

Hartley Creek Restoration Project- 2007 As-built Report



Prepared for:
Ministry of Transportation
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**INTERIOR
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Leadership In Natural Resource Management



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January 14, 2008

Our File: 07MOTK07

Brent Persello
Environment Services Manager
Ministry of Transportation
231 - 447 Columbia St.
Kamloops, BC
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Attention: Mr. Brent Persello, Environment Services Manager

RE: Hartley Creek Restoration 2007 As-built Report

As requested, we are providing the following interim letter report for Ministry of Transportation (MOT) to provide an update the progress of restorative works at Hartley Creek in south eastern BC, Canada (Figure 1). In 2006, Interior Reforestation Ltd. Co. (Interior) of Cranbrook, BC was approached by the British Columbia Ministry of Transportation (MOT) to provide recommendations for improving bedload movement through the Hartley Creek Highway 3 crossing north east of Fernie, BC (Figure 1).

1) Background

A detailed field survey conducted by Interior in 2004, found the stream channel downstream of the Highway 3 crossing, to be aggraded likely as a result of an undesirable width/depth (w/d) ratio and unstable banks. The channel downstream of the culvert had become highly disturbed from a combination of gravel excavation and cattle grazing, resulting in an over-widened stream channel with little hydraulic diversity (one riffle with no sinuosity) and a non-functional riparian zone. Interior proposed the installation of multiple instream and bank-side structures to restore a functional w/d ratio. The w/d ratio is calculated as the bankfull width divided by the bankfull depth. Sinuosity is calculated as the stream length divided by the corresponding linear distance. The overall goal of the construction was to address these characteristics in order to restore the hydraulic conditions necessary to carry transported gravel further downstream and improve fish habitat in the process. Restoration activities also included the establishment of functional riparian vegetation.

The following presents a summary of historic works completed on the Hartley Creek crossing prior to the August 2007 rehabilitation works:

- Pre-2004: MOT maintenance crews regularly excavated aggraded gravel downstream of the Highway 3 crossing at a time of year when westslope cutthroat trout eggs were potentially incubating within the reach.
- Summer 2004: Interior developed a restoration prescription to address the channel aggradation issue being experienced at the MOT culvert crossing on Hartley Creek.
- September 2006: Interior crews rehabilitated approximately 250 m of stream channel with a series of vortex weirs to help establish a more sinuous thalweg. After decreasing the w/d ratio, eroding corners were armoured with root wads, tree revetments and boulders. The first 100 m section downstream of the culvert was left unchanged to allow for the gravel deposited within the culvert to move through.

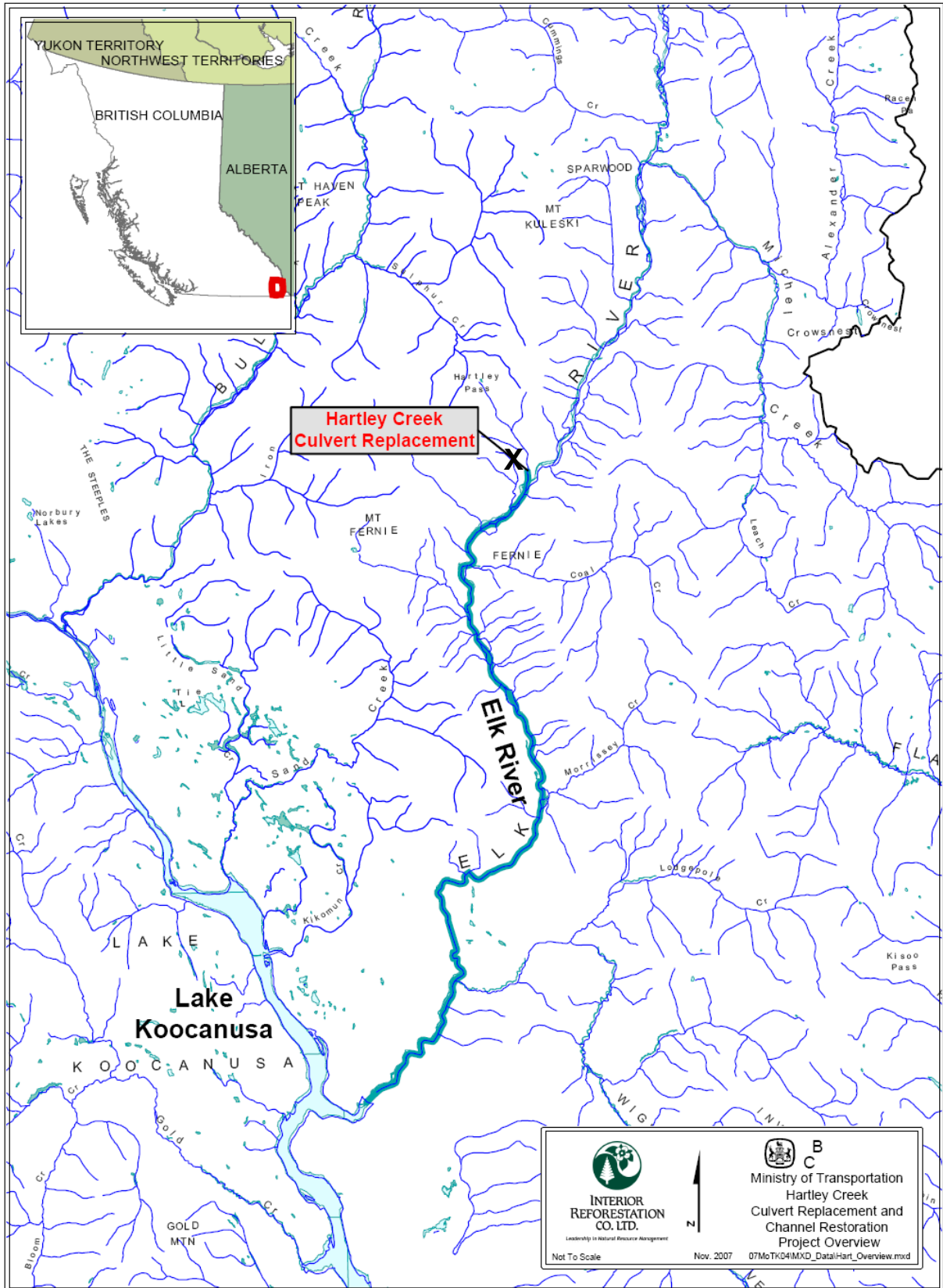


Figure 1: Location map of Hartley Creek construction site.

2) 2006 As-built Topographical Survey (completed April 2007)

In April/May 2007, Interior completed a topographical survey of the channel and riparian area. This survey provided detailed descriptions of the channel and planting areas as they existed prior to spring freshet (Figure 2). The detailed channel profile obtained by the survey will serve as a baseline for monitoring channel development, including tracking changes in channel substrate aggradation and/or degradation over time. The topographical survey also aided Interior staff in preparing 2007 construction prescriptions in the following areas: identifying areas requiring riparian planting, estimating the volume of topsoil needed to prepare the planting areas, and defining the perimeter to be fenced following planting (Figure 3).

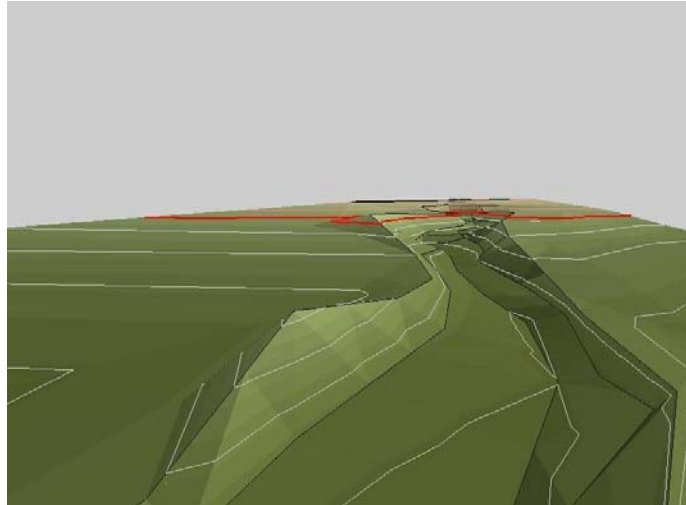


Figure 2: Contour map created from topographic survey completed on April 24, 2007. View looking upstream towards culvert from approximately 250 m downstream.

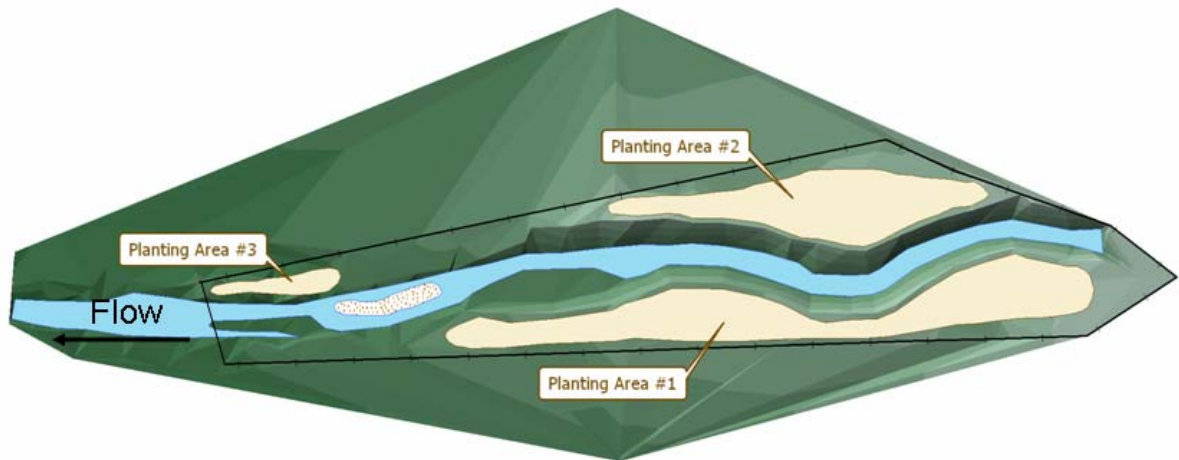


Figure 3: Estimated Planting Areas identified during April 24, 2007 survey and as-built fence line.

3) Riparian Planting and Site Preparation (May 2007)

Prior to planting, Interior subcontracted JRJ Fencing (Cranbrook, BC) to construct a four-strand barb wire fence around the entire site (Figure 3). Approximately 200 m of fence defined the site perimeter. The fence was erected to prevent cattle from continuing to disturb stream banks and to promote the establishment of planted stock. On May 15, 2007 eight 10 m³ dump truck loads of topsoil were brought on site to improve establishment of vegetation. Six loads were spread over Planting Areas #2 and #3 and two loads on Area #1 (Figure 3). Approximately 300 plants were planted primarily in Planting Areas #2 and #3. Area #1 remained mostly unplanted at the furthest downstream end, as machinery required access to the channel at this location for the instream works. All planted stock received one fertilizer disk before backfilling. Seeding with an annual rye/single-cut red clover mix preceded planting. In addition to potted plants and plugs, Interior staff inserted nine cottonwood and dogwood cuttings at two locations along the right and left stream banks. The cuttings were planted to the depth of the watertable. Two 3.99 m radius plots and one 15 m X 1 m linear plot were established to allow for monitoring of planting success.

Table 1: 2007 Hartley Creek riparian restoration plant species and quantities .

Description*	Planting Area / Quantity		
	Area #1	Area #2	Area #3
(#1) Cotton Wood – <i>Populus trichocarpa</i>	20	30	
(#1) Aspen – <i>Populus tremuloides</i>	5	20	
(#1) Alders – <i>Alnus incana</i>	5	15	
(#615) Red-Osier Dogwood – <i>Cornus stolonifera</i>	6	34	10
(#1) Black Hawthorn – <i>Crataegus douglasii</i>	5	15	
(#1) Choke Cherry – <i>Prunus virginiana</i>	5	15	
(#1) Rose – <i>Rosa woodsii</i>	5	35	
(#1) Wolf Willow – <i>Eleagnus commutate</i>	5	25	
(#1) Moch Orange – <i>Philadelphus lewisii</i>	5	15	
(#1) Snowberry – <i>Symphiocarpos</i>	5	15	
(#615) Cottonwood - <i>Populus trichocarpa</i>		17	25
Total	66	236	35

* #1 = 2 gallon pots, #615 = plugs

4) 2007 Instream Works (August 2007)

In August 2007, Interior commenced rehabilitation works on two target locations following landowner agreement and issuance of a *British Columbia Water Act* Section 9 approval. The 2007 channel reconstruction works were designed to increase sinuosity and reduce (>12) w/d ratio, in order to improve conditions from observed in 2004. With these improvements, Hartley Creek is predicted to be more efficient at transporting sediment further downstream away from the culvert outlet, as opposed to aggrading immediately downstream of the culvert outlet.

Fish salvage

A 105 m section of channel required dewatering to allow for instream work to occur in the dry. This area was first sectioned off with stop nets and then subjected to a three-pass electrofishing fish salvage (Table 2). Once electrofishing was completed, the section was slowly dewatered by diverting water to the opposite bank (right bank) from where bio-engineered structures were to be installed (left bank). Three Interior staff performed a hand-salvage as the channel dewatered. The

hand-salvage yielded a much higher number of westslope cutthroat trout (*Oncorhynchus clarkii lewisi*, WCT) than the electrofishing had (Table 3).

Table 2: 2007 results of electrofishing salvage prior to instream work.

Pass	# captured	Species/Stage*
1	15	WCT/J
	3	WCT/F
	3	BT/J
	7	MW/J
Total	28	
2	4	WCT/J
	13	WCT/F
	1	BT/J
	1	MW/J
Total	19	
3	3	WCT/J
	5	WCT/F
	0	BT/J
	2	MW/J
Total	10	

*WCT=Westslope cutthroat trout (*Oncorhynchus clarkii lewisi*), BT=Bull trout (*Salvelinus confluentus*), MN = Mountain whitefish (*Prosopium williamsoni*), J=juvenile and F=Fry.

Table 3: 2007 results of hand-salvaging.

Count	Species/Stage
3	WCT/J
86	WCT/F
7	MW/J

Fish salvage efforts were also completed prior to undertaking the 2006 instream works, within the same area. Salvage collection data suggests a considerable increase in fish abundance between 2006 and 2007 (Figure 4 and Table 4). In 2006, 98 m were salvaged before dewatering and comparably, 105 m in 2007. Between years, salvages were also similar in electrofishing seconds (1586 in 2006 and 1530 in 2007). A comparison between years shows an increase in abundance for both WCT fry and juveniles of approximately 50%, regardless of if abundance was calculated as density (fish/m) or catch per unit effort (fish/second) (Table 4).

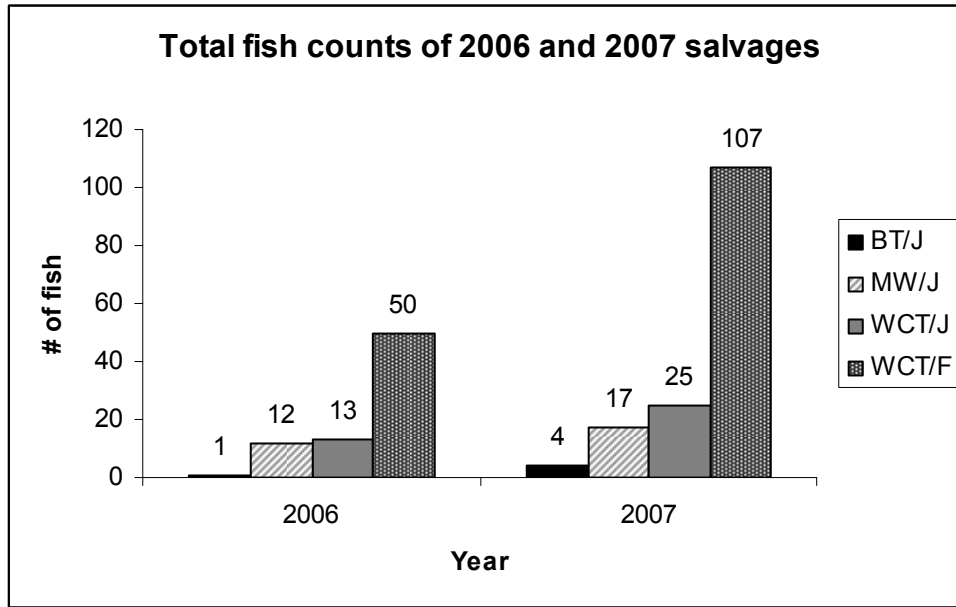


Figure 4: Total fish counts of 2006 and 2007 salvages.

Table 4: Change in fish abundance between 2006 and 2007 by density and effort.

Species/Stage	Fish/m		%Δ* abundance	Fish/second		%Δ abundance
	2006	2007		2006	2007	
WCT/J	0.13	0.24	56%	0.008	0.016	50%
WCT/F	0.51	1.02	50%	0.032	0.070	45%
BT/J	0.01	0.04	27%	0.001	0.003	24%
MW/J	0.12	0.16	76%	0.008	0.011	68%

*Δ=change. WCT=Westslope cutthroat trout (*Oncorhynchus clarkii lewisii*), BT=Bull trout (*Salvelinus confluentus*), MN = Mountain whitefish (*Prosopium williamsoni*), J=juvenile and F=Fry

Instream Works

The first 100 m section downstream of the culvert, which was left unimproved in 2006, was one of the two areas targeted for the 2007 restoration (Figure 5). In this area, a vortex weir was installed approximately 40 m downstream of the culvert outlet (Figure 6). The weir was installed with an alignment designed to direct the thalweg from the center of the channel into the armoured right bank (river right). This is predicted to effectively move the majority of flows towards the eroding bank (outside corner). However, at high flows the vortex weir will likely be unable to redirect all of the discharge resulting in some of the hydraulic energy being directed at the deposition bank (i.e. point bar, inside corner). During freshet of 2007, flows similar to this were observed sheering off unprotected point bars as the bank material of Hartley Creek is highly erodable. This erosion resulted in the loss of the beneficial meander. To help prevent point bar erosion, a series of six rootwads were installed on the deposition bank to prevent major erosion and maintain the stream meander until riparian vegetation is established (Figure 7).

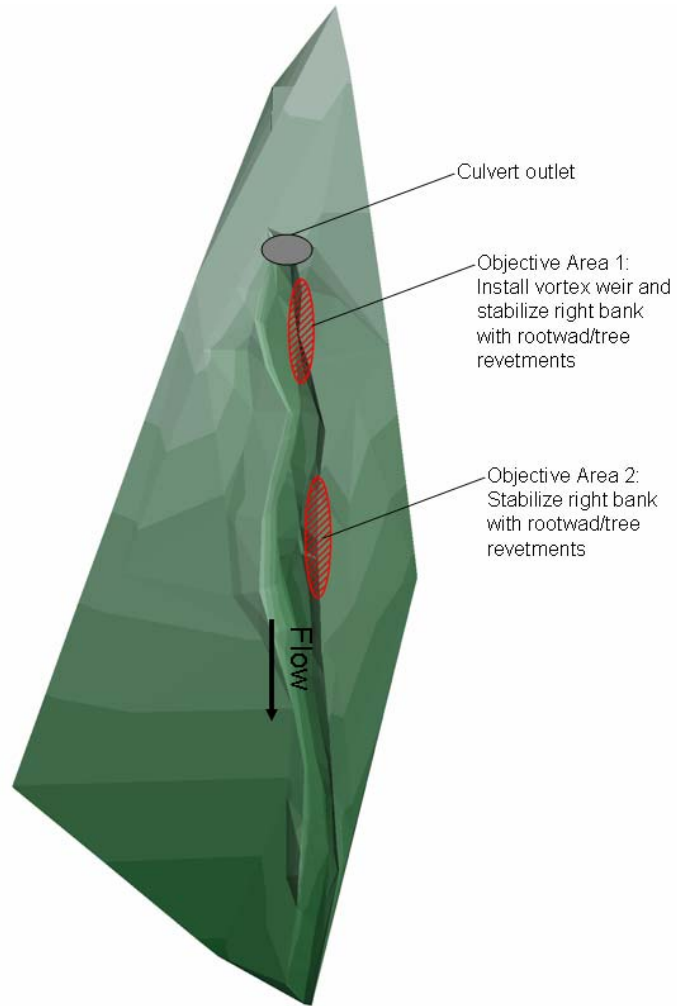


Figure 5: Two objective areas for the 2007 instream works.



Figure 6: Vortex weir installed approximately 40 m downstream of culvert outlet.



Figure 7: Series of six rootwads installed on deposition bank immediately downstream of the Highway 3 crossing.

The second objective area for 2007 restoration efforts (Figure 5) was a depositional corner that experienced considerable erosion during the 2007 freshet. The objective in this area was primarily maintenance, as structures had been placed both upstream and downstream in 2006. Visual inspections deemed it necessary to armour the corner with rootwads and tree revetments as described above to re-establish a functional meander and w/d ratio (Figure 8). Prior to backfilling the rootwads, two alder bushes and one hawthorn, with roots attached, were placed to the depth of the water table. These plantings were conducted in order to help accelerate the re-establishment of functional riparian vegetation, as alder possess symbiotic mycorrhiza capable of fixing nitrogen and ultimately increasing soil nutrients.



Figure 8: Downstream view of second area targeted in 2007 works. Note transplanted alder and hawthorn shrubs.

5) Riparian Planting Effectiveness Monitoring (August 2007)

On August 7, 2007, Interior staff visited the site to evaluate the success of the spring plantings. Vegetative monitoring plots were repeated in Planting Area's #2 and #3. All plants in these plots were found to be dead in appearance and yielded no change in height. Live cuttings placed along the stream edge were the only planted stock that showed any green leaves. The apparent dead/desiccated state of planted stock is likely a result of the abnormally dry month of July, where only 20 mm of rainfall was recorded. This is well below the average of 73.9 mm of rainfall derived from values recorded between 1971-2000 (<http://www.climate.weatheroffice.ec.gc.ca>). Although plants appeared to have died from lack of moisture, it is unclear if many were not simply dormant. A survey in early summer 2008 will help quantify plant loss due to drought stress. The rye/clover seed mix appeared to have had adequate growth before turning dormant. This is predicted to greatly limit surface erosion during fall rains and snowmelt in 2008, as well as to provide organic material to the soil.

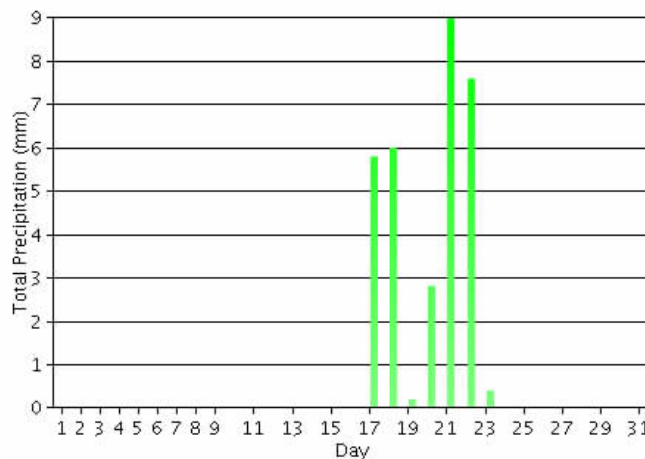


Figure 9: Bar graph depicting July 2007 rainfall (www.climate.weatheroffice.ec.gc.ca). Note y-axis scale.

6) As-built Topographical Survey (October 2007)

On November 16, 2007, Interior staff completed an as-built topographical survey of the Hartley Creek site. The survey focused specifically on the 2007 instream works. This data provided a means of identifying changes in the w/d ratio, channel sinuosity and channel slope, from the 2004 pre-construction conditions through the 2006 and 2007 restoration works (Figure 10). A comparison between the years showed a measurable decrease in the w/d ratio with time. Cross-sectional data collected in 2004 and 2007 was used to calculate the w/d ratio at twelve locations within the site (Figure 11). The w/d ratio of the reconstructed channel is presently more comparable to that of the undisturbed section upstream of the Highway 3 crossing (upstream w/d = 4.82). Although the photos and topographical surface appear to show an improved sinuosity (meander morphology), the current position of the thalweg does not yet fully conform to the restored banks, therefore yielding only a minor increase in sinuosity (Figure 10). Sinuosity is expected to improve (i.e. increase) with each spring freshet as the channel morphology develops in response to the new bank structures. The thalweg is expected to more accurately reflect the bank meander pattern as high flows create areas of erosion and deposition.



	2004 Pre-construction	2007 As-built
Width: Depth	11.78	8.4
Sinuosity	1	1.04
Thalweg slope (%)	1.16	0.75

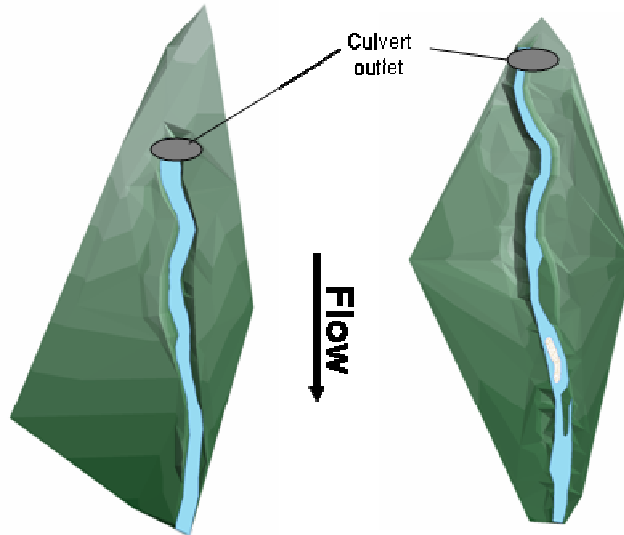


Figure 10: a.) Photo of 2004 Preconstruction state b.) Photo and topographical survey of 2006 as-built state showing incomplete sinuosity along the left bank and c.) Photo and topographical survey of 2007 as-built state showing restored sinuosity. Table included to provide width:depth ratios and sinuosity.

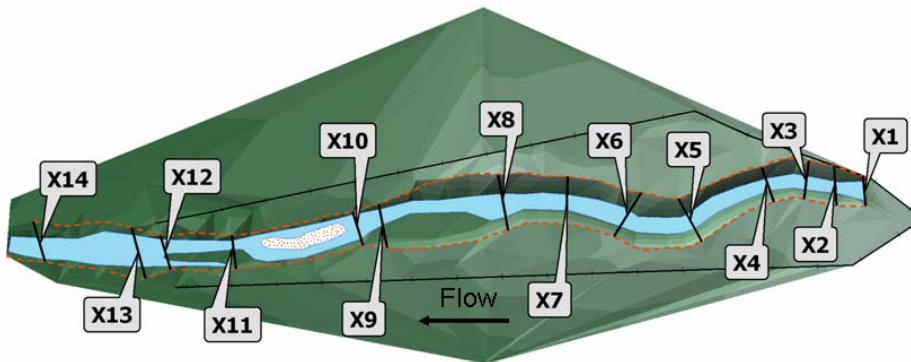


Figure 11: Location map of cross-sections completed during the 2007 as-built survey.

7) 2008 Monitoring and Recommended Works

The 2008 Effectiveness Monitoring Program should include the following:

- 1.) Vegetation plots to identify plant survival;
- 2.) Topographical survey to identify changes in channel morphology;
- 3.) Aerial surveys (CropCam photos) to provide long-term monitoring over the entire site through photo-monitoring and to provide detailed floodplain mapping; and,
- 4.) Fish population estimates to study the affect of habitat enhancement structures on the fish community.

Each of these components will provide a means for long-term monitoring of the Hartley Creek site. By acquiring data capable of conducting statistical analysis, Interior will be able to quantify and present accurate, measurable effects of how these restorative works have influenced the biologic community of Hartley Creek.

In addition to the monitoring program some mandatory follow-up work for 2008 is required:

- 1.) The addition of topsoil (approximately 80 m³) to provide a suitable planting medium;
- 2.) Planting and seeding on areas disturbed by this year's work to establish a functional riparian zone. To be completed with similar target densities and species of that planted in May 2007;
- 3.) Live staking on two gravel bars along the stream channel; and,
- 4.) Potential maintenance work (e.g. fill planting, fence repairs, etc.).

It is strongly suggested that future works address the improvement/modification of the landowner's ford crossing downstream of the rehabilitated site. The ford presents topographic relief on either bank that could potentially lead to major flooding (observed a minor event in 2007) of the landowner's field. Interior will pursue potential partnerships with organizations interested in funding aquatic habitat restoration projects. Past consultation with the landowner suggests their support for improvements to this crossing.

8) Summary

Rehabilitation efforts of 2007 were completed in an environmentally sensitive and efficient manor. The survival success of planted stock is uncertain at this point, but will be confirmed with assessments in the spring and summer of 2008. Preliminary results suggest that habitat restoration efforts of 2006 were effective in increasing the spawning/rearing capacity of Hartley Creek. The change in fish density is potentially reflective of an increase in suitable fish habitat provided by the 2006 restoration works and the prevention of aggraded substrate excavation. It should be noted that this inter-annual change in abundance is not outside of natural fluctuations. By implementing the suggested 2008 monitoring program, Interior will be able to effectively quantify the success of these restorative works at Hartley Creek. The suggested monitoring program will provide scientifically relevant results to MOT and other interested parties that will provide an increased understanding of the effectiveness of the techniques used.

If you have any questions, please do not hesitate to contact me.

Sincerely,



Mike Robinson, M.Sc., B.I.T.
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