

Interior Watershed Assessment Update

Horsefly above Falls Watershed

1.0 WATERSHED DESCRIPTIVE INFORMATION

Table 1.1 Summary information – Biophysical

Size (km ²)	BEC Zones	Elevation Range (m)	H ₆₀ Elevation (m)	Stream Density km/km ²	Distribution of slope gradients within the watershed (% of watershed)			
					<10% slope	10 to 30% slope	30 to 60% slope	>60% slope
777.28	ESSFwk1/ w3 ICHwk2 ATp	860 – 2540	1452	1.85	22.11	43.83	30.99	3.07

Table 1.2. Characteristics of main stream reaches – (assessment is based on a combination of air-photo interpretations, TRIM maps, helicopter over-flight and various reports).

Reach ID	Minimum Elevation (m)	Maximum Elevation (m)	Reach Length (m)	Reach Gradient (%)	Stream Disturbance Assessment ¹
Main-R1	899	900	2623	0.04	Minor localized instability
Main-R2	900	900.5	4328	0.01	Minor localized instability
Main-R3	900.5	901	2815	0.02	Minor localized instability
Main-R4	901	908.977	5934	0.13	Minor localized instability
Main-R5	908.977	913.828	2978	0.16	Minor localized instability
Main-R6	913.828	918	5536	0.08	Minor localized instability
Main-R7	918	941.047	1615	1.4	
Main-R8	941.047	982.813	4327	0.97	
Main-R9	982.813	999.78	1951	0.87	
Main-R10	999.78	1020	3589	0.56	
Main-R11	1020	1040.64	5295	0.39	
Main-R12	1040.64	1059.98	1736	1.11	
Main-R13	1059.98	1139.63	2803	2.84%	
Main-R14	1139.63	1179.49	2288	1.74	
Main-R15	1179.49	1180	4088	0.01	
Main-R16	1180	1206.57	5584	0.48	
Main-R17	1206.57	1259.97	2899	1.84	
Main-R18	1259.97	1285.26	3364	0.75	
Main-R19	1285.26	1439.08	3642	4.22	
Main-R20	1439.08	2004.56	4588	12.33	

Reach ID	Minimum Elevation (m)	Maximum Elevation (m)	Reach Length (m)	Reach Gradient (%)	Stream Disturbance Assessment ¹
Trib1-R1	918	920	2242	0.13	Stable, irregular channel
Trib1-R2	920	922.818	1866	0.15	Stable, irregular channel
Trib1-R3	922.818	923	7064	0.00	Stable, irregular channel
Trib1-R4	923	939.995	4291	0.40	Stable, irregular channel
Trib1-R5	939.995	940.4	2401	0.02	Stable, irregular channel
Trib1-R6	940.4	940.006	10800	0.00	Lake
Trib1-R7	940.006	980.726	2882	1.41	
Trib1-R8	980.726	998.306	1386	1.27	
Trib1-R9	998.306	1023.24	3045	0.82	
Trib1-R10	1023.24	1099.61	3163	2.41	
Trib1-R11	1099.61	1121.46	1086	2.01	
Trib1-R12	1121.46	1282.97	2643	6.11	
Trib1-R13	1282.97	1365.22	2270	3.62	
Trib1-R14	1365.22	1727.51	3603	10.06	
Trib2-R1	1020	1099.3	2065	3.84	
Trib2-R2	1099.3	1140.3	2967	1.38	
Trib2-R3	1140.3	1199.4	3121	1.89	
Trib2-R4	1199.4	1238.62	3888	1.01	Stable – boulder & bedrock controlled
Trib2-R5	1238.62	1240.21	1860	0.09	Stable – boulder & bedrock controlled
Trib2-R6	1240.21	1280.03	5109	0.78	Stable – boulder & bedrock controlled
Trib2-R7	1280.03	1320.17	1753	2.29	Stable – boulder & bedrock controlled
Trib2-R8	1320.17	2190.28	5815	14.9	Stable – boulder & bedrock controlled

RPg = Riffle-Pool gravel morphology

Trib 1 = McKuskey Creek

Trib 2 = MacKay Creek

2.0 WATERSHED HARVESTING, ROADS AND LAND-USE HISTORY

Table 2.1. Horsefly above Falls Watershed – (entire watershed)

Private	Total harvest 2002 (%)	Current ECA (%)	Planned Harvest (%)	Current ECA below H60 (%)	Current ECA Above H60 (%)	Peak Flow Index		Road Density Active (km/km ²)		Stream Crossing density active (#/km ²)		Road Density De-active (km/km ²)	
						Current (2002) (%)	End of FDP (2007)(%)	Current (2002)	End of FDP (2007)	Current (2002)	End of FDP (2007)	Current (2002)	End of FDP (2007)
0	21.41	22.79	3.00	17.8	5.0	25.3	28.7	0.77	0.82	0.59	0.65	0.25	0.27

Table 2.2. Club Sub-basin (sub-basin only)

Private	Total harvest 2002 (%)	Current ECA (%)	Planned Harvest (%)	Current ECA below H60 (%)	Current ECA Above H60 (%)	Peak Flow Index		Road Density Active (km/km ²)		Stream Crossing density active (#/km ²)		Road Density De-active (km/km ²)	
						Current (2002)(%)	End of FDP (2007)(%)	Current (2002)	End of FDP (2007)	Current (2002)	End of FDP (2007)	Current (2002)	End of FDP (2007)
0	70.48	43.70	11.64	7.5	36.2	61.8	78.2	2.22	2.71	1.80	2.43	0.07	0.07

Table 2.3. Doreen Sub-basin (sub-basin only)

Private	Total harvest 2002 (%)	Current ECA (%)	Planned Harvest (%)	Current ECA below H60 (%)	Current ECA Above H60 (%)	Peak Flow Index		Road Density Active (km/km ²)		Stream Crossing density active (#/km ²)		Road Density De-active (km/km ²)	
						Current (2002)(%)	End of FDP (2007)(%)	Current (2002)	End of FDP (2007)	Current (2002)	End of FDP (2007)	Current (2002)	End of FDP (2007)
0	40.43	35.33	8.64	14.7	20.7	45.7	56.1	1.49	1.52	0.60	0.60	0.28	0.28

3.0 SUMMARY OF EXTENT OF RIPARIAN REMOVAL (agriculture and forestry)

Table 3.1. Horsefly above Falls Watershed

Watershed name	Length (km) of riparian removal on small tributaries (<5m in width)	Length (km) of riparian removal on large tributaries (>5m)	% Riparian removal of all tributaries	Length (km) of riparian removal on mainstem	% Riparian removal of mainstem	Total length of all tributaries (from Trim) (km)	Total length of mainstem (km)
Horsefly above falls	193.41	2.91	13.68	1.01	1.68	1435.20	59.70

Table 3.2.Club sub-basin

Watershed name	Length (km) of riparian removal on small tributaries (<5m in width)	Length (km) of riparian removal on large tributaries (>5m)	% Riparian removal of all tributaries	Length (km) of riparian removal on mainstem	% Riparian removal of mainstem	Total length of all tributaries (from Trim) (km)	Total length of mainstem (km)
Club	7.20	0.00	54.12	2.58	52.79	13.31	4.89

Table 3.3.Doreen sub-basin

Watershed name	Length (km) of riparian removal on small tributaries (<5m in width)	Length (km) of riparian removal on large tributaries (>5m)	% Riparian removal of all tributaries	Length (km) of riparian removal on mainstem	% Riparian removal of mainstem	Total length of all tributaries (from Trim) (km)	Total length of mainstem (km)
Doreen	5.08	0.00	18.17	1.29	41.35	27.98	3.12

4.0 SUMMARY OF LARGE SEDIMENT SOURCES

Table 4.1. Horsefly above Falls Watershed

Watershed Name	Large natural sediment sources		Large natural sediment sources directly connected to a stream		Large land-use related sediment sources		Large land-use related sediment sources directly connected to a stream		Large sediment sources	
	number	density (#/km ²)	number	density (#/km ²)	number	density (#/km ²)	number	density (#/km ²)	number	density (#/km ²)
Horsefly above falls	66	0.085	17	0.022	22	0.028	11	0.014	90	0.116

Table 4.2. Club Sub-basin

Watershed Name	Large natural sediment sources		Large natural sediment sources directly connected to a stream		Large land-use related sediment sources		Large land-use related sediment sources directly connected to a stream		Large sediment sources	
	number	density (#/km ²)	number	density (#/km ²)	number	density (#/km ²)	number	density (#/km ²)	number	density (#/km ²)
Club	0	0.000	0	0.000	1	0.105	0	0.000	1	0.105

Table 4.3. Doreen Sub-basin

Watershed Name	Large natural sediment sources		Large natural sediment sources directly connected to a stream		Large land-use related sediment sources		Large land-use related sediment sources directly connected to a stream		Large sediment sources	
	number	density (#/km ²)	number	density (#/km ²)	number	density (#/km ²)	number	density (#/km ²)	number	density (#/km ²)
Doreen	0	0.000	0	0.000	2	0.109	0	0.000	2	0.109

5.0 SUMMARY OF LAND-USE ACTIVITIES ON UNSTABLE TERRAIN

Table 5.1. Horsefly above Falls Watershed

Watershed	Length of road on unstable terrain (km)		Area of cut blocks on unstable terrain (km ²)		Road density on unstable terrain (km/km ²)	Source of information for stability assessment
	Active	Proposed	Harvested	Proposed		
Horsefly above Falls	0.13	1.11	3.165	0.644	0.0016	a mix of IV and V, U and slopes >60%

Table 5.2 Club Sub-basin

Watershed	Length of road on unstable terrain (km)		Area of cut blocks on unstable terrain (km ²)		Road density on unstable terrain (km/km ²)	Source of information for stability assessment
	Active	Proposed	Harvested	Proposed		
Club	0	0	0	0	0.0000	slope>60%

Table 5.3 Doreen Sub-basin

Watershed	Length of road on unstable terrain (km)		Area of cut blocks on unstable terrain (km ²)		Road density on unstable terrain (km/km ²)	Source of information for stability assessment
	Active	Proposed	Harvested	Proposed		
Doreen	0	0	0	0	0.0000	slope>60%

6.0 SUMMARY OF ROAD RELATED SOURCES OF SURFACE EROSION

Table 6.1 Horsefly above Falls Watershed - summary of stream crossing sediment source survey –			
Number of crossings surveyed	Estimated total # of crossings (TRIM maps)	Percentage surveyed	Watershed Size (km ²)
182	500	36.4	777.3

Table 6.2 Summary of Water Quality Concern Ratings (WQCR) – Horsefly above Falls Watershed							
No Concern		Low		Medium		High	
Number	Percentage	Number	Percentage	Number	Percentage	Number	Percentage
33	18.1	55	30.2	42	23.1	52	28.6

Stream Width Class	Table 6.3 Summary of Water Quality Concern Ratings by Stream Size - Horsefly above Falls Watershed								# of streams surveyed per class
	None		Low		Medium		High		
	Number	Percentage	Number	Percentage	Number	Percentage	Number	Percentage	
1	2	66.67%	0	0.00%	0	0.00%	1	33.33%	3
2	4	23.53%	8	47.06%	2	11.76%	3	17.65%	17
3	9	25.00%	11	30.56%	9	25.00%	7	19.44%	36
4	16	16.84%	24	25.26%	27	28.42%	28	29.47%	95
5	2	6.45%	12	38.71%	4	12.90%	13	41.94%	31

Table 6.4 ESC Summary - Horsefly	
WQCR	“Equivalent” number of stream crossings
No Concern	0.0
Low	45.3
Moderate	80.8
High	142.9
Total	269

Table 6.5 Surface erosion hazard – Horsefly above Falls Watershed	
Equivalent stream crossing density (xings/km ²)	Surface Erosion Hazard
0.35	High

7.0 SUMMARY OF MAINSTEM CHANNEL CONDITIONS

Table 7.1. Extent of channel disturbance along mainstem below MacKay

Reach ID	Reach Length (m)	Reach Gradient (%)	Length disturbed (m)	% of channel disturbed	Level of channel disturbance	Probable cause of disturbance
Main-R1	2623	0.13	0	0	None	N/a
Main-R2	4328	0.15	0	0	None	N/a
Main-R3	2815	0.00	1194	42	Moderate	Riparian harvest
Main-R4	5934	0.40	752	13	Moderate	Unknown
Main-R5	2978	0.02	1037	35	Moderate	Riparian harvest
Main-R6	5536	0.00	1450	26	Moderate	Riparian harvest
Main-R7	1615	1.41	0	0	None	N/a
Main-R8	4327	1.27	0	0	None	N/a
Main-R9	1951	0.82	0	0	None	N/a
Main-R10	3589	2.41	0	0	None	N/a

8.0 SUMMARY OF FISHERIES RESOURCES IN THE WATERSHED

Table 8.1. Documented fish species presence

Category	Common Name	Latin Name	Species Code	Reference
Freshwater game species	Rainbow Trout	<i>Oncorhynchus mykiss</i>	RB	Fish Wizard ¹
	Unidentified Species	N/A	N/A	Fish Wizard ¹

¹Fish Wizard available at <http://pisces.env.gov.bc.ca>

9.0 SUMMARY OF HAZARDS FOR THE HORSEFLY ABOVE FALLS WATERSHED

Table 9.1. Watershed assessment hazards

Watershed	Sub-basin	Hazard Ratings ²						Generalized Channel Disturbance ¹
		Increases in peak-flows (Current/Proposed)	Reduction in riparian functions	Large logging related sediment sources	Road related sediment sources (field work)	Accelerated surface erosion from GIS (Current/proposed)	Accelerated mass wasting	
Horsefly above Falls		L/L	M	M	H	H/VH	L	4
	Club ³	VH/VH	VH	VL	N/a	VH/VH	VL	3
	Doreen	H/VH	VH	VL	N/a	H/H	VL	1

¹ Note: Generalized channel disturbance codes: 1 = no disturbance identified, 2 = localized channel disturbance, 3 = minor localized land-use related disturbance, 4 = moderate land-use related channel disturbance, 5 = extensive land-use related channel disturbance.

² Note: Hazard ratings: VL=very low, L=low, M=moderate, H=high, VH=very high

³ Note: Surface erosion hazard could not be calculated in the field for Club and Doreen watersheds because of very limited access.

10.0 INTERPRETATIONS

10.1 Peakflow Hazards

The peak flow hazard is currently **Low** for the Horsefly above Falls watershed (PFI = 25.3%) and will remain low throughout the current forest development plan (PFI in 2007 = 28.7%). Forest disturbance (i.e. logging and fire) is concentrated in the lower sections of the watershed where there is a fair amount of fire disturbance (mid-1960's). It is my opinion that this level of disturbance will not affect peak flows for such a large river system.

The peakflow hazard for the Club sub-basin is currently **Very High** (PFI= 62%) and for the Doreen sub-basin it is **High** and will increase to **Very High** by the end of the FDP. Both of these sub-basins are relatively small and such high PFI's will likely cause an increase in spring peak flows. There was no indication of channel instability in the Doreen watershed when we completed the overview flight. There was too much vegetation over Club Creek to make an assessment of channel stability during the overview flight.

10.2 Hazards Associated with a loss in Riparian Functions

There has been a substantial amount of historical riparian harvesting in the lower sections of this watershed, much of it associated with the forest fire salvage operations (probably late 1960's early 1970's). A minor amount of riparian harvesting has occurred along the mainstem of the Horsefly River, while most of the riparian harvesting occurred along tributary streams. This has resulted in a hazard assessment of **Moderate** for this IWAP indicator. I believe that the riparian area is fully functional along the mainstem of the Horsefly, but this is not the case for several tributary streams. This could have a negative impact on fish habitat.

Extensive riparian harvesting occurred along the mainstem and tributary streams of both the Club and Doreen sub-basin, although it was more extensive in the Club sub-basin. Riparian hazards for both of these sub-basins are **Very High**. Most of the forest harvesting in these two basins occurred several decades ago and dense vegetation has established along the stream network. Although these riparian areas are still not fully functional, they are well on their way to significant recovery.

10.3 Hazards Associated with Large Sediment Sources

In addition to the large sediment sources identified in the MacKay, McKuskey and Upper Horsefly watersheds, we identified 10 in the lower section of this watershed. Only one of these is directly connected to a stream. For the entire Horsefly above Falls watershed (777km²) we identified only 11 large logging related sediment sources that were directly connected to a stream. This has resulted in a hazard assessment of **Moderate** for this IWAP hazard. For the two sub-basins this hazard is **Very Low**.

10.4 Hazards Associated with Road Related Surface Erosion

For the entire Horsefly above Falls watershed we surveyed 182 stream crossings, which is 36% of crossings identified on TRIM maps (Table 6.1). Many crossings were not accessible because of dense vegetation re-growth on the roads (Photograph #212-9). In many cases we could not even find any indication that there had once been a road. Typically these stream crossings are no longer sediment producers. We could not access any significant amount of roads in either the Club or the Doreen sub-basins because of vegetation re-growth. Consequently, we have not reported the statistics for these sub-basins because the sample size is too small.

Of the crossings that we surveyed, 52% had a Water Quality Concern Rating (WQCR) of medium or High (Table 6.2). Although most of these crossings were located on small streams (0.5 to 1.5 m in width), many were located on larger streams (Table 6.3). The equivalent stream crossing density for the Horsefly above Falls watershed is 0.35 crossings/km² and this has resulted in a **High** hazard for surface erosion (Table 6.5). This level of hazard is significant enough to potentially have a localized negative effect on water quality and fish habitat.

10.5 Hazards Associated with Accelerated Mass Wasting (from logging on steep slopes).

There has been a small amount of forestry activity on unstable or potentially unstable slopes in the Horsefly above Falls watershed. Based on the calculations presented in Table 5.1, the hazard level for this indicator is **Low**. For the two sub-basins, the hazard is **Very Low** (Tables 5.2 and 5.3). Although the hazard is Low for the entire Horsefly above Falls watershed, there have been a few slope failures. Consequently, it is important to maintain vigilance when planning activities on steeper slopes (i.e. site level slope stability assessments).

10.6 Watershed Cumulative Effects and Channel Stability

The main cumulative effect concern in this watershed is the surface erosion hazard associated with stream crossings. There are a high number of crossings with a moderate or high water quality concern rating. The level of erosion and sediment delivery at each individual crossing may not appear to be very significant, but the problems can add up over time and space (i.e. at each storm throughout the watershed) and have the potential to cause detrimental water quality impacts. This issue can be dealt with by implementing effective erosion and sediment control.

11.0 RECOMMENDATIONS

11.1) Recommendations for the Forest Development Plan (landscape level)

Although there is a high concentration of forest harvesting activity in the lower portion of this watershed, the extent of harvesting over the entire watershed is not very high. Consequently, I do not believe that there is a peak flow concern associated with the extent of harvest in this watershed, at least not when considered over the entire 777km² of the watershed. The location of individual cut-blocks must carefully consider slope stability issues and riparian management, but taken collectively they are not a significant issue. There are several site specific concerns in this watershed and these are addressed in the following section.

11.2) Recommendations for Site Specific Activities (site level)

Since the Upper Horsefly, McKuskey and MacKay watersheds make up most of the area of this watershed, the site specific recommendations provided for them also apply to this watershed. There are four specific issues that must be addressed in the management of this watershed.

1. Erosion and sediment control in the vicinity of stream crossings can be improved. Remedial measures should be undertaken at some of the high concern areas on existing crossings (identified on the maps and the database). Erosion control procedures, especially at small streams, could be improved and standard operating procedures should be developed (or improved) and implemented. The forest licensees operating in this watershed should maintain effective Erosion and Sediment Control plans for this watershed. This would include: a) Development of a plan with precise objectives and standards and clear operating procedures, b) clearly define the types of erosion and sediment control practices that need to be implemented, c) regular maintenance of any ESC structure that has been installed, d) regular field monitoring to evaluate the effectiveness of the plan.
2. If possible, watershed restoration activities should continue in the highly impacted sub-basins of this watershed (e.g. Hawkley, Pegasus, Skyes-Fire and Cosmoskey). Although a lot of work has already been completed in these tributary drainages, maintenance and monitoring are required if these works are to meet their initial objectives.
3. Although slope stability is not an overwhelming concern in this watershed (except maybe in the Upper Horsefly and the Upper Mackay), continued vigilance for indicators of slope instability is important. Appropriate drainage control is a key tool for the management of landslide prone terrain and should be applied aggressively. The continued use of qualified slope stability experts for site assessments is an important management tool.

APPENDIX 1 – Database of disturbed riparian areas

(This database only includes the lower part of the Horsefly above Falls watershed. The information for the other parts of the watershed (e.g. MacKay, McKusky and Upper Horsefly) can be found in their respective reports)

ID	Channel Width	Stream Type	One or 2 sided	Length of RL (km)	Landuse
HorAFRL-001	4	3	2	1.5181	1
HorAFRL-007	4	2	2	0.8932	1
HorAFRL-008	4	2	2	0.7936	1
HorAFRL-009	4	2	2	0.5004	1
HorAFRL-010	4	2	2	0.3636	1
HorAFRL-011	3	2	2	0.4845	1
HorAFRL-012	3	2	2	1.4553	1
HorAFRL-013	3	2	2	1.4136	1
HorAFRL-014	3	2	2	1.3431	1
HorAFRL-003	3	1	2	2.4068	1
HorAFRL-015	4	3	2	0.6971	1
HorAFRL-016	4	3	2	0.1329	1
HorAFRL-017	4	3	2	0.3801	1
HorAFRL-018	4	3	2	0.8541	1
HorAFRL-019	4	3	2	0.2503	1
HorAFRL-020	4	2	2	0.9308	1
HorAFRL-004	3	2	2	0.7638	1
HorAFRL-005	3	2	2	0.8203	1
HorAFRL-021	4	3	2	1.4869	1
HorAFRL-022	3	3	2	1.6472	1
HorAFRL-023	4	3	2	0.3019	1
HorAFRL-024	4	3	2	0.2365	1
HorAFRL-025	3	3	2	0.8083	1
HorAFRL-026	4	3	2	0.4705	1
HorAFRL-027	4	3	2	0.3799	1
HorAFRL-028	4	3	2	0.2575	1
HorAFRL-029	4	3	2	0.5274	1
HorAFRL-030	4	3	2	0.2958	1
HorAFRL-031	4	3	2	0.2531	1
HorAFRL-032	4	3	2	0.1497	1
HorAFRL-033	4	3	2	0.2028	1
HorAFRL-034	3	2	2	0.4901	1
HorAFRL-035	4	3	2	0.1153	1

ID	Channel Width	Stream Type	One or 2 sided	Length of RL (km)	Landuse
HorAFRL-036	3	3	2	0.6584	1
HorAFRL-037	4	3	2	0.607	1
HorAFRL-038	4	3	2	0.5566	1
HorAFRL-039	4	3	2	1.3734	1
HorAFRL-040	3	2	2	0.3412	1
HorAFRL-006	3	2	2	1.133	1
HorAFRL-041	4	2	2	0.6305	1
HorAFRL-042	4	2	2	0.6968	1
HorAFRL-043	4	3	2	1.5827	1
HorAFRL-044	4	2	2	0.8653	1
HorAFRL-045	4	2	2	0.9425	1
HorAFRL-046	4	3	2	0.3581	1
HorAFRL-001	3	2	2	4.1324	1
HorAFRL-047	4	3	2	0.3348	1
HorAFRL-002	4	3	2	2.5123	1
HorAFRL-048	4	3	2	1.9639	1
HorAFRL-049	4	3	2	1.6628	1
HorAFRL-050	4	3	2	1.1876	1
HorAFRL-051	4	3	2	0.9814	1
HorAFRL-052	4	3	2	0.7691	1
HorAFRL-053	4	3	2	2.476	1
HorAFRL-054	4	3	2	0.4584	1
HorAFRL-055	3	2	2	0.1568	1
HorAFRL-056	4	3	2	0.5069	1
HorAFRL-064	4	3	2	0.4829	1
HorAFRL-060	4	3	2	0.2944	1
HorAFRL-061	4	3	2	0.4912	1
HorAFRL-062	4	3	2	0.2895	1
HorAFRL-063	4	3	2	0.7919	1
HorAFRL-059	4	3	2	0.8085	1
HorAFRL-057	4	3	2	0.6403	1
HorAFRL-058	4	3	2	0.3702	1
HorAFRL-059	4	3	2	1.3473	1
HorAFRL-060	3	3	2	0.4376	1
HorAFRL-061	4	3	2	0.4956	1
HorAFRL-062	4	3	2	1.2463	1
HorAFRL-063	4	3	2	1.9047	1
HorAFRL-064	4	3	2	0.9861	1

ID	Channel Width	Stream Type	One or 2 sided	Length of RL (km)	Landuse
HorAFRL-065	4	3	2	1.1003	1
HorAFRL-066	4	3	2	0.4413	1
HorAFRL-067	4	3	2	0.4381	1
HorAFRL-068	3	3	2	0.8072	1
HorAFRL-069	3	3	2	0.7448	1
HorAFRL-070	4	3	2	0.618	1
HorAFRL-071	4	3	2	0.4009	1
HorAFRL-072	4	2	2	0.4126	1
HorAFRL-073	3	3	2	0.5925	1
HorAFRL-074	4	2	2	1.1284	1
HorAFRL-075	4	3	2	1.077	1
HorAFRL-076	4	3	2	0.3016	1
HorAFRL-077	4	2	2	0.5445	1
HorAFRL-078	4	2	2	1.4499	1
HorAFRL-079	3	2	2	0.9462	1
HorAFRL-080	3	3	2	1.0333	1
HorAFRL-081	3	3	2	0.2953	1
HorAFRL-082	3	3	2	0.9597	1
HorAFRL-083	4	3	2	0.7296	1
HorAFRL-084	4	3	2	0.1779	1
HorAFRL-085	4	3	2	0.2356	1
HorAFRL-086	4	3	2	0.2813	1
HorAFRL-087	4	3	2	0.2447	1
HorAFRL-088	4	3	2	0.7602	1
HorAFRL-089	4	2	2	0.9653	1
HorAFRL-090	4	3	2	1.9326	1
HorAFRL-091	4	2	2	0.7364	1
HorAFRL-092	4	2	2	0.8491	1
HorAFRL-093	3	3	2	0.7431	1
HorAFRL-094	4	3	2	0.2943	1
HorAFRL-095	4	3	2	0.1491	1
HorAFRL-096	4	3	2	0.2031	1
HorAFRL-097	4	3	2	0.3529	1
HorAFRL-098	4	3	2	0.658	1
HorAFRL-099	4	3	2	0.6697	1
HorAFRL-100	4	3	2	0.4627	1
HorAFRL-101	4	3	2	0.6644	1
HorAFRL-102	4	3	2	1.3126	1

ID	Channel Width	Stream Type	One or 2 sided	Length of RL (km)	Landuse
HorAFRL-103	4	3	2	1.2782	1
HorAFRL-104	4	3	2	0.408	1
HorAFRL-105	3	2	2	0.8223	1
HorAFRL-106	3	2	2	1.2852	1
HorAFRL-107	4	3	2	0.2726	1
HorAFRL-108	4	3	2	0.3335	1
HorAFRL-109	4	3	2	0.4346	1
HorAFRL-110	4	3	2	0.613	1
HorAFRL-111	4	3	2	0.3958	1
HorAFRL-112	4	3	2	0.5341	1
HorAFRL-113	4	3	2	0.5265	1
HorAFRL-114	4	3	2	0.2064	1
HorAFRL-115	4	3	2	0.3786	1
HorAFRL-116	4	3	2	1.1589	1
HorAFRL-117	4	3	2	0.4701	1
HorAFRL-118	4	3	2	1.4742	1
HorAFRL-119	4	3	2	0.4246	1
HorAFRL-120	3	2	2	2.5894	1
HorAFRL-121	4	3	2	0.4315	1
HorAFRL-123	4	3	2	0.3112	1
HorAFRL-124	4	3	2	0.279	1
HorAFRL-125	4	3	2	0.4723	1
HorAFRL-126	4	3	2	0.2898	1
HorAFRL-127	4	2	2	0.7353	1
HorAFRL-128	4	2	2	0.5433	1
HorAFRL-129	1	1	1	0.4102	1
HorAFRL-130	4	2	2	0.6416	1
HorAFRL-131	4	3	2	0.6482	1
HorAFRL-132	4	3	2	1.0723	1
HorAFRL-133	4	2	2	0.5035	1
HorAFRL-134	4	3	2	0.0795	1
HorAFRL-135	4	2	2	0.555	1
HorAFRL-136	4	3	2	1.3358	1
HorAFRL-137	4	3	2	2.4463	1
HorAFRL-138	1	1	1	0.4457	1
HorAFRL-139	1	1	1	0.1498	1

APPENDIX 2 – Database of large sediment sources

(This database only includes the lower part of the Horsefly above Falls watershed. The information for the other parts of the watershed (e.g. MacKay, McKusky and Upper Horsefly) can be found in their respective reports)

ID	Type	Cause	Deliverability	Degree of Revegetation	Activity Level
HorAFLS-001	4	3	1	1	1
HorAFLS-002	4	2	2	1	1
HorAFLS-003	3	1	2	3	1
HorAFLS-004	4	2	3	1	3
HorAFLS-005	3	2	1	2	1
HorAFLS-006	3	2?	1	2	1
HorAFLS-007	4	2	2	2	2
HorAFLS-008	3	2	2	2	2
HorAFLS-009	4	1	2	1	3
HorAFLS-010	4	1	2	1	3

APPENDIX 3 – Database of stream crossing survey (surface erosion)

(This database only includes the lower part of the Horsefly above Falls watershed. The information for the other parts of the watershed (e.g. MacKay, McKusky and Upper Horsefly) can be found in their respective reports)

Sub Basin	Crossing ID	UTM Easting	UTM Northing	Structure type	Size of Culvert	Crossing Erosion Score	WQCR	Stream width Class	Stream gradient Class
Residual	L09	651792	5805581	5	600	0.0	Low	3	1
Residual	L10	651712	5805348	1	N/A	0.0	None	2	1
Residual	L11	651834	5805199	1	N/A	0.0	None	3	2
Residual	L12	652174	5804942	5	400	0.9	High	4	1
Residual	L13	652533	5804886	5	400	0.0	None	4	1
Residual	L14	652409	5804469	5	800	0.9	High	3	1
Residual	L15	652197	5803656	5	800	1.0	High	3	2
Residual	L16	652375	5802311	5	600	1.0	High	5	1
Residual	L17	652380	5802251	5	500	1.0	High	4	1
Residual	L18	652710	5801949	5	600	1.0	High	4	2
Residual	L20	651977	5801993	5x2	500	1.0	High	4	2
Residual	L22	651931	5801919	5	500	1.0	High	5	2
Residual	L50	639290	5800571	8	N/A	0.8	High	1	2
Residual	L53	633814	5801019	4	N/A	0.0	None	4	4
Residual	L54	633376	5800806	4	N/A	0.0	None	4	5
Residual	L55	636759	5806196	5	600	0.4	Low	4	2
Residual	L56	636861	5804151	5	500	0.5	Med	4	2
Residual	L57	636898	5804079	5	500	0.4	Low	4	2
Residual	L58	636935	5803738	4	N/A	0.9	High	4	3
Residual	L59	637376	5802810	5	500	0.3	Low	4	2
Residual	N02	653362	5806413	5	2400	0.5	Med	4	3
Residual	N03	653191	5806341	5	500	0.2	Low	5	3
Residual	N04	652924	5806224	5	500	0.4	Low	5	3
Residual	N05	652845	5806151	5	600	0.4	Low	5	3
Residual	N06	651794	5805652	5	600	0.5	Med	4	5
Residual	N07	651674	5805600	5	600	0.8	High	4	6
Residual	N08	651261	5805592	5	600	0.3	Low	4	6
Residual	N09	650992	5805604	5	600	0.5	Med	5	3
Residual	N50	644956	5802679	5	800	0.5	Med	3	3
Residual	N51	644495	5802489	5x2	600	0.4	Med	4	2
Residual	N52	643362	5801370	5	1000	0.4	Med	3	3
Residual	N53	641471	5800229	5	800	0.3	Low	4	3

APPENDIX 4- Inventory of disturbed channel reaches

(This database only includes the lower part of the Horsefly above Falls watershed. The information for the other parts of the watershed (e.g. MacKay, McKusky and Upper Horsefly) can be found in their respective reports)

ID	Length (m)	Instability level	Source	Reach
Horse-01	752	M	4	M-R4
Horse-02	523	M	4	M-R5
Horse-03	669	M	1	MR6
Horse-04	369	H	1	MR6
Horse-05	412	M	1	MR6
Horse-06	514	H	1	MR5
Horse-07	1194	M	1	MR3

APPENDIX 5 – Selected photographs



Photograph #1188. Club Creek Watershd



Photograph #1195. De-activated road – Club Creek watershed



Photograph # 1221. Doreen Creek watershed- view upstream



Photograph # 1226. Upper Doreen watershed

APPENDIX 5 – Selected photographs



Photograph #1248. Horsefly above falls-extensive harvest



Photograph #1265. Natural sediment sources – bank erosion



Photograph # 1661. Site L15, score = 1.0 (High)



Photograph #1667. Site L18, score 1.0 (High) – Needs de-activation

APPENDIX 5 – Selected photographs



Photograph #1642. Main road into Club Creek watershed



Photograph # 212-9. Site L54, score=0.0 (low)