Grilse Creek LWD Post Construction Maintenance and Monitoring, 2016

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Prepared for:
Fish and Wildlife Compensation Program

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Executive Summary

In 2014, the British Columbia Conservation Foundation (BCCF) with funding from the Fish and Wildlife Compensation Program (FWCP) re-built 18 Large Woody Debris (LWD) structures in the lowest 4 km reach of Grilse Creek, a headwater tributary of the Salmon River. This project aligns with the FWCP Campbell Salmonid Action Plan under the action to "maintain existing constructed habitat enhancements for all salmonids". The objective of this project was to conduct Routine Effectiveness Evaluations (REE's) on all 18 structures re-built/built in 2014 and to complete all required maintenance. This project will help maintain and evaluate constructed LWD habitats on Grilse Creek used by Coho and Chinook Salmon, steelhead, Cutthroat Trout and Dolly Varden Char. On June 22, 2016, Routine Effectiveness Evaluations (REE's) were conducted on all Large Woody Debris (LWD) sites located in Grilse Creek. The 2016 REE's showed that three of the 18 structures had physical deficiencies and required maintenance. Additionally, another three structures had sediment collection in and around the site which caused drying of the structure in low summer flows (a result of river migration). Overall the REE's showed that the majority of the sites were performing as expected or were exceeding expectations, even though the overall REE scores had decreased from the 2015 survey. Required maintenance was completed in August of 2016 on two of the three structures; the third structure required an excavator which was not in the scope of this project. Future monitoring is needed to optimize each structure's physical and biological performances.

1.0 Introduction

The Salmon River watershed has a long history of human activity and resource development including extensive forest harvesting and water diversion for power generation. As a result, the quantity and quality of fish habitats have declined significantly over the last half century (B.C. Hydro 2000).

Historical logging of riparian old-growth has increased bank erosion, sediment loading, and contributed to the significant widening of stream channels. Spawning beds have shifted, scoured, and channel complexity has decreased, leaving fewer pools and stable large woody debris (LWD) jams which provide optimum rearing conditions for juvenile fish (Murphy 1995).

Salmon and steelhead escapements to the Salmon River are variable but have declined to roughly 25% of historical numbers for many species (BC Hydro 2000; Lill 2002). Because Pacific Salmon are considered keystone species that return energy (i.e. essential fatty acids) and marine-derived nutrients into nutrient-poor, granitic watersheds on Vancouver Island, ecosystem productivity has also declined with spawning escapements. Reduced carcass retention further diminishes nutrient recycling; simplified stream channels lack LWD and pool depth and thus have a weakened ability to retain carcasses (Slaney and Zaldokas 1997).

LWD is an essential part of a healthy riverine ecosystem by providing important habitat for salmonids including physical cover, shade, hydraulic variability and localized scour pools; The BC Conservation Foundation (BCCF) discovered, through an intensive mark-recapture snorkel survey study on Vancouver Island streams, Little Qualicum and Chemainus, evidence that suggests juvenile salmon densities increased three to four times in sites containing LWD when compared to similar habitat with no LWD (J. Damborg, RP. Bio. BCCF Biologist, Pers. Comm.).

According to a diagnostic summary of salmonid habitat conditions, Grilse Creek has a poor rating for pool frequency, percent pool area and percent wood cover in pools (Gaboury and Murray 2003). In part, this poor rating propelled a 2003 restoration project implemented by Mainstream Biological Consulting, which attempted to follow prescriptions developed by LGL Ltd (Gaboury and Murray 2003). Inspection of this project in 2007 revealed a large degree of failure, which resulted in accelerated bank erosion and reduced functionality of the sites. Prescriptions for constructing 14 new sites and repairing 11 previously built structures were developed in 2008 (Silvestri and Gaboury 2008).

The prescriptions outlined in the 2008 report (Silvestri and Gaboury 2008) were found to be out of date. In the spring of 2014 new prescriptions were designed by BCCF staff

along with Marc Gaboury (LGL. Ltd). The new prescriptions were for five new LWD structures and the reconstruction of 15 existing structures built in 2003. The reconstruction proved to be more intensive than expected. Most reconstructions resulted in disassembling and rebuilding with a mixture of new and existing wood material.

During the summer of 2014 BCCF completed the Grilse Creek LWD Rehabilitation Project; 18 LWD structures and two riffle enhancements (equaling approximately 3600 m^2 of habitat) were constructed. An excavator was used instream during low flow conditions to place logs and ballast rock, a three-man crew followed and cabled structures to secure them in place. The expected lifespan of the structures is 15 to 20 years.

In the spring of 2015 an REE was conducted on all 18 sites built in the 2014 Grilse Creek LWD Rehabilitation Project. The REE revealed that one site (3+035) had been altered during the high flows of the previous fall/winter.

1.1 Goals and Objectives

The objective of this project was to:

1. Utilizing standardized REE methods to assess the habitat and biological performances of all 18 LWD sites during the spring of 2016.
2. Conduct all required maintenance on structures as outlined in both the 2015 and 2016 REE's.

2.0 Study Area

Grilse Creek is the third largest tributary of the Salmon River, entering the mainstem 9.5 km upstream of the BC Hydro Diversion. The sub-basin area of 96 km^2 accounts for over 7% of the Salmon River watershed, which is in the Leeward Island Mountains eco-section of central Vancouver Island. The river enters Kelsey Bay and the Johnstone Strait at Sayward, about 65 km north of Campbell River. The study area includes Grilse Creek from its confluence with the Salmon River upstream approximately 4 km.

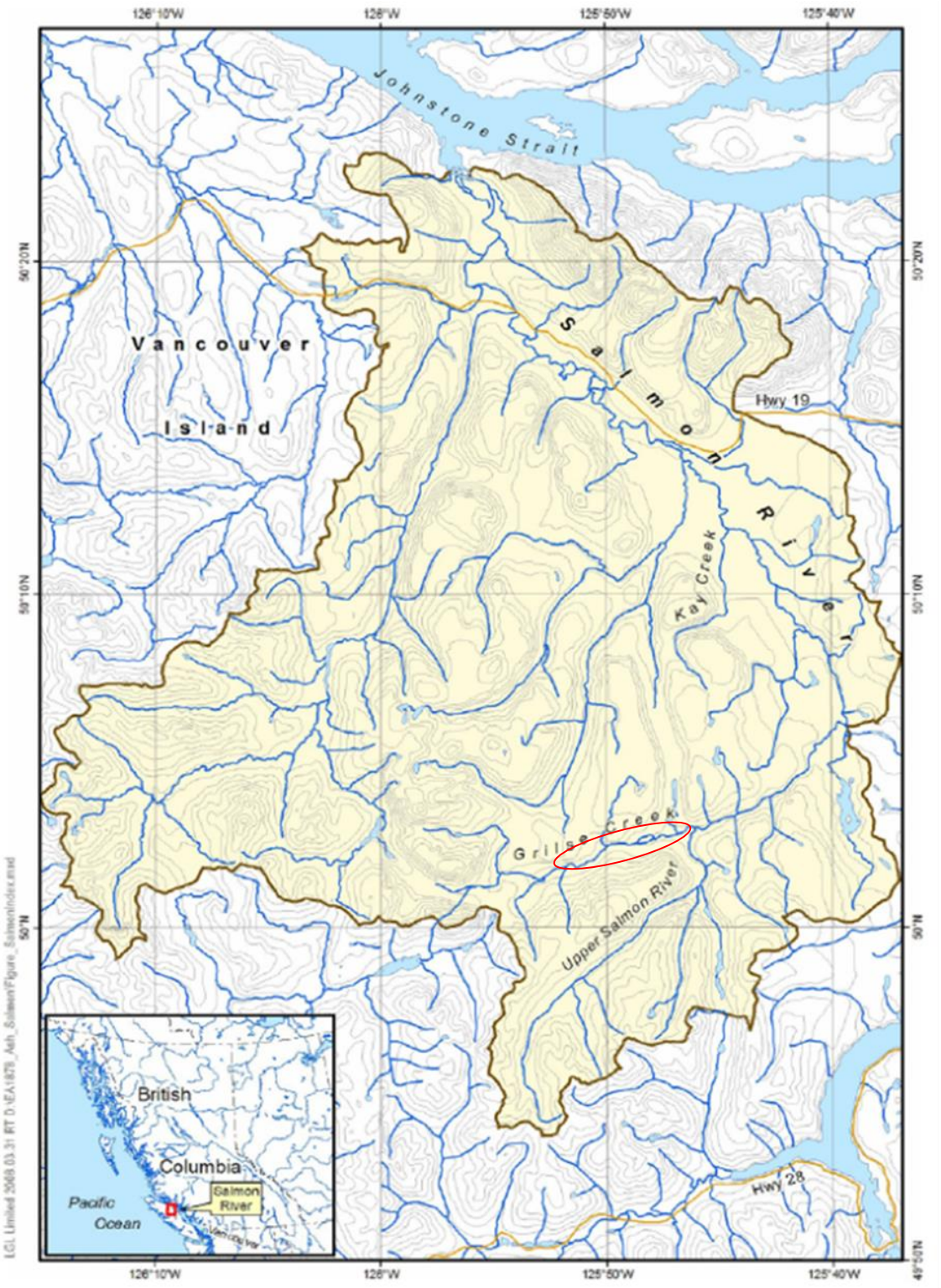

Figure 1. Map of the Salmon River watershed and the Grilse Creek project area, 2016.

3.0 REE Methods

A site-specific evaluation, of the physical, biological and structural performances was used to evaluate LWD, boulder groyne, and boulder riffle enhancement sites. Evaluations were

conducted as per techniques outlined in "Guidelines for In-Stream and Off-channel Routine Effectiveness Evaluations" (Anonymous 2003). REE's allow for the monitoring of a structures overall condition to be monitored over time. Photographs were taken at each construction site, and a selection was included in Appendix 3.

The physical performance category ranked each site on how well it met the design objectives such as creation or maintenance of riffle habitat, protection of stream banks, stream cover, and an overall rating. Biological performance objectives included the quality and quantity of overwintering, rearing, and holding habitats for all fish species and age classes (Table 1).

Table 1: Ranking system for physical and biological performance of artificial fish habitat structures from the *Guidelines for In-Stream and Off-channel Routine Effectiveness Evaluations*.

Rank	Condition
4.00	Site conditions resulting from works are exceeding expectations and objectives.
3.00	Site conditions resulting from works are meeting expectations and objectives.
2.00	Site conditions resulting from works are failing to meet expectations or objectives.
1.00	Site conditions resulting from works fail to meet objectives. Expectations are not met (Usually a complete site failure).

4.0 Results

A total of 18 restoration sites were evaluated on June 22, 2016 (Appendix 4). Of the 18 sites, three were identified as sites that required maintenance. From the evaluations it was determined that most of the sites met expectations, with overall physical and biological performance ratings of 3.01 and 2.92 respectively (Fig.1).
Comparison between the two REE's conducted (winter 2015 and spring 2016) shows that the average physical and biological performance ratings have declined slightly (Fig. 2). This is most likely reflective of two sites becoming dry in the summer due to natural river movement.

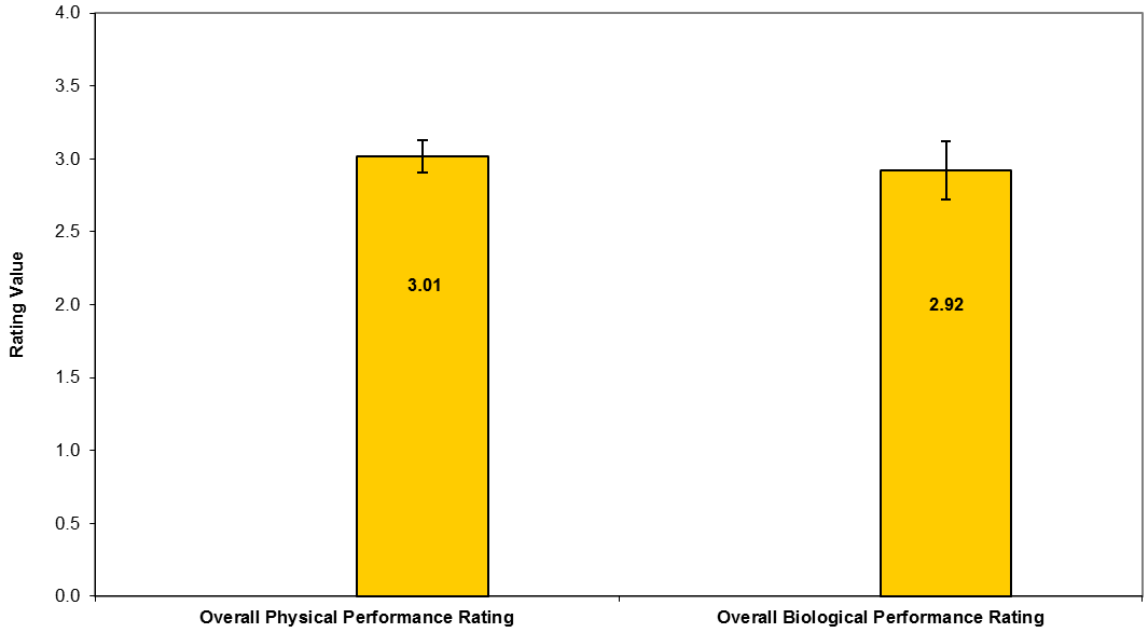

Figure 2. Summary of physical and biological performance rating (with Standard Error) for all 18 LWD structures built on Grilse Creek in 2014 as evaluated June 22, 2016.

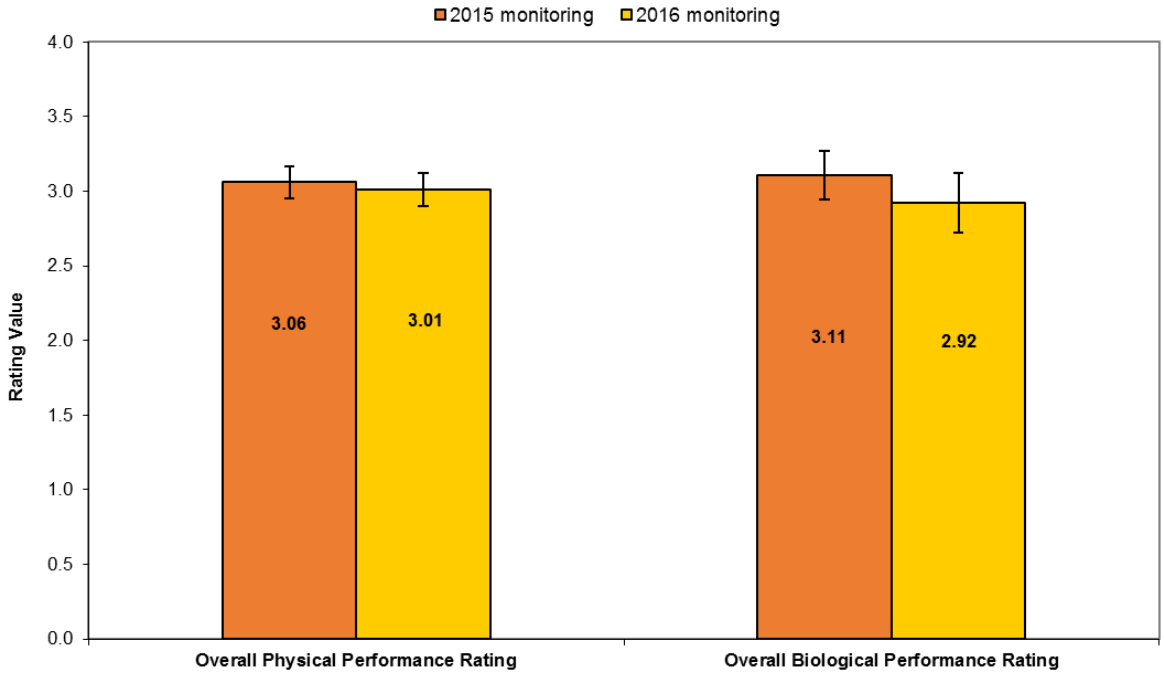

Figure 3. A two year comparison (with Standard Error), from REE's conducted in 2015 and 2016, of all 18 structures built in Grilse Creek in 2014.

5.0 Outcomes

Out of the 18 restoration sites evaluated, 15 sites were functioning as expected with no maintenance required. Overall, when compared to the 2015 REE there were a total of three sites that required maintenance and one required to be re-cabled.

Most sites were preforming as expected (Fig. 1). Due to the fluidness of Grilse Creek some sites had large amounts of gravel collection either above, below or within the site, additionally the river migrated resulting in two sites (3+661, 2+219) being left dry in low summer flows (Appendix 3).

The biological performance of these sites over the last two evaluations has dropped in rating value (Fig. 2). This drop can be correlated to the constant channel migrations of Grilse Creek. Sedimentation has occurred throughout some of the sites negating the depth and back eddies provided by the LWD structures.

Although some structures have seen declines in LWD functionality (due to sediment collection), environmental factors have helped negate this decline. The natural addition of LWD and Small Woody Debris (SWD) has increased complexity of structures, in effect providing natural rearing benefits. Coinciding with these additions, the continual increase in residual pool depth beneath most structures aids in their overall performances.

The continual monitoring of previously installed restoration works should remain a high priority for the Fish and Wildlife Compensation Program. Restorative habitats have proven to be beneficial in increasing wild steelhead smolt production (Lill 2002). Even though structures have/will decline in effectiveness over time, the monitoring and future enhancement/maintenance of these structures should remain a priority.

Monitoring of restoration/enhancement work is critically important to improving future restoration works. Without sufficient monitoring, a potential exists to repeat techniques that result in failure to meet the designed physical and/or biological objective(s) of restoration projects. Results of routine effectiveness monitoring are thus an invaluable resource for project managers implementing future rehabilitation works.

6.0 Acknowledgements

Extended thanks goes out to Jeramy Damborg, Mike Friesen and Kevin Pellet of the BCCf for helping to facilitate this project through all of its stages. This project would not have been possible without funding provided exclusively by the Fish and Wildlife Compensation Program (FWCP).

7.0 References

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Appendix 1:

Map of Grilse Creek, 2016


10/4/2016
2010
2016
Salmon River Rd
First Lake
3+582
3+661
3+455
3+439
3+300
3+162
3+102
3+035
2+850
2+800
2+520
2+219
2+190
2+120
2+089
1+960
1+936
1+876
1+187
S Fork Rd
Image © 2016 DigitalGlobe
© 2016 Google
© 2016 Cnes/Spot Image
425 m
2013
Google Earth
Imagery Date: 7/27/2013 10 U 299859.93 m E 5547224.28 m N elev 343 m eye alt 2.40 km

Appendix 2:

Restoration sites that required maintenance, Grilse Creek, 2016

Site #	Site Description	Maintenance Required
3+455	LTR-4	Armor Bank With Rock (Not Applicable Without Excavator)
3+035	LT-2, DJ5	Lower Structure Needs Float-ins cabled, Upper Structure Needs Re-Cabling Due to Movement
2+089	DJ-5X2	Add Staples to Loosened Cable

Appendix 3:

Photo Documentation

Photo 1. Site 3+102, Winter 2015.

Photo 2. Site 3+102 with some captured small woody debris, Summer 2016.

Photo 3. Site 1+187, Winter 2015.

Photo 4. Site 1+187 Gravel Collection, Summer 2016

Photo 5.Site 3+661 Winter 2015 flows prior to river movement.

Photo 6. Site 3+661 Summer 2016, natural movement of riverbed above site.

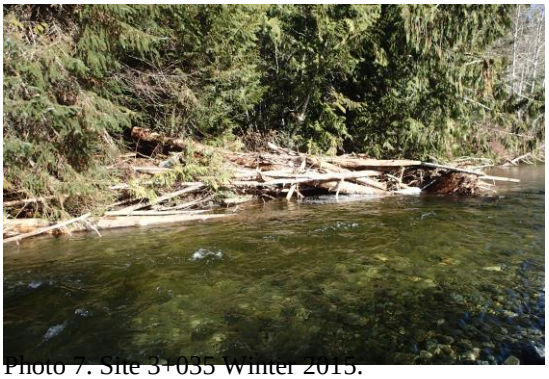

Photo 7. Site 3+035 Winter 2015.

Photo 8.Site 3+035 Winter 2015

Photo 1. Site 3+035, Summer 2016.

Photo 2. Site 3+035, Summer 2016.

Photo 3. Site 3+035, During structure maintenance, August, 2016.

Photo 4. Site 3+035, during structure maintenance, August, 2016.

Photo 5. Site 3+035, during structure maintenance, August, 2016.

Photo 6. Site 3+035, during structure maintenance, August, 2016.

Photo 7. Site 3+035 after structure maintenance, August, 2016.

Photo 8. Site 3+035 after structure maintenance, August, 2016.

Appendix 4:

Routine Effectiveness Evaluations Data Sheet

Watershed Salmon River
Sub-watershed Grilse Creek
Date June 22, 2016

Survey Crew JD and JA
Weather / Flow Sunny, ~7CMS

REE Interval Year 2

				Performance Objectives															Overall						Comments
				Physical							Biological														
Construction Year	Site ID #	Structure Type	Site Objective	Pool	Riffle	Gravel Bar	Streambank	Stream Cover	Nutrient	Overall rating	Species	Life Stage	Overwinter	Rearing	Holding	Spawning	Incubation	Overall rating	Structural Condition	Structural Stability	High Flow Function	Low Flow Function	Maintenance Recommendation	Photo Numbers	
2014	3+661	LT-3 (with upstream rock Groyne)	Protect Bank	2.00	-	-	4.00	-	-	3.00	RB CO	ALL	2.00	1.00	1.00	-	-	1.33	3.00	3.00	3.00	3.00	No		Pool looks good some erosion at upper groyne
	3+582	LT-8	Pool	2.00	-	-	3.00	3.00	-	2.67	RB CO	ALL	3.00	3.00	3.00	-	-	3.00	4.00	4.00	4.00	3.00	No		Change in Flow dynamics, Good SWD float in's
	3+455	LTR-4	Pool	4.00	-	-	2.00	4.00	-	3.33	RB CO	ALL	3.00	3.00	3.00	-	-	3.00	3.00	3.00	3.00	3.00	No		30 BDH float in, scour behind
	3+439	DJ-7	Pool	4.00	-	-	3.00	3.00	-	3.33	RB CO	ALL	3.00	3.00	3.00	-	-	3.00	3.00	3.00	3.00	3.00	No		Great Pool, stability looks solid
	3+300	DJ-5	Riffle Habitat	3.00	3.00	-	3.00	3.00	-	3.00	ST CO	ALL	3.00	3.00	3.00	-	-	3.00	4.00	4.00	3.00	3.00	No		Good Scour, Solid, High Velocity
	3+162	LTR-4	Stabilize large natural Cedar	3.00	-	-	3.00	3.00	-	3.00	RB CO	ALL	3.00	3.00	3.00	-	-	3.00	3.00	3.00	3.50	3.00	No		Lots of SWD float in's
	3+102	DJ-7	Pool 1.5m	3.00	-	-	3.00	3.00	-	3.00	RB CO	ALL	3.00	3.00	3.00	-	-	3.00	3.00	3.00	3.00	3.00	No		Ptoential Erosion concern, SWD in (inside)
	3+035	LT-2, DJ5	Enhance existing structure, add pool compexity	2.00	-	-	2.50	3.50	-	2.67	RB CO	ALL	3.00	3.00	3.00	-	-	3.00	2.00	2.00	2.50	3.00	No		Upper part broken cable, Upper cross LWD failed, snapped cable. Lower cross logs look excellent, some movement, both tight and loose cables. Lots of LWD and SWD. Deep Pool, Bank looks good.
	2+850	IMB-5	Add pool complexity	3.00	-	-	3.00	2.50	-	2.83	RB CO	ALL	3.00	3.00	3.00	-	-	3.00	3.00	3.00	3.00	3.00	No		Couple of LWD float in's, Solid Structure. Good holding CO fry
	2+800	DJ-5	Armour	-	-	-	3.00	-	-	3.00	RB CO	ALL	-	-	-	-	-		3.00	3.00	3.00	3.00	No		Armour holding
	2+520	IMB-4	reinforce existing structure, add pool complexity	4.00	-	-	3.00	3.00	-	3.33	RB CO	ALL	3.00	3.00	3.00	-	-	3.00	3.00	3.00	3.00	3.00	No		50 cm DBH float in, SWD float in's
	2+219	Tree Cabled to Root Anchor	Tree to Root Thalweg Change	2.00	-	-	3.00	3.00	-	2.67	RB CO	ALL	3.00	3.00	3.00	-	-	3.00	3.00	3.00	3.00	3.00	No		Simple site as expected
	2+190	Natural Collection	Cabled front 2 float-in's, secure natural collecton	3.00	-	-	3.00	3.00	-	3.00	RB CO	ALL	3.00	3.00	3.00	-	-	3.00	3.00	3.00	4.00	3.00	No		Log jam forming
	2+120	DJ-5	Add pool complexity	3.00	-	-	3.00	3.00	-	3.00	RB CO	ALL	3.00	3.00	3.00	-	-	3.00	3.00	3.00	3.00	3.00	No		Pool wider, deeper (~1.5 m), erosion threat
	2+089	DJ-5 x2	Add pool complexity	4.00	-	-	3.00	3.00		3.33	RB CO	ALL	3.00	3.00	3.00	-	-	3.00	3.00	3.00	3.00	4.00	No		Impressive Pool 2 m, solid
	1+960	1 Cedar Float in									RB CO	ALL													Large float in cedar still there, new channel forming behind cedar through the forest.
	1+936	LTR-7	Stabilize bank, increase pool depth	4.00	-	-	3.00	3.00	-	3.33	RB CO	ALL	3.00	3.00	4.00	-	-	3.33	3.00	3.00	3.00	3.00	No		Pool great, deeper and larger, Fines collecting inside site,
	1+876	DJ-5	Secure existing structure, reduce structure porosity.	3.00	-	2.00	3.00	3.00		2.75	RB CO	ALL	3.00	3.00	3.00	-	-	3.00	3.00	3.00	3.00	3.00	No		Upstream infilling with gravel, pool downstream looks good
	1+187	DJ-7	reconfigure existing structure, create run habitat.	3.00	-	-	3.00	3.00	-	3.00	RB CO	ALL	3.00	3.00	3.00	-	-	3.00	3.00	3.00	3.00	3.00	No		Sediment Collecting Downstream, Armour holding. As-built has not changed.

Notes 1. Bolded numbers denote the objective of the restoration site.