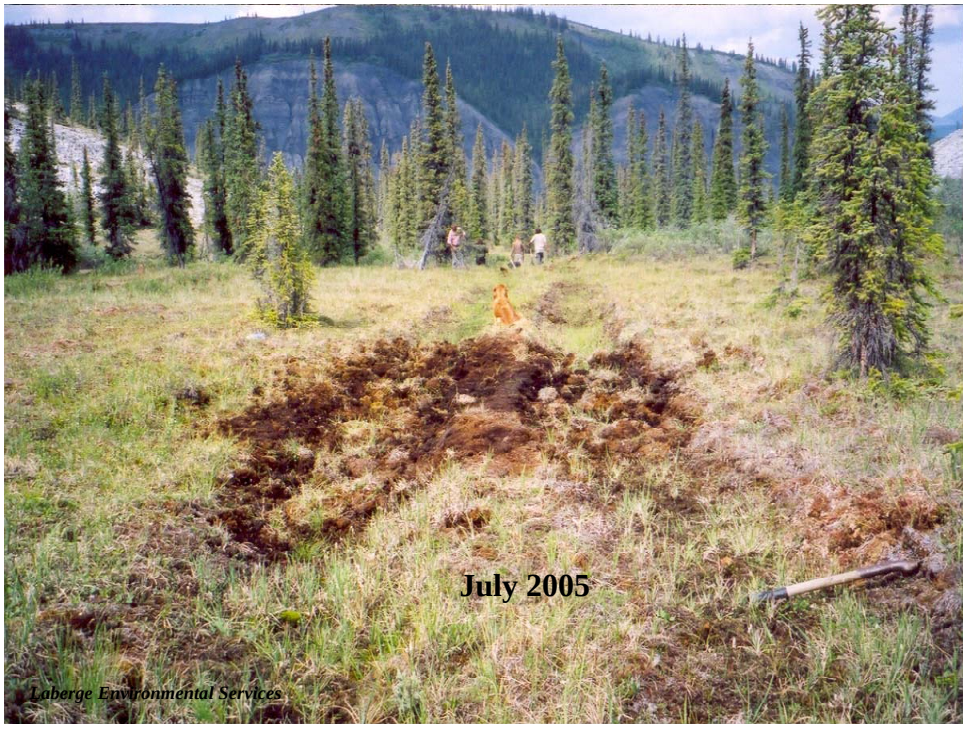

Photo #28: The completion of the remediation work at Site 7 on July 13, 2005.

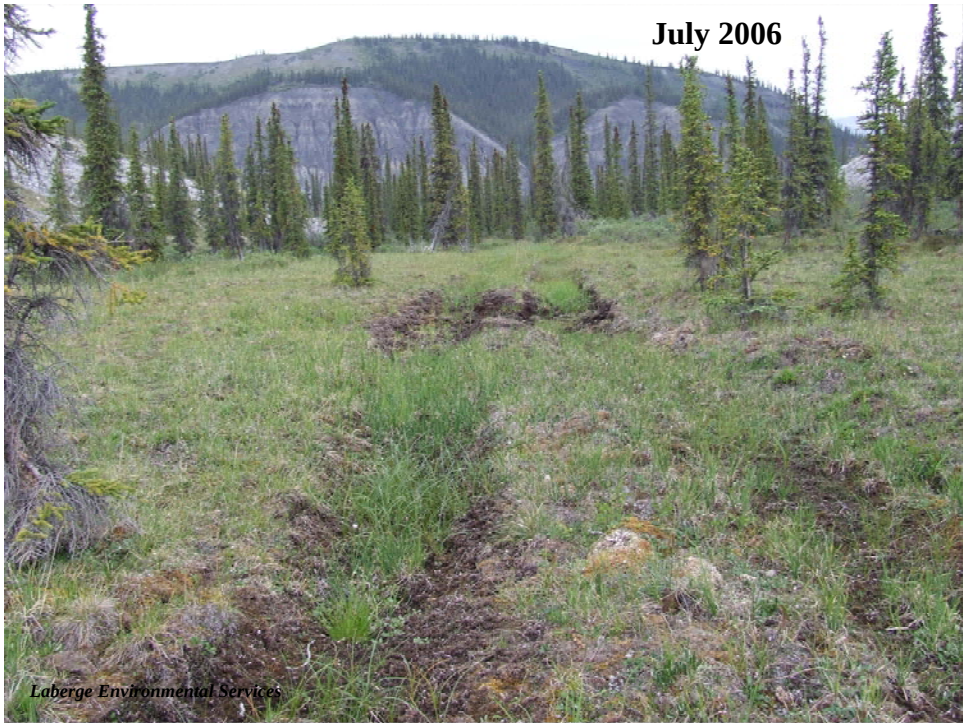

Photo #29 : Grasses are colonizing most of the backfilled ruts at Site 7, July 2006.

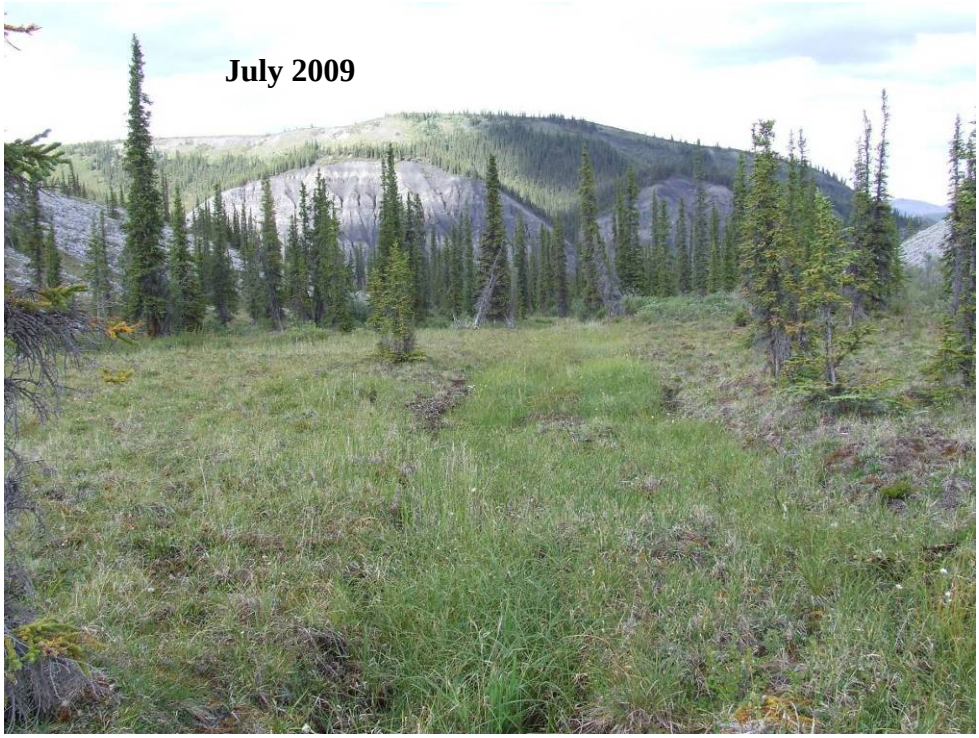

Photo # 30: Grasses have continued to propagate throughout the rutted areas so that on July 24, 2009, the ruts are barely discernible at Site 7.

Photo #31: Site 10; The original creek channel at the lower creek crossing is approximately 80 cm wide and 20 cm deep.

Photo #32: Site 10; the live willow staking that was installed in September 2004 shows good survival rates in July 2005.

Photo # 33: Site 10; The upper ford of the lower creek crossing shows continued good survival rates of the live staked willows in July 2006.

Photo # 34: Site 10; The willow stakes at the lower ford of the lower creek crossing are thriving in July 2009.

Photo # 35: Site 12; The bottom of the rutted section below the lower crossing that was mitigated in July 2005. This photo was taken on July 21, 2006. Portions of dead spruce trees as well as the removed material were used as fill.

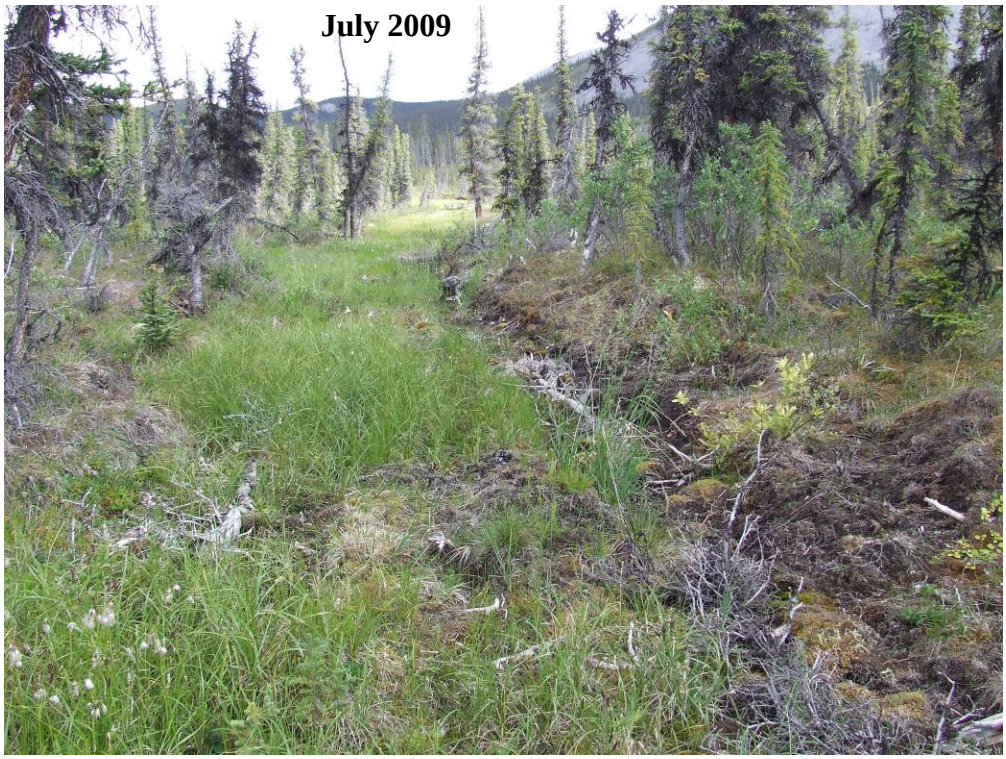

Photo # 36: Site 12 in July 2009 showing increased grass and sedge growth, and stabilized condition.

Photo #37: A section of Site 15 in May 2003. Photo credit: Al Rothwell, EMR, YG, Dawson City

Photo #38 : The same general area of Site 15 in September 2004 after initial remediation.

Photo #39 : The same general area of Site 15 in July 2009 showing excellent results from the amendments applied in July 2005.

Photo # 40: A section of Site 15 looking west, after the site had been mitigated with clumps of vegetation and peat moss, July 2005.

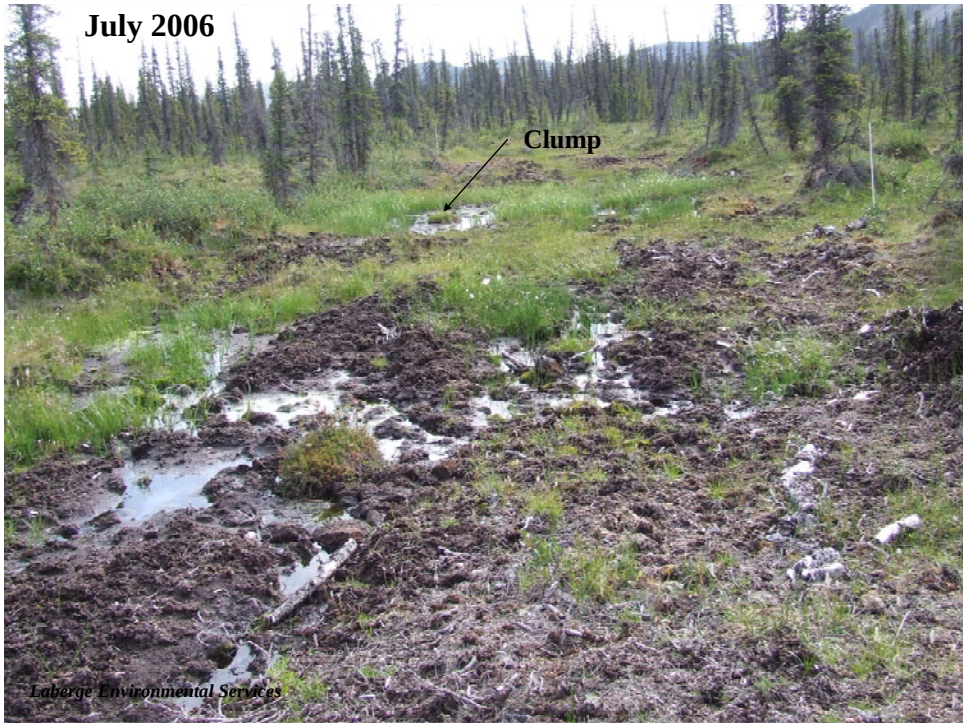

Photo # 41: Site 15; looking east along the mitigated trail toward the large clump in July 2006. Standing water is present, however this is typical of this particular area.

Photo #42 : Site 15 looking west, July 2009. Significant cover of grasses and sedges.

Photo #43: The deep ruts at Site 16 were frozen in September 2004.

Photo # 44: Tarp loads of peat are hauled across the dry river bed to the trail head to be deposited into the ruts at Site 16.

Photo #45: The peat and dead trees were used as fill to remediate the deep ruts, July 2005.

Photo #46: Site 16 appears to be mitigated following 25 tarp loads of peat on July 19th, 2005.

Photo #47: A year later the applied loads of peat were insufficient to absorb the water and Site 16 was boggy in July 2006.

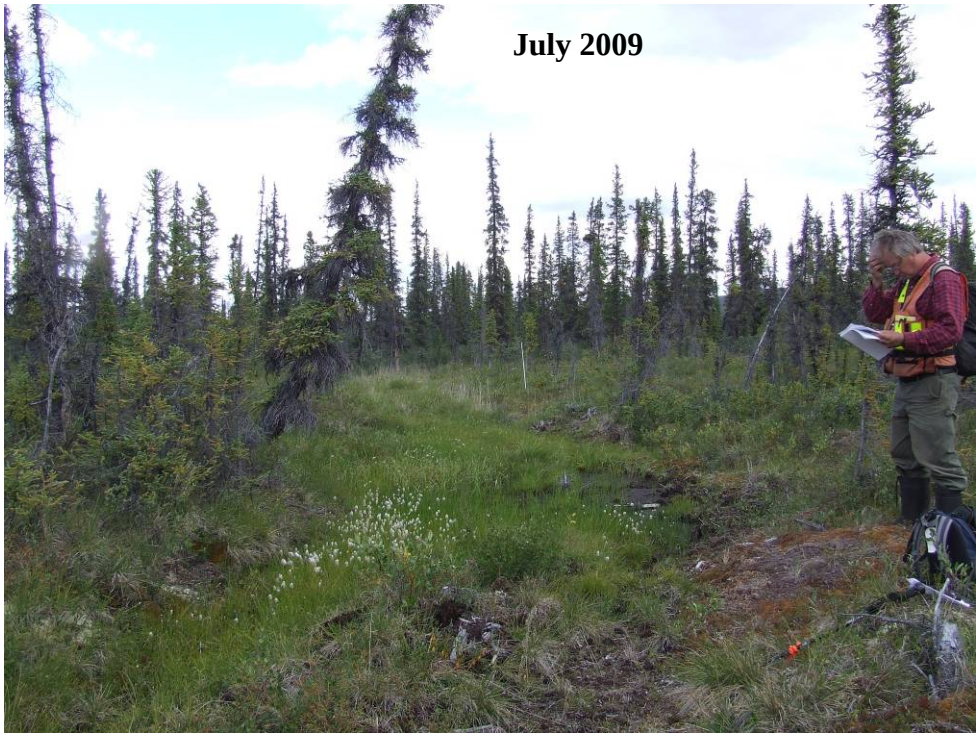

Photo #48: By July 2009 however, a significant cover of sedges was established although the site was still soft.

Photo # 49: By July 2006, less than a year from removing the material from this donor site, grasses and sedges have begun to colonize the cavity.

Photo #50: A donor site from one of the drier areas has shown slow recovery by July 2009 with just a few blades growing.

APPENDIX B

LIST OF SPECIES COLONIZING THE MITIGATED AREAS

List of Species Colonizing the Mitigated areas in 2009:

Anemone sp.
Calamagrostis canadensis
Carex lugens
Carex podocarpa
Carex scirpoidea
Coeloglossum viride
Dryas sp.
Eriophorum angustifolium
Eriophorum vaginatum
Festuca saximontana
Juncus castaneus
Pedicularis sudetica
Poa arctica
Polemonium acutiflorum
Polygonum bistorta
Saussurea angustifolia
Saxifraga aizoides
Saxifraga flagellaris
Saxifraga hieracifolia
Saxifraga hirculus
Stellaria sp.
Valeriana capitata