Gitanyow Fisheries Authority

2008 Assessment of Forestry Road Crossings in the Kispiox River Watershed using the Water Quality Effectiveness Evaluation

Report Prepared by:
Kevin Koch, BSc. and Mike McCarthy, HBSc.
Gitanyow Fisheries Authority
PO Box 148
Kitwanga, BC V0J 2A0

Prepared for:
Gitxsan Forest Enterprises Inc.
4315 Field Street
Box 65
Hazelton, BC V0J 1Y0

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Abstract

The intersections of streams and forestry roads are common points of erosion and sedimentation in watersheds, the effects of which can be mitigated through various means. We assessed 146 mapped road crossings for sedimentation risk in the Ironside, Cullon and Lower Kispiox sub-basins of the Kispiox River Watershed in northwest British Columbia. The Water Quality Effectiveness Evaluation was used at each crossing, as developed by Carson et al. (2008), which ranks each crossing and gives it a Total Crossing Score. Using 1:50,000 scale maps, we estimated there to be 350 crossings in the study area; therefore approximately 42% of the total were surveyed in 2008. Of the 146 mapped crossings in these sub-basins that we attempted to locate, the breakdown of sediment risk rankings was Very High (5.5% - n=8), High (13.7% - n=20), Moderate (29.5% - n=43), Low (16.4% - n=24), Very Low (34.2% - n=50) and 1 mapped crossing was not found. Preliminary prescriptions were developed for 56 crossings with an estimated budget of $660,000. Recommendations were made on another 5 crossings to mitigate beaver related problems, and maintenance issues were noted at 3 others. It is also recommended the remaining crossings are surveyed as soon as possible, at an estimated cost of $40,000.

Acknowledgements

The Gitanyow Fisheries Authority would like to thank the BC Ministry of Forests and the Forest Investment Account for each providing funding for this project. Thanks to Lorne Wilson and Alex Johnson from Anspayaxw Development Ltd. for their efforts at field data collection and data entry. Thanks to Ken Rabnett and Tim Wilson of the Gitxsan Watershed Authority for their valuable work in 2006 surveying stream crossings, as this information was very useful for this project.

1.0 Introduction

The purpose of the 2008 Kispiox River watershed, Forestry Road Crossing Assessment Project was to protect fish habitat by identifying stream crossings within the Cullon, Ironside, and Lower Kispiox Watersheds that are producing road related sediment that could transfer to an adjacent watercourse. Funding for this project was made available through the British Columbia Ministry of Forests (MoF Contract #10005-40/EN09Q7G037) and the Forest Investment Account (FIA). The Gitanyow Fisheries Authority (GFA) subcontracted on this project to Anspayaxw Developments Ltd. (ADL) of Kispiox, B.C.

For this project the GFA utilized the Water Quality Effectiveness Evaluation (WQEE, Carson et. al. 2008) at each crossing. The scope of this project included mainly forestry-based roads under the jurisdiction of the B.C. Ministry of Forests and Range (MOF) along with several sites along the Kispiox Trail under jurisdiction of the B.C. Ministry of Transportation (MOT).

The WQEE survey provides an estimate of the amount of road related sediment entering a stream, including the road surface, ditchlines, cuts and fills. The purpose of the WQEE is to measure the effects of forestry related activities on stream water quality and to provide a simple means of prioritizing restoration activities (Carson et. al., 2008). The WQEE survey systematically assesses the sediment delivery potential of a road crossing by evaluating the size and characteristics of road related sediment sources and the likelihood of the eroded material reaching the stream. This method assumes that all forestry related sedimentation originates from a point source that can be easily identified and quantified on the ground. WQEE inspections are undertaken in locations with the highest likelihood of generating sediment, including road crossings and harvested areas in close proximity to a watercourse. Problematic crossings were then prioritized based on benefits gained by remediation in reducing sedimentation impacts.

Field crews were able to cover a large area by pick-up truck, however many roads were inaccessible due to brushed-in roadways, blow-down on road, deactivated crossings and hazardous road surfaces. Crossings not accessed in 2008 should be surveyed in the 2009 field season.

Results of this assessment will be used to initiate funding of remedial works in 2009 and beyond from the various stakeholders responsible for forestry and public road maintenance within the Gitxsan Traditional Territory.

1.1 Description of Project Area

The Kispiox River is a relatively large tributary that enters into the right bank of the middle northern section of the Skeena River (Gottesfeld and Rabnett, 2008). It is a fifth order stream that drains an area approximately 2,088 km^2 in size. Fish values in the watershed are extremely high, and the river is world renowned for its steelhead fishing.

Gottesfeld (2002) rated the Kispiox River as the most productive sub-basin in the Skeena Watershed.

The Kispiox River provides habitat for all species of anadromous Pacific salmon, including sockeye (*Oncorhynchus nerka*), chinook (*O. tshawytscha*), coho (*O. kisutch*), pink (*O. gorbuscha*), chum (*O. keta*) and steelhead (*O. mykiss*). Freshwater resident species that have been documented in the watershed include rainbow trout (*O. mykiss*), cutthroat trout (*O. clarki clarki*), kokanee (*O. nerka*), bull trout (*Salvelinus confluentus*), Dolly Varden char (*S. malma*), lake trout (*S. namaycush*), mountain whitefish (*Prosopium williamsoni*), lake whitefish (*Coregonus clupeaformis*), northern pikeminnow (*Ptychocheilus oregonesis*), largescale sucker (*Catastomus macrocheilus*), longnose sucker (*Catostomus catostomus*), river lamprey (*Lampetra ayresi*), longnose dace (*Rhinichthys cataractae*), redside shiner (*Richardsonius balteatus*) and prickly sculpin (*Cottus asper*).

During this project, GFA focused on the Ironside Creek (watershed code (WC) 470-335400) and Cullon Creek (WC 470-245700) watersheds, and an area termed the Lower Kispiox (Figure 1), which are all areas known to have high fish values. The Lower Kispiox area included, most notably, a section of the Kispiox River mainstem, Murder Creek (WC 470-161000), Mitten Lake (WC 470-364800), Helen Lake (WC 470-252300-65200-19502) and Elizabeth Lake (WC 470-313200). Ironside Creek is known to support coho, pink and steelhead salmon, cutthroat and rainbow trout, Dolly Varden and mountain whitefish. Cullon Creek is known to support chinook, coho, pink and steelhead salmon, cutthroat and rainbow trout, Dolly Varden, lamprey, longnose dace, mountain whitefish, northern pikeminnow and longnose dace (Gottesfeld and Rabnett, 2008). The Lower Kispiox area would be assumed to support all of the species known to exist in the Kispiox River as a whole.

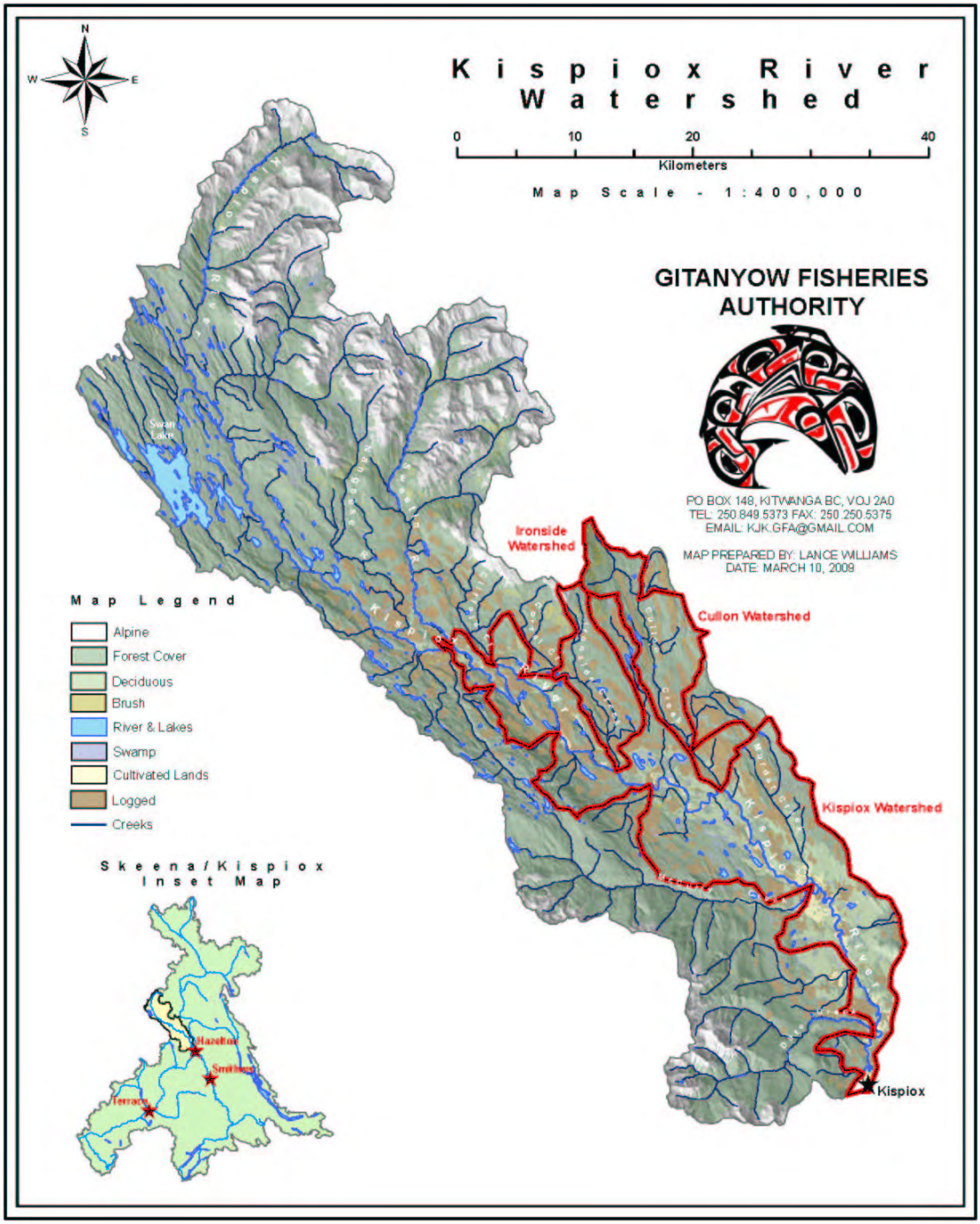

Figure 1: Overview map of the Kispiox Watershed with the study area highlighted in red (Ironside Creek, Cullon Creek and Lower Kispiox River Watersheds).

Forestry has been the main development activity in the Kispiox watershed since European settlers inhabited the area, starting in 1914 with harvesting related to agricultural land clearing, upon the completion of the railroad through the Skeena

(Gottesfeld and Rabnett, 2008). By 1966 the Kispiox Trail mainline was already 90km long, accessing the east side of the river, and by the early 1980's, the Kispiox watershed was connected to Highway 37 via the Mitten Main Forest Service Road (FSR) (Gottesfeld and Rabnett, 2008). This project focused on road crossings built on FSR's, although some crossings on the Kispiox Trail were assessed as well, which are under the jurisdiction of the BC Ministry of Transportation.

Gottesfeld and Rabnett (2008) described the forestry related impacts to the Kispiox watershed as "complex and result from the interactions of naturally unstable soils and high-energy stream systems draining into low-gradient valley-bottom reaches that are incapable of transporting large amounts of sediments produced by poor logging practices."

2.0 Methods

The Water Quality Effectiveness Evaluation (WQEE) was carried out at road crossings following the guidelines described in Carson et al. (2008). The WQEE survey was undertaken between October 7th and November 14th, 2008. The objective was to assess the amount of sediment entering a stream from road related sources in the Cullon and Ironside Creek and the Lower Kispiox River watersheds. Prior to entering the field, 1:50,000 scale maps were produced and reviewed in the office to identifiy all stream crossings (waterways and road networks) and a work plan was developed. Efforts began in the Cullon Creek watershed, continued into the Ironside Creek watershed, and finished in the Lower Kispiox River watershed. The onset of winter and persistent snow cover following November 14th prevented a full assessment of the three sub-basins in the study area.

2.1 Field Assessment

At each site the geographical location, crossing structure characteristics, and fish habitat quality was recorded. The roadway on either side of the crossing was assessed for sedimentation potential from the road surface, ditches, cutbanks, road fill and bridge decks. In addition, photographs were taken of the crossing structure, stream channel, and adjacent roadway. In the field, information was recorded on WQEE Form 3 datasheets (Carson et al. 2008).

Sites were evaluated for fine sediment contribution from mass wasting that occurred in the past and from surface erosion that is ongoing. Stream crossings were divided into 11 road elements (Column 1 on the WQEE field form; the left/right designation is relative to the evaluator facing downstream):

- Left road surface (LRS)
- Left road upper and lower ditches [LRD (u), LRD (l)]
- Left road upper and lower cutbanks [LRC (u), LRC (l)]
- Right road surface (RRS)
- Right road upper and lower ditches [RRD (u), RRD (l)]
- Right road upper and lower cutbanks [RRC (u), RRC (l)]

- Fill banks
- Bridge decking

In the field, each road element was assessed and scored according to a series of characteristics:

- Connectivity to the stream (Column 2)
- Portion of fine sediment in erodible material (Column 3)
- Fine sediment contribution from mass wasting (Column 4)
- Fine sediment contribution from surface erosion (Columns 7 and 8)

A series of calculations were performed to arrive at the sediment contribution (m^3) of each element. Calculations are provided in the digital copy of the field data form in Appendix C.

2.2 Data Analysis

Field forms were digitized and a summary database was created using Microsoft Excel. The Total Crossing Score was calculated as the sum of the fine sediment contribution from mass wasting and surface erosion of each road element. Each site was then classified based on the total volume of sediment (Total Crossing Score) generated according to the WQEE ranking guidelines:

- Very Low - < 0.2 m^3
- Low – 0.2 to 1 m^3
- Moderate – 1 to 5 m^3
- High – 5 to 20 m^3
- Very high - >20 m^3)

2.3 Reporting

For this report, aside from one crossing ranked low, only the stream crossings ranked as moderate to very high sedimentation were described and discussed in any detail. Recommendations were made to reduce or eliminate sedimentation from the road elements that contributed the most to the sediment score.

2.4 Deliverables

- A summary of assessment results – in report
- All prescriptions for works - in report
- Pictures of problem sites – in report and in Appendix A (on CD)
- Location maps – 1:50,000 hardcopy and digital file in Appendix B (on CD)
- WQEE Database – in Appendix C (on CD)
- Copies of completed field cards (WQEE and FPCI cards) – (included in final package)

3.0 Results and Discussion

A two-person crew consisting of one biologist/field supervisor from the GFA and one technician from Anspayaxw Development Ltd. (ADL) conducted WQEE assessments between October 24th and November 14th, 2008. On the evening of November 14th, a large amount (~30cm) of snow fell, making assessment of the erosion risks impossible beyond that date. There was minor snow covering that occurred during the project but in general the conditions were good for assessing sediment risks.

Analysis of 1:50,000 maps produced by the Gitxsan Watershed Authorities (2006) indicated approximately 350 crossings in the three sub-basins, 27 of which are on the Kispiox Trail (MoT jurisdiction) and 13 on the Poplar Park Road (unknown jurisdiction). Of these 350 crossings, under the NWFREP funding there were 100 sites assessed and under FIA funding another 46 sites were assessed. Therefore, approximately 42% of the total available sites were assessed during this project.

All sites assessed were given a sediment risk ranking as per the WQEE protocol (Carson, 2008) (Table 1). In general, the majority of sites assessed during this project were not considered to be a significant risk for causing sedimentation in these watersheds, and were given a very low (34.2%: n=50) or low (16.4%: n=24) ranking. In these areas, most or all of the areas immediately adjacent to the crossing had re-vegetated with grasses, forbs, mosses, shrubs or small trees to the point where the vegetation could filter out most sediment. In the categories of moderate, high and very high sediment risk, there were 29.5% (n=43), 13.7% (n=20) and 5.5% (n=8) respectively. Prescriptions for remedial works on these sites are in the following sections and are summarized in Table 2.

Table 1: Summary of sediment risk rankings for the Kispiox Watershed.

Sediment Ranking	#	%
Very High (>20)	8	5.5
High (5-20)	20	13.7
Moderate (1-5)	43	29.5
Low (0.2-1)	24	16.4
Very Low (<0.2)	50	34.2
No crossing found	1	0.7
TOTAL	**146**	

Erosion caused by road surfaces was one of the more common issues at crossings. In many cases, roads had lost their crown and water was essentially funneled down the road surface and would often pool at the crossing, creating potholes filled with turbid water. In some areas the road surface itself was highly erodible, and when combined with the water on the road surface being directly connected to the watercourse, resulted in higher rankings for erosion risk. Detailed recommendations and costs involving road reconstruction activities are beyond the scope of this report. However, all sites with problem road surfaces were noted, and within the following sections, there are sites where a road assessment by an engineer is recommended to determine the most cost-

effective solution. Recommendations and cost estimates are made for road issues, but they need refining. As well, prescriptions for other erosion and sediment control work in this report should be considered preliminary and general, especially with regards to budget estimates.

Of the 146 sites assessed, prescriptions were developed for 56 crossings. Sites with WQEE scores ranging from low to very high, that have prescriptions developed, are summarized in Table 2. In sections 3.1, 3.2 and 3.3, a more detailed description and photographs are provided for certain higher priority sites. The total cost estimate for the Table 2 prescriptions is $660,000. For sites where a road engineer assessment was recommended, and our recommendations are to re-surface and crown the road, the cost estimate includes both those activities. For sites 45 and 34 the prescription was to have an engineer assess the site for a possible crossing replacement, and for a decision to be made by the appropriate bodies to either deactivate or replace the structure. The potential cost to implement their recommendations is not included in our cost estimate.

Note: While reading this report, it is recommended to view the photographs which are organized by Site # in the Appendix A folder on the attached CD.

Table 2: Summary of sites surveyed in 2008 with very high, high and moderate WQEE Rankings.

Site #	Road Name	WQEE Ranking	Fish-Bearing Status *	Erosion Issue	Prescription	Priority	Estimated Cost
99	Date Cr FSR	Very High	Confirmed	-mass wasting on cutbanks -erodible road surface	-fall unstable trees at top of slope -bio-engineering of cutbanks -grass-seed and mulch -road engineer assessment required (re-surface, crowning)	Very High	$105,000
100	Date Cr FSR	Very High	No	-mass wasting on cutbanks -erodible road surface -eroding ditchline	-fall unstable trees at top of slope -bio-engineering of cutbanks -grass-seed and mulch -clear ditches of sediment -possible culvert replacement -road engineer assessment required (re-surface, crowning)	Very High	Included with Site 99
101	Date Cr FSR	Very High	No	-mass wasting on cutbanks -erodible road surface -eroding ditchline	-fall unstable trees at top of slope -bio-engineering of cutbanks -grass-seed and mulch -clear ditches of sediment -possible culvert replacement -remove existing sediment fence -road engineer assessment required (re-surface, crowning)	Very High	Included with Site 99
45	Bailey FSR	Very High	Confirmed	-road washing out -mass wasting of road fill -beaver dams on both sides of road	-road engineer assessment required (deactivation/replacement of crossing) -grass-seed and mulch of road fill -beaver dam maintenance required (breaching and trapping)	Very High	$3,000 for engineer assessment plus costs to deactivate / replace

98	Date Cr FSR	Very High	No	-erodible left road surface (also right road to lesser extent) -eroding left road ditch and cutbank	-road engineer assessment required (re-surface, crowning) -grass-seed and mulch -bioengineering of left road cutbank	High	$32,000
69	Kispiox Trail	Very High	Confirmed	-erodible road surfaces	-replace culvert as per Rabnett and Wilson, 2007).	Very High	NA
73	Kispiox Trail	Very High	No	-erodible road surfaces	-road engineer assessment required (re-surface, crowning) -grass-seed and mulch	Moderate	$18,000
121	Helen 2000 FSR	Very High	Inferred	-eroding ditchline -erodible right road cutbank	-armor ditchline with riprap -apply grass seed and straw mulch on right	High	$11,000
75	Kispiox Trail	High	Inferred	-erodible road surfaces -eroding ditchlines	-road engineer assessment required (road re-surface, crowning)	High	$18,000
59	Kispiox Trail	High	No	-erodible road surfaces	-road engineer assessment required (road re-surface, crowning) -front of culvert needs cleaning	Moderate	$12,000
34	Hemlock FSR	High	Confirmed	-damaged bridge -erodible road surface and left cutbank	-road engineer assessment required (bridge removal) -remove/replace bridge **(SAFETY ISSUE)** -apply best mgmt practices if/when new crossing and road constructed -remove wood piles -grass-seed and mulch immediately after completion	High	$3,000 Cost of initial engineer assessment
71	Kispiox Trail	High	Confirmed	-erodible road surfaces -debris pile left over from grading	-road engineer assessment required (re-surface, crowning) -grass-seed and mulch	Moderate	$15,000

118	Helen FSR	High	Confirmed	-erodible road surfaces and left road ditch	-road engineer assessment required (re-surface, crowning) -remove sediment from left side ditch -grass-seed and mulch	Moderate	$7000
64	Kispiox Trail	High	Confirmed	-erodible road surfaces	-replace culvert as per Rabnett and Wilson (2007)	Very High	NA
107	Helen FSR	High	Unknown	-erodible road surfaces and ditches	-road engineer assessment required (re-surface, crowning) -if decked logs are removed, grass-seed and mulch as required	Moderate	$6,000
139	Helen FSR	High	Inferred	-erodible road surfaces	-road engineer assessment required (re-surface, crowning)	High	$8,000
125	Helen FSR	High	Confirmed	-erodible road surfaces	-road engineer assessment required (re-surface, crowning)	High	$10,000
124	Helen 2000 Rd.	High	Inferred	-erodible road surfaces	-road engineer assessment required (re-surface, crowning)	High	$10,000
17	Kuldo FSR	High	Confirmed	-erodible road surfaces	-road engineer assessment required (re-surface, crowning)	High	$18,000
137	Helen FSR	High	Inferred	-erodible road surfaces	-road engineer assessment required (re-surface, crowning)	High	$10,000
129	Helen FSR	High	Inferred	-erodible road surfaces	-road engineer assessment required (re-surface, crowning)	High	$8,000
11	Kuldo FSR	High	Inferred	-erodible road surfaces	-road engineer assessment required (re-surface, crowning)	High	$14,000
7	Kuldo FSR	High	Inferred	-erodible road surfaces	-road engineer assessment required (re-surface, crowning)	High	$10,000
104	Helen FSR	Moderate	Inferred	-erodible road surfaces	-road engineer assessment required (re-surface, crowning)	Low	$28,000
105	Helen FSR	Moderate	Inferred	-erodible road surfaces	-road engineer assessment required (re-surface, crowning)	Low	$20,000
119	Helen FSR	Moderate	Confirmed	-erodible road surfaces	-road engineer assessment required (re-surface, crowning)	Low	$10,000

116	2000 Rd Helen	Moderate	Inferred	-slumping RRCU is causing erosion, filling ditch with sediment and spilling water onto road -erodible road surfaces	-re-ditch RRDU (using Best Mgmt Practices to minimize sedimentation) -stabilize RRCU with bioengineering, grass-seed and mulch	High	$8,000
53	Mitten FSR	Moderate	Unknown	-erodible road surfaces	-road engineer assessment required (re-surface, crowning) -conduct fish sampling	Moderate	$24,000
48	Kispiox Trail	Moderate	Confirmed	-erodible road surface -beaver dam with history of breaching and road flooding	-reassess periodically -conduct trapping to maintain moderate beaver populations	Moderate	$10,000
102	Helen FSR	Moderate	Inferred	-erodible left road surface -eroding LRCU	-road engineer assessment required (re-surface, crowning) -grass-seed and mulch	Moderate	$5,000
108	Helen FSR	Moderate	Unknown	-erodible road surfaces	-assess fish-bearing status -if found to be fish-bearing then have engineer assess road	Low	$8,000
113	2100 Rd Helen	Moderate	Inferred	-erodible road surfaces	-no prescription at this time	Very Low	NA
106	Helen FSR	Moderate	Inferred	-erodible right road surface -erodible RRDU	-re-assess in spring once logs are removed from what was an active logging area in fall 2008, to see if erosion control is needed -will likely need grass-seed	Moderate	$6,000
76	Corral FSR	Moderate	Inferred	-erodible right road surface -erodible LRDU and LRCU	-grass-seed and mulch cutbank and ditch -remove berm in RRDL which is preventing water from entering into ditch, and preventing vegetation growth in ditch	Low	$7,000
109	Helen FSR	Moderate	Unknown	-erodible road surfaces	-assess fish-bearing status -if found to be fish-bearing then have engineer assess road	Low	$6,000

80	Corral FSR	Moderate	Inferred	-beaver dam downstream of crossing is flooding road -erodible road surfaces -erodible LRCL	-further assess beaver dam and breach and trap if necessary -road engineer assessment required	High	$9,000
86	Helen FSR	Moderate	No	-erodible road surfaces -erodible LRCU and RRCU	-Not fish-bearing but very close to fish-bearing lake -bio-engineering of eroding cutbanks -grass-seed and mulch -road engineer assessment (need machine in to clean out RRDU to restore flow)	Moderate	$16,000
74	Kispiox Trail	Moderate	Inferred	-erodible left road surface -erodible LRDU and LRDL	-Close to Kispiox River -road engineer assessment required -grass-seed and mulch	Moderate	$5,000
70	Kispiox Trail	Moderate	Unknown	-erodible road surfaces -erodible ditches	-road engineer assessment required (culvert appears set too high) -grass-seed and mulch	Low	$9,000
63	Kispiox Trail	Moderate	No	-erodible road surface	-very little flow, not close to fish-bearing -grass-seed if in area only	Very Low	0
117	2000 Rd Helen	Moderate	Unknown	-erodible road surface	-not a stream, area well vegetated in spite of road being erodible	Very Low	0
61	Kispiox Trail	Moderate	Unknown	-erodible road surface	-grass-seed and mulch if in area only	Low	$4,000
112	2100 Rd Helen	Moderate	Unknown	-erodible road surfaces	-assess fish-bearing status -if found to be fish-bearing, have engineer assess road	Low	$6,000

90	Helen FSR	Moderate	No	-erodible road surfaces -erodible LRDU	-road engineer should assess to see if culvert needs replacing (upstream end is damaged) -non fish-bearing but close to Mitten Lake here	Low	$11,000
111	2100 Rd Helen	Moderate	No	-erodible road surfaces	-very well vegetated all around -no action required	Very Low	0
37	Bailey FSR	Moderate	Unknown	-erodible LRCU	-grass-seed if in area only	Very Low	0
60	Kispiox Trail	Moderate	Unknown	-erodible road surfaces -standing water on both sides of crossing	-no culvert actually found here -sediment risk appears low because area is very flat	Very Low	0
95	Sunday FSR	Moderate	Unknown	-erodible road surfaces	-road engineer should assess for possible re-surfacing -assess for fish-bearing status	Moderate	$7,000
89	Helen FSR	Moderate	No	-erodible left road surface -erodible LRCU	-road engineer should assess for possible culvert replacement (culvert damaged) -grass-seed and mulch LRCU	Low	$8,000
140	Helen FSR	Moderate	Inferred	-erodible road surfaces	-road engineer should assess for possible re-surfacing	Moderate	$6,000
4	Kuldo FSR	Moderate	No	-erodible road surfaces	-road engineer should assess for possible re-surfacing	Moderate	$6,000
132	Helen FSR	Moderate	No	-erodible road surfaces	-road engineer should assess for possible re-surfacing	Moderate	$6,000
135	Helen FSR	Moderate	Unknown	-erodible road surfaces	-road engineer should assess for possible re-surfacing	Moderate	$5,000
136	Helen FSR	Moderate	Unknown	-erodible road surfaces	-road engineer should assess for possible re-surfacing	Moderate	$4,000
127	Helen FSR	Moderate	Inferred	-erodible road surfaces	-road engineer should assess for possible re-surfacing	Moderate	$4,000
8	Kuldo FSR	Moderate	Confirmed	-erodible road surfaces	-road engineer should assess for possible re-surfacing	Moderate	$5,000
131	Helen FSR	Moderate	No	-erodible road surfaces	-road engineer should assess for possible re-surfacing	Moderate	$5,000

10	Kuldo FSR	Moderate	Confirmed	-erodible road surfaces	-road engineer should assess for possible re-surfacing	Moderate	$8,000
128	Helen FSR	Moderate	Unknown	-erodible road surfaces	-road engineer should assess for possible re-surfacing	Moderate	$10,000
133	Helen FSR	Moderate	No	-erodible road surfaces	-road engineer should assess for possible re-surfacing	Moderate	$7,000
20	Skeena Carrigan FSR	Moderate	Inferred	-exposed soil around recent culvert replacement project	-apply grass-seed, fertilizer and straw mulch over all exposed soil that could lead to the stream -road engineer should assess for reconstruction of recently covered LRD(u)	High	$8,000
6	Kuldo FSR	Moderate	Inferred	-erodible road surfaces	-road engineer should assess for possible re-surfacing	Moderate	$4,000
14	Kuldo FSR	Moderate	Inferred	-erodible road surfaces	-road engineer should assess for possible re-surfacing	Moderate	$5,000
49	Mitten FSR	Low	Confirmed	-damaged bridge -channel dry and aggraded -erodible road surfaces	-road engineer should assess for bridge replacement -replace bridge -conduct FHAP on stream	Very High	$60,000
Total Estimated Budget for Moderate, High and Very High Scoring Sites							~$600,000

*From Rabnett and Wilson, 2007.

3.1 Very High Sediment Risk Sites

Sites 99, 100 and 101 – Date Creek FSR – Very High Priority

These crossings had the highest WQEE Scores of all the crossings surveyed in 2008, which were Site 99 (5,852 m^3), Site 100 (21,601 m^3) and Site 101 (3,621 m^3).

These sites will be discussed as a group because of their close proximity to each other, and because the erosion issues should be dealt with as a whole, not as individual projects. A series of eroding cutbanks exist along a steep, east-facing slope from 550m – 875m along the Date Creek FSR. In this area we found three crossings, one on Dale Creek, which is S3 sized (750m up Date Creek FSR), and two on seepages in very close proximity to the Kispiox River (<80m). Rabnett and Wilson (2007) confirmed fish presence in Dale Creek (Site 99) in 2006 (GWA Site 403).

Photo 1: Site 99. Looking upstream at culvert outlet. Note 2 large culverts and one smaller one in background left.

Photo 2: Site 99. Looking at un-vegetated cutbank on the left road cut (upper side). Bioengineering is recommended to stabilize this slope.

Photo 3: Site 99. Looking away from the crossing at the left road surface. This surface contributed significantly to the high ranking of this crossing, due to its erodible surface and connectivity to the stream.

Photo 4: Site 100. Looking at eroded cutbank requiring stabilization on the left road cut (upper side). Note that ditch on upper side (left side photo) is almost full of sediment.

Photo 5: Site 100. Looking at upstream end of culvert, with large accumulation of highly erodible sediment.

Photo 6: Site 101. Looking at eroded cutbank on left road cut (upper side). Another example of highly unstable banks in this area requiring rehabilitation.

Photo 7: Site 101. Looking at upstream end of culvert, which is almost completely full of sediment, originating from the eroding cutbank in the previous photo.

Remedial Prescriptions

The cutbanks along this stretch of road are quite steep, and are clearly not able to re-vegetate naturally. Along the top of the cutbanks, as the slope unravels, there are trees either falling down or already down, creating further instability. A detailed prescription is required for this slope, but general recommendations are as follows:

- Fall trees along the top of slope that are unstable, or have already partially fallen. Bring these trees down onto the slope to assist in stabilization and to reduce work hazards at the site (may need to conduct a Danger Tree assessment before deploying crews to site).
- Construct modified brush layers, and potentially other bioengineered structures (Polster, 2002).
- Grass-seed
- Apply straw mulch and/or erosion control blankets.
- Clear ditches of sediment and dispose of appropriately.
- After cleaning ditches, inspect culverts for potential replacement.
- Remove improperly installed sediment fence on downstream side of Site 100 culvert.

Site 45 – Bailey FSR – Very High Priority (WQEE Score 120 m^3)

This crossing is a round metal culvert that passes an S3/S4 sized stream which Rabnett and Wilson (2007) confirmed is fish-bearing. There are large beaver dams on both sides of the road, and the road is washing out but still passable. The biggest erosion risk at this site is if the road washes out, which is possible. An area of mass wasting on the downstream side of the culvert has already deposited a large amount of sediment into the stream, and is now exposed and eroding.

Photo 8: Site 45. Looking at a large washout on the downstream side of the Bailey FSR at the Site 45 crossing.

Photo 9: Site 45. Looking at an area of mass wasting and exposed soil on the downstream side of the crossing. Submerged culvert is visible in lower right side of photo.

Remedial Prescription

- Requires engineer assessment to determine best course of action (deactivation/replacement). Is currently a **major safety issue**, as this road is used frequently by hunters and mushroom pickers.
- Recommend applying grass-seed, erosion control blankets and straw mulch to the site this season, while a decision is made about the ultimate fate of this crossing.

Site 98 – Date Creek FSR – High Priority (WQEE Score 59 m^3)

This crossing is a round metal culvert that passes an S6 sized stream, which Rabnett and Wilson (2007) determined was non-fish-bearing. Although the stream is non-fish-bearing, it was classified as moderate priority because of its very high WQEE ranking of 59 and its close proximity to the Kispiox River (~600m). The main erosion risk at this site is the left road surface. This road was active at the time of survey, with a gradient of 10-12% and a highly erodible surface over its estimated 500m length of drainage into the creek. In addition, the left road ditch and lower cutbank require erosion control, and the right road surface is likely contributing sediment. There has been some recent, successful grass-seeding on the upper side of the left ditch.

Photo 10: Site 98. Looking at left road surface, a ~500m stretch of highly erodible surface, directly connected to an S4 sized stream.

Photo 11: Site 98. Looking at the right road surface, also highly erodible.

Photo 12: Site 98. An example of the partially vegetated left bank cut (lower side), requiring some remediation.

Remedial Prescriptions

The main issue at this site is the relatively long and steep erodible road surfaces that lead directly into a creek, and that this road had logging activity at the time of survey. The recommendations are:

- Assessment by road engineer to potentially re-surface the road and to ensure the road is crowned.
- Because road is so erodible and likely difficult to deal with, it is imperative that the ditches and cutbanks are highly vegetated. Modified brush layers should be built on cutbanks, and any other exposed surface should be grass-seeded and covered in straw mulch and/or erosion control blankets.

Site 121 – Helen FSR 2000 - High Priority (WQEE Score = 24 m^3)

This crossing is a round metal culvert over an S4 stream with moderate quality riffle/pool habitat. Rabnett and Wilson (2007) inferred fish presence at this crossing in 2006 (GWA Site 180). The RRD(u) and the RRC(u) were the main sediment contributors. Instead of crossing the stream at a right angle, the road right-of-way crosses the stream almost parallel to the original channel. This stream enters the RRD(u) 70 meters from the crossing and significant erosion and mass wasting has occurred along a 40 meter section of the ditch line where the stream is now flowing (Photo PB130070). A 300-meter exposed RRC(u) is directly connected to the stream (Photo PB130069). All LR elements slope away from the stream, while the RRS drains mostly past the stream into the LR.

Photo 13: Site 121. Eroding RRD(u) where original stream has been channeled at Helen FSR 2000 Road km 3.0.

Photo 14: Site 121. Eroding RRD(u) and exposed RRC(u) in background at Helen FSR 2000 Road km 3.0.

Remedial Prescriptions

- Armor the eroding RRD(u) and artificial stream channel with riprap (approximate volume of 40 x 4 x 0.5 meters = 80 m),
- Apply grass seed and straw mulch to the RRC(u) (approximate area of 100 x 3 meters = 300 m^2), and
- Install cross-ditch culverts along the 300 meter long RR to divert water from the erodible RRC(u) into the downslope forest. This would require a site inspection by a qualified road engineer.

Site 69 – Kispiox Trail – High Priority (WQEE Score 23 m^3)

This crossing is a large round wooden culvert that passes Skunsnat Creek. Rabnett and Wilson (2007) confirmed Skunsnat to be fish-bearing. The erosion risk at this site stems from the highly erodible road surface, exacerbated by the heavy use of this road (Kispiox Trail). This crossing was previously recommended as high priority for replacement (Rabnett and Wilson, 2007).

Remedial Prescription

Considering this culvert is recommended as high priority for replacement, it is not recommended as cost effective to be conducting erosion control work at this time. What is required is a commitment and timeline from the MoT on when this culvert will be replaced. If it will be more than two years, then it is recommended that in the meantime:

- Have engineer assess road (re-surfacing and crowning).
- Apply grass-seed and mulch to ditches and road fill.

Considering the previously established fish values in this creek and the recommendation for replacement of this culvert, and now with the very high ranking for sediment risk, it is considered overdue for this culvert to be replaced.

Site 73 – Kispiox Trail – Moderate Priority (WQEE Score 21 m^3)

Erodible road surfaces create an erosion risk at Site 73. Although having a very high ranking, this crossing is a seepage, therefore direct fisheries risk is considered low. However, the ease of access at this site, being along the Kispiox Trail, and the high amount of activity on this road, make it a good candidate for remedial work.

Remedial Prescription

- Have engineer assess road (re-surfacing and crowning).
- Grass-seed ditches and apply straw mulch and/or erosion control blankets.

3.2 High Sediment Risk Sites

Site 34 – Kispiox Trail – High Priority (WQEE Score 11 m^3)

Site 34 consists of severely degraded bridge with no deck, overtop an S4 stream, in which Rabnett and Wilson (2007) have confirmed fish presence. This bridge is a **major safety issue**, as there was evidence that people have still been driving vehicles over. Erodible road surfaces were the main sediment risk at this site, with a minor contribution from an eroding left road cutbank. No sites were surveyed beyond this point as it was foot access only beyond this bridge.

Photo 15: Site 34. Looking across degraded bridge with no deck.

Remedial Prescriptions

- Road engineer should assess and appropriate licensees/MoF determine whether bridge should be removed/replaced.
- Remove/replace bridge and re-vegetate site appropriately.
- If bridge is replaced, construct road in vicinity of crossing to minimize sedimentation of stream.

Site 71 – Kispiox Trail – Moderate Priority (WQEE Score 11 m^3)

A large round wooden culvert passes Corral Creek at Site 71, which is a confirmed fish-bearing stream (Rabnett and Wilson 2007). The left and right road surfaces are the biggest sediment risk here, as well as a pile of debris left overtop the culvert from road grading.

Photo 16: Looking at right road surface with small pile of un-vegetated debris on bottom left side of photo, left over from road grading.

Remedial Prescriptions

- Requires assessment by road engineer for potential re-surfacing.
- Grass-seeding and mulch exposed soil in and around culvert.

Site 139 – Helen FSR - High Priority (WQEE Score = 10 m^3)

This crossing is over a small S4 or S6 stream with shallow riffle/pool habitat. The LRS and RRS were the main sediment contributors. Fish presence was not confirmed at this crossing by Rabnett and Wilson (2007, GWA Site 183), however it is located within 1 kilometer of confirmed or suspected fish bearing waters (Helen Lake drainage). Ditches and shoulders were well vegetated and do not require any work.

Photo 17: Site 139. Long 200-meter run of left road surface directing runoff towards stream at Helen FSR km 8.7.

Remedial Prescription

- Recommend that a qualified road engineer inspect the road surfaces.

Site 125 – Helen FSR - High Priority (WQEE Score = 9 m^3)

This crossing is a bridge over a fast moving S2 stream with a good quality riffle/pool habitat. Rabnett and Wilson (2007) confirmed fish presence at this crossing (GWA Site 201). The LRS and RRS were the main sediment contributors. Ditches, cutbanks, and shoulders were well vegetated and do not require any work.

Photo 18: Site 125. Ruts on LRS drawing sediment towards a fish-bearing stream at Helen Lake FSR km 19.

Remedial Prescription

- Recommend that a qualified road engineer inspect the road surfaces.

Site 124 – Helen 2000 FSR - High Priority (WQEE Score = 8 m^3)

This crossing is a round metal culvert over a fast moving S3 or S6 stream with marginal cascade/riffle over bedrock habitat. Fish presence was not confirmed at this crossing by Rabnett and Wilson (2007, GWA Site 183), however it is located within 300 meters of suspected but not confirmed fish bearing waters. The LRS and RRS were the main sediment contributors. Ditches, cutbanks, and shoulders were well vegetated and do not require any works.

Photo 19: Site 124. Long 300 meter run on RRS and potholes above the crossing at Helen FSR 2000 Road km 3.8.

Remedial Prescription

- Recommend that a qualified road engineer inspect the road surfaces.

Site 118 – Helen Lake FSR – Moderate Priority (WQEE Score 8 m^3)

A round metal culvert passes an S4 sized stream at Site 118, which is confirmed to be fish-bearing (Rabnett and Wilson, 2007). Erodible road surfaces are the main sediment risk here, as well as the left road ditch (upper side).

Photo 20: Site 118. Looking at left road and left ditch (upper side).

Remedial Prescription

- Requires assessment by road engineer for potential re-surfacing with clean coarse roadbed material.
- Left side ditches are very shallow and may require material to be removed, and then should be grass-seeded and mulched.

Site 17 – Kuldo FSR - High Priority (WQEE Score = 6 m^3)

This crossing is a round metal culvert over an S3 stream with good pool/riffle habitat. A 2-meter high beaver dam located 30 meters upstream of the crossing has created a large pond and the potential for a road blowout if the dam breaks. Rabnett and Wilson (2007) confirmed fish presence at this crossing in 2006 (GWA Site 56). The LRS and RRS were the main sediment contributors. Ditches, cutbanks, and shoulders were well vegetated and do not require any work.

Photo 21: Site 17. Long 600 meter run on LRS leading to fish-bearing stream at Kuldo FSR km 15.2.

Remedial Prescription

- Recommend that a qualified road engineer inspect the road surfaces.

Site 64 – Kispiox Trail – Moderate Priority (WQEE Score 6 m^3)

A large round wooden culvert passes Clifford Creek at Site 64, which is a confirmed fish-bearing stream (Rabnett and Wilson, 2007). The road surfaces are highly erodible here, and high amounts of sediment likely enter the creek during rainstorms.

Photo 22: Site 64. Looking at the highly erodible road surface.

Remedial Prescription

Considering this culvert is recommended as high priority for replacement, it is not recommended as cost effective to be conducting erosion control work at this time. What is required is a commitment and timeline from the MoT on when this culvert will be replaced. If it will be more than two years, then it is recommended that in the meantime:

- Have engineer assess road (re-surfacing and crowning).
- Apply grass-seed and mulch to ditches and road fill.

Considering the previously established fish values in this creek and the recommendation for replacement of this culvert, and now with the high ranking for sediment risk, it is considered overdue for this culvert to be replaced.

Site 107 – Helen Lake FSR – Moderate Priority (WQEE Score 6 m^3)

A round metal culvert passes an S4/S6 sized stream at Site 107, which has a fish-bearing status of unknown (Rabnett and Wilson, 2007). There was active logging in the immediate vicinity of this site when it was surveyed in 2008, and a light snow cover. The road surfaces and ditches were all quite disturbed and erodible, likely because the logging was just done.

Photo 23: Site 107. Looking at the right road ditch (upper side) with decked logs in background.

Remedial Prescription

- Road engineer assessment for potential re-surfacing.
- If logs are removed already, apply grass-seed and mulch to exposed soil surfaces.

Site 137 – Helen FSR - High Priority (WQEE Score = 5 m^3)

This crossing is a round metal culvert over an S4 or S6 stream with shallow pool/riffle habitat. Logging to the stream banks has occurred upstream. Fish presence was not confirmed at this crossing by Rabnett and Wilson (2007, GWA Site 227), however it is located at the upstream limit of suspected fish bearing waters. The LRS and RRS were the main sediment contributors. Ditches, cutbanks, and shoulders were well vegetated and do not require any work.

Photo 24: Site 137. Muddy LRS leading to crossing at Helen FSR km 9.9.

Remedial Prescription

- Recommend that a qualified road engineer inspect the road surfaces.

Site 129 – Helen FSR - High Priority (WQEE Score = 5 m^3)

This crossing is a round metal culvert over an S3 stream with good quality riffle/pool habitat. Logging to the stream banks has occurred upstream of the crossing. Rabnett and Wilson (2007) inferred fish presence at this crossing in 2006 (GWA Site 206). The LRS and RRS were the main sediment contributors. Ditches, cutbanks, and shoulders were well vegetated and do not require any work.

Photo 25: Site 129. Muddy LRS leading to crossing at Helen FSR km 14.8.

Remedial Prescription

- Recommend that a qualified road engineer inspect the LRS (150 meters) and the RRS (120 meters).

Site 11 – Kuldo FSR - High Priority (WQEE Score = 5 m^3)

This crossing is a round metal culvert over an S3 stream with good quality riffle/pool habitat. Rabnett and Wilson (2007) inferred fish presence at this crossing in 2006 (GWA Site 61). The LRS and RRS were the main sediment contributors. Ditches, cutbanks, and shoulders were well vegetated and do not require any work.

Photo 26: Site 11. Long 350-meter run on the RRS leading to stream at Kuldo FSR km 23.

Remedial Prescription

- Recommend that a qualified road engineer inspect the road surfaces.

Site 7 – Kuldo FSR - High Priority (WQEE Score = 5 m^3)

This crossing is a round metal culvert over an S3 stream with good quality riffle/pool habitat. Rabnett and Wilson (2007) inferred fish presence at this crossing in 2006 (GWA Site 20). The LRS and RRS were the main sediment contributors. Ditches, cutbanks, and shoulders were well vegetated and do not require any work.

Photo 27: Site 7. Muddy potholes over stream and muddy RRS leading to stream at Kuldo FSR Km 7.8.

Remedial Prescription

- Recommend that a qualified road engineer inspect the road surfaces.

3.3 Moderate and Low Sediment Risk Sites

Site 20 – Skeena Carrigan FSR – High Priority (WQEE Score = 1.3 m^3)

This crossing is a newly installed culvert over an S3 stream with riffle-pool habitat, at which Rabnett and Wilson (2007) inferred fish presence. Exposed soils within the construction site area contributed to a moderate ranking. A landing was created beside the stream on the left road to pile the rotten wood structure that was removed. The first 50 meters of the LRD(u) has been covered by the landing and runoff now spreads over a wide un-vegetated area before reaching the stream.

Photo 28: Site 20. Exposed soil following recent construction project (bridge removal/culvert installation) at Skeena Carrigan FSR.

Remedial Prescription

- Recommend applying grass-seed and straw mulch over all exposed soil (landing, front fill, back fill, cutbanks, approximately 300 m^2).
- Recommend that a cross-ditch culvert be installed upslope of the landing across the left road or that the LRD(u) is reconstructed through the landing (these two options require an assessment by a road engineer).

The area surrounding the construction site was well vegetated and does not require any work.

Site 49 – Mitten FSR – High Priority (WQEE Score = 0.5 m^3)

This site is the location of the current road closure at 7.3km on the Mitten FSR. People have moved the barrier aside and are currently using the road. Sediment related issues are low at this site, with the right road surface being the only current sediment contributor. The main issues at this site are the bridge itself being a safety concern, and the current state of the habitat in the creek. At the time of survey, the creek was completely dry. Rabnett and Wilson (2007) confirmed fish presence in this creek.

Photo 29: Site 49. Looking empty up the Mitten FSR at the Site 49 crossing.

Photo 30: Site 49. Looking upstream at the bridge at 7.3 km on the Mitten FSR. Note the dry channel.

Photo 31: Site 49. Looking downstream from the bridge at a dry channel.

Remedial Prescription

- Have engineer assess site for bridge replacement.
- Replace bridge.
- Conduct FHAP of this stream to determine if flow has been diverted somewhere upstream, or if the channel is severely aggraded, resulting in sub-surface flow.

3.4 Beaver Related Issues at Crossings

Site 27 – Cancel FSR

A large beaver dam on the downstream side of the road has flooded the road at this site. We could drive through but water levels were quite deep. The dam looks quite old. Rabnett and Wilson (2007) inferred fish presence at this site.

Photo 32: Site 27. Road flooded by beaver dam on Cancel FSR.

Remedial Prescription

- Further fish assessment to determine if this dam is a barrier to adult salmonids and to determine if fry are using this pond.
- Ongoing breaching of dam and beaver trapping to eliminate road flooding.
- Would likely need a machine in to remove debris from the vicinity of the road (engineer assessment required).
- If the road is repaired and a new culvert installed, it is recommended to use a beaver stop.

Site 36 – Bailey FSR

Large beaver dams exist on both sides of the road at this site, however the road is not yet flooded. There is a hole forming in the road, however, which is full of water. The road is currently driveable but not very safe. The culvert is not visible on either side and is likely plugged. Rabnett and Wilson (2007) did not survey this site, however the stream is shown as fish-bearing on maps produced in 2006 by the Gitxsan Watershed Authority (Williams, 2006).

Photo 33: Site 36. Looking downstream from crossing at large beaver dam. Water level is close to road level at this site.

Remedial Prescription

- Further fish assessment to determine if this dam is a barrier to adult salmonids and to determine if fry are using this pond.
- Road repair or deactivation is required soon for this site (engineer assessment required).
- If these dams are blocking migratory salmonids, conduct breaching and trapping to enable fish passage.

Site 38 – Bailey FSR

There are large beaver ponds on both sides of this crossing, which is an old wood box culvert ~4m wide. There appears to be clear passage through this culvert. There are recent trees felled by beavers onto the culvert, which could be the start of the culvert being dammed again. This crossing was not assessed by Rabnett and Wilson (2007) but the stream was mapped as fish-bearing (Williams, 2006).

Photo 34: Site 38. Looking at upstream side of culvert with new beaver felled tree resting on wood box culvert.

Remedial Prescription

- Recommend checking this site periodically throughout the fall to see if culvert becomes blocked with beaver debris.
- Further fish assessment to determine if this dam is a barrier to adult salmonids and to determine if fry are using this pond.

Site 43 – Bailey FSR

A beaver dam constructed just upstream of the culvert inlet would likely block adult fish passage at this site. Beavers are currently active with 3-4 beaver runs observed. The stream at this site has riffle-pool habitat downstream of the crossing with moderate to good rearing potential. Rabnett and Wilson (2007) confirmed fish presence at this site. The area around this crossing was too overgrown to be able to photograph adequately.

Remedial Prescription

- Beaver dam at culvert needs to be breached periodically throughout the spawning seasons to maintain passage for adult salmonids.
- Recommend trapping to reduce beaver activity in area.

Site 46 – Bailey FSR

At Site 46 a round metal culvert passes water that drains from a large beaver pond on the upstream side of the road, into a wetland on the downstream side. Dead standing

trees on the downstream side are evidence that this side has been ponded by beavers in the past as well. The culvert is mostly full of beaver debris. Rabnett and Wilson (2007) inferred fish presence at this crossing.

Photo 35: Site 46. Looking at downstream side of crossing. Note dead standing trees of evidence of past flooding.

Photo 36: Site 46. Looking at downstream end of culvert with beaver debris in it.

Remedial Prescription

- This culvert at this site requires cleaning.
- This site should be checked regularly and kept free of beaver debris.
- Beaver stop is a possible solution for this site.

3.5 Sites Requiring General Maintenance

GFA observed 3 sites that had very low WQEE rankings but which had maintenance issues worth flagging. Note that Rabnett and Wilson (2007) also listed sites which had maintenance issues.

Site 26 – Cancel FSR

There is a log corduroy culvert here that is collapsing, and the road is slumping a small amount. The watercourse at this site is a seepage, so there are no fish passage issues.

Site 32 – Cancel FSR

There is a round metal culvert here that is plugged. The watercourse at this site is a seepage, so there are no fish passage issues.

Site 40 – Bailey FSR

There is an old wood culvert here that has collapsed. Water currently seeps through it. The watercourse at this site is a seepage, so there are no fish passage issues.

4.0 Conclusions and Recommendations

The majority of crossings (51%) surveyed during this project ranked in the very low to low range for sediment risk, an indication that most sites have at least re-vegetated to the point where the erosion risk is predicted to be minimal. Of these, 5 were flagged as requiring beaver dam related work (Sites 27, 36, 38, 43 and 48). Another 3 were flagged as requiring general maintenance (Sites 26, 32, 40) and Site 49, although given a low WQEE score, was recommended for a bridge replacement.

The remaining 49% of crossings were ranked in the moderate, high to very high categories for sediment risk, and prescriptions have been completed for most of these. There were 14 crossings that received moderate WQEE rankings but did not get prescriptions done at this time. These were sites 86, 74, 70, 63, 58, 117, 61, 112, 90, 111, 37, 60, 95 and 89. Based on the moderate WQEE rankings for these sites, there were erodible components in the vicinity of the crossing. However, most of these crossings were either on non-fish-bearing streams or seepages, therefore the priority to restore them was considered lower. If any of these can be grass-seeded and mulched while crews are in the vicinity of these sites, while working on higher priority crossings, it is recommended that they do so.

During this project, GFA focused on visiting a high number of sites to get a better understanding of the scope of the sediment problems in these watersheds, rather than spending more time at each site developing detailed prescriptions. For certain sites, more time will be required to obtain detail on the prescriptions. Most notably perhaps are sites 99, 100 and 101 along the Date Creek road, where a detailed bioengineering prescription is recommended. Budget estimates were provided for all prescriptions to give MoF and FIA a rough estimate of the costs associated with these remedial works.

Regarding further prioritization of remedial work, it is recommended to focus more on the priority ranking in Table 2 than on the WQEE score, as the WQEE scores do not take into account whether a crossing is near a fish-bearing stream or not.

Most recommendations were included in Section 3 under Remedial Prescriptions for each site. However, some further, general recommendations include:

- Early in the spring of 2009, conduct a one-day site tour with a road engineer and a fisheries consultant (and other relevant parties i.e. GFE, MoF, FIA) to do overview assessment of road issues.
- Approximately 164 sites remain to be assessed in the Ironside, Cullon and Lower Kispiox watersheds, not including those along the Kispiox Trail and the Poplar Park Road. Adequate planning and completion of these sites should be done as soon as possible, to determine if there are any high priority sites that need to be addressed in these watersheds. The estimated cost to complete this work is $40,000 (based on $250/site).
- For any road re-surfacing, it is recommended that an engineering firm be hired to assess local gravel pits to see if an adequate mix of gravel, sand and silt exists that will bind properly, to increase the life of the road surface (Pers. comm., Neil Nesting, 2009).
- Conduct adequate project planning to increase efficiency of the remedial work. This includes separating all projects into geographical areas and finishing all/most work in an area before moving to another area. This will reduce travel time and set-up/take-down time, and is especially important when machines are involved (i.e. for road re-surfacing).
- Start collecting willow and other cuttings before leaf out occurs in spring, to have stock ready for summer bioengineering.
- Any non-essential roads should be deactivated to reduce the overall road density and cumulative sedimentation impacts. Consultation with local communities and the Gitxsan Watershed Authority is recommended before any roads are deactivated.
- A general recommendation is that all companies conducting road or cutblock development in the area complete an erosion and sediment control course. This would be a very inexpensive way to create awareness amongst operators of how impacts can be further minimized.
- **Erosion and sediment control is a practice that should occur during and immediately following industrial development, not years or even months later. This would likely reduce overall costs as problems could be dealt with before they become seriously problematic (i.e. seed and mulch a cutbank**

before it slumps into a ditch, which then may require a machine be brought to the site to remove the substrate, which often results in culverts being damaged, etc.).

- Finally, the Gitxsan Watershed Authority, who has local expertise and knowledge of fisheries values within the study area, should be consulted with before any of the following recommendations are implemented.

To conclude, although it is expected that much of the sediment related damage to streams, from industrial forestry development, has already been done in the Kispiox watershed, this project could serve to help mitigate effects from some of the lingering problem crossings, as well as from new forestry developments.

5.0 References

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Appendix A - Photographs

See attached CD titled **GFA Kispiox Road Crossings 2008**.

Appendix B – Kispiox Road Crossings Final Map

See maps titled **Assessment of Road Crossings in the Ironside, Cullon and Lower Kispiox Watersheds – 2008**, which are on the attached CD.

Appendix C – WQEE Database

See Excel spreadsheet titled **2008 Kispiox WQEE Database FINAL GFA**, which is on the attached CD.