Grandon Creek Stream Survey – 2015

On behalf of

The Regional District of Nanaimo

Drinking Water & Watershed Protection

August 2015

Written By D.R. Clough Consulting

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Introduction

The Regional District of Nanaimo Drinking Water & Watershed Protection program led by Julie Pisani had requested a community workshop and training session. The objective was to survey the habitat and physical characteristics of Grandon Creek with the local stewardship group in the hopes of the participants gaining understanding of the health of their watershed, and become trained in data collection methods. This data is intended to serve as a reference to help inform the interpretation of water quality data collected by the Qualicum Beach Streamkeepers as part of the RDN Community Watershed Monitoring Network. This culminates as an effort to monitor the state of the watershed and possibly guide restoration, remedial actions, and/or further monitoring activities.

Methods

The Urban Salmon Habitat Program (USHP) survey[1] was utilized. This method of survey had been initiated in 1997 by the Ministry of Environment. The methodology has been adopted and used by the majority of stewardship groups on Vancouver Island and the lower mainland.

The data collection objective was to measure ten habitat units (pools or rifles) within each reach segment. Reach 2, 3 and 4 were surveyed on June 11 and 12, 2015.

The method collects up to 40 data points on each habitat unit. The data points are then entered into an excel program and the macro function compares the results of key habitat functions with BC standards.

The participants in the survey were; Gordon Almond, Don Lister, James Milne, Julie Pisani and Lauren Fegan. The survey was instructed by David Clough RPBio.

Survey Area

Grandon Creek is in a developed watershed where it has farmland in the headwaters and residential housing and road/rail networks in the lower reaches. The stream is approximately 6.1 km long to where its catchment is a series of farm ditches.

Reach 1: Not surveyed, it is approximately 160 m long from the beach front to the entrance of the fishway at West Crescent. This reach has salmon and trout access between residences.

Salmon Fishway: Installed by the Town of Qualicum Beach and the QB Streamkeepers in 1999. It is an approximately 80m long enclosed concrete caisson fishway. It was built to recover Salmon and Trout access to Reach 2. Before the fishway, the upper reaches were blocked by an impassable culvert under West Crescent for over 60 years.

[1] Michalski, T.A., G.E. Reid, G.E. Stewart, 1997. Urban Salmon Habitat Program ,Assessment And Mapping Procedures for Vancouver Island. Ministry of Environment, Lands and Parks, Fisheries Section. Nanaimo B.C.

Reach 2: Surveyed in 2015. It is in Grandon Creek Park owned by the Town. The reach is approximately 600m long. It has been the subject of past habitat restoration projects by the Town and Streamkeepers.

Reach 3: Surveyed in 2015. This reach begins above the culvert located at the E&N Railway and Hoy Lake Rd. There are two connected culverts that are a barrier to salmon due to length (over 30m), change indirection leaving no visible exit and midpoint change in elevation (a step at the flange connection between two different pipe sizes). This reach rises up through a confined valley through parcels owned by the Town of Qualicum ending at Rupert Road. Reach 3 is approximately 1.9 km long.

Reach 4: Surveyed in 2015. This reach starts at Rupert Road culvert and goes upstream along side a treed area and farms to Parker Road. This reach is approximately 900m long.

Reach 5 was not surveyed in 2015. It appears entirely ditched. It is adjacent farmland and has limited riparian vegetation. It does have observed populations of resident trout primarily in mid and lower reaches. The reach ends at the Highway 19 crossing. Above Highway 19 it is entirely lost as a creek with no fish habitat in heavily modified ditch catchment along the roads and farms. The upper limit of the watershed is approximately at the Alberni branch of the E&N Rail.

Figure 1: Survey Area – Grandon Creek

Results and Discussion – Grandon Creek Habitat Survey

The habitat was summarized for each Reach 2, 3 and 4 in Appendix 1, 2 and 3 respectively. These appendices show the raw data as well as the sums and averages of all the detailed parameters. In the reach summaries below, only the 12 most important habitat parameters are summarized, rated and scored. Scoring is based on the USHP rating system where a Good result is scored as a 1, a Fair result scored as a 3 and a Poor result scored as a 5. The lower the score, the better the habitat.

Reach 2:

This reach, located in the Town Park is in a treed valley setting surrounded by steep sidewalls. There are residential houses and roads at the top of bank. There are storm water drainage pipes and channels entering on both banks. There is a community trail along the entire right bank. The trail is offset from the stream channel by 5 to 15 m. The survey began at the first pool above the fishway and we measured six pools and six riffles over 145m. The average channel width was 6.0m,the wetted width was 2.6m on a 1.9% average channel gradient. The water flow was estimated at 25 lpm and the water temperature measured at 10 am was 13C and at 1 pm was 15 C. The air temperature outside the Park was 22C for the day. The results are shown in Table 1 below;

Table 1; Reach 2 Habitat Results

Habitat Parameter	Grandon R2	Ratings
% Pool Area	22.8	5
Large Woody Debris/Bankfull Channel Width	1.7	3
% Cover in Pools	8.4	3
Average% Boulder Cover	3.8	5
Average % Fines	25.0	5
Average % Gravel	44.2	not rated
% of Reach Eroded	11.1	5
Obstructions	0.0	0
% of Reach Altered	9.0	3
% Wetted Area	43.1	5
Dissolved Oxygen	9.4	1
pH	7.0	1
Totals		**36**

The survey was conducted in low flow during a record dry and warm year resulting in limited pool and wetted area. The best reach 2 habitat scores were for Water Quality parameters of Oxygen and pH. The poorest results were Pool Area, Boulder Cover, Fine Sediments, and Wetted Area. The lack of Boulder Cover is a deficiency, related to the fine sediments burying the rocks from the numerous erosion sites.

Most recently in winter of 2014/15 a storm water channel from the upland residential area on the left bank resulted in a landslide into the creek. It filled the downstream pools with sediment. The slide filled

in one pool that was 1.6m deep as well as many smaller pools. The large pool (and fishway) was cleaned of sediment with excavators and suction truck in July 2015 by the Qualicum Beach Streamkeepers and Town. Soon after the slide, the faulty storm water circuit was re-directed by the Town towards a more stable channel.

While surveying this reach we saw juvenile Trout and Coho in every pool. The fishway appears to be effective in annually passing the anadromous migration. This reach has had considerable restoration through pool construction, LWD placement, spawning gravel and riparian planting by the Qualicum Beach Streamkeepers and the Town. The reach would have been much worse without the past recovery efforts. The placed LWD was observed to have scoured some if the recent slide sediment out of the pools. The spawning gravels placed in the stream in 2013 and 2014 are buried in sands except for small patches near the LWD. In concert with the direct removal of the sediment in 2015, the structures appear to be taking care of the remaining material over time. A few more slide free winters may clean up the stream bed.

The Riparian features of Reach 2 are shown in Table 2 below taken from the USHP summary tables.

Table 2; Reach 2 Riparian Results

Reach	Grandon R2	Ratings
Land Use	23	1
Riparian Slope	48	2
Bank Stability	74	3
% Crown Cover	88	1
% of Reach Accessed	17	3
Average Vegetation Depth	28.5	1
Totals		**17**

The riparian features of the reach are good. Although it was entirely logged, It has regenerated with a closed canopy of mixed species of Conifer (mostly Douglas Fir, Red Cedar, Hemlock) and deciduous (mostly aging Red Alder and some Maple). The riparian values are all Good or Fair in Reach 2. The Vegetation Depth of almost 30m from each bank is the most important value as this width provides the room for the plants to function as a riparian area.

Reach 3:

Reach 3 starts above the E&N Railway/Hoy Lake Rd culverts that are the salmon barrier, and after 1.9 km ends at Rupert Road. This reach has resident Cutthroat Trout throughout, with many observed during the survey. The survey site in Reach 3 was in the upper section where it is flatter and wider than the confined lower area. We walked in off Rupert Road downstream to a trail crossing on an old logging bridge. We noticed the discharge was approximately half of the lower Reach 2 but was still offering connected flow between pools. The water temperature was a cool 12C during a warm 22C day in the open. The channel width average was 3.6m with a wetted width average of 2.0 m on a 1.4% gradient. The reach 3 fish habitat results are shown in Table 3 below;

Table 3; Reach 3 Habitat Results

Habitat Parameter	Grandon R3	Ratings
% Pool Area	57.2	1
Large Woody Debris/Bankfull Channel Width	0.4	5
% Cover in Pools	8.0	3
Average% Boulder Cover	0.7	5
Average % Fines	38.0	5
Average % Gravel	35.0	not rated
% of Reach Eroded	13.0	5
Obstructions	0.0	0
% of Reach Altered	3.9	1
% Wetted Area	56.0	5
Dissolved Oxygen	6.5	3
pH	6.7	1
Totals		**34**

The top USHP habitat parameters of Reach 3 indicate the Good scores were in % Pool Area, % Altered and pH. The Poor ratings for were LWD, Boulder Cover, Fines, Erosion and Wetted Area. This is similar to Reach 2 below with the a few more concerns. This reach felt younger, more recently disturbed by logging although it was showing recovery. There are numerous recently established trails along and across the channel which are a concern with regards to the loss of adjacent shrubbery as well as erosion. The oxygen levels are a concern, 6.5 ppm is fine in June but the water could heat up in midsummer and drop to anoxic levels in the upper areas of the reach more exposed.

The restoration options in this reach are plenty; address the salmon barrier at Hoy lake Rd, add LWD to make pools deeper and more protected, address erosion by moving/deactivating/upgrading the trails, drainage ditches, culverts and bridges in this reach.

The riparian area of reach 3 was logged at least twice; there are springboard notches on the cedar stumps from pioneer loggers as well as roads, bridges and ditch lines from more recent mechanized logging. The trees are regenerating second growth similar to Reach 2 but younger; Conifer and Deciduous trees with Red Alder as the dominant species. The logging roads and skidway scars are still evident in many areas. The site shows no evidence the loggers deactivated the roads or re-planted trees. The riparian condition is summarized below in Table 4.

Table 4; Reach 3 Riparian Results

Reach	Grandon R3	Ratings
Land Use	20	1
Riparian Slope	10	1
Bank Stability	61	3
% Crown Cover	88	1
% of Reach Accessed	13	3
Average Vegetation Depth	30	1
Totals		**10**

Reach 3 riparian results were Good or Fair. The closed Crown Cover and 30m plus Vegetation Depth are the highlights of this reach. The stream flow was at a trickle but water quality remained fish sustainable due to the shade. The riparian area is on flat or gently sloping ground with no slide issues but many banks slumping due to lack of old growth streamside root protection. The channel has head cut down below its historic grade by 0.3 to 1.0m due to post land clearing flushes. The deeper sidewalls on the channels also contribute to the bank erosion.

The current pressures on this forest are people. The human trails and erosion from multiple access points is degrading the habitat scores. It appears the reach is a victim of its beauty and is in need of help to control people usage.

Given the human impacts, the Reach 3 riparian recovery options recommended are to; manage people access by blocking or improving off sensitive creek access. The forest needs a riparian planting prescription as it is deficient in understory conifers. The old bridges need to be removed and upgraded. The ditch lines and roads need to be assessed for erosion and re-direction of runoff. There may be opportunities to re-establish seasonal wetlands that were drained with the ditches.

Reach 4:

This is the last reach with an adjacent forest canopy. It goes from Rupert Road to Parker Road, approximately 900km. The survey area was from Rupert Road upstream 8 habitat units taking up 79m of length. Resident Cutthroat were observed in this reach as well. The Bankfull Channel Width average was 4.0 m with a Wetted Width of 1.9 m flowing on a 0.5% gradient. There was a trickle flow at this location and unlikely fry are able to migrate through the shallow ingrown riffles in Reach 4. The Habitat Results for Reach 4 are shown in Table 5 below;

Table 5; Reach 4 Habitat Results

Habitat Parameter	Grandon R4	Ratings
% Pool Area	77.4	1
Large Woody Debris/Bankfull Channel Width	0.3	5
% Cover in Pools	21.8	1
Average% Boulder Cover	0.0	5
Average % Fines	61.5	5
Average % Gravel	35.6	not rated
% of Reach Eroded	13.3	5
Obstructions	2.0	2
% of Reach Altered	0.0	1
% Wetted Area	47.0	5
Dissolved Oxygen	6.5	3
pH	6.7	1
Totals		**34**

Reach 4 habitat results are rated Good in; Pool Area, Cover, Altered and pH. The Poor ratings are in LWD, Boulders, Fines, Erosion, and Wetted Area. The channel may have been historically ditched in this reach as it appears to be straightened and there are some old spoil piles in the forest floor. The reach appears to be holding in this state with no recent improvements or degradations. But in its current state it lacks adequate pool depth to support a summer fish population. Living conditions in the channel could be improved by dredging the sediment out of the first pool upstream of Rupert Road as it has good access. This reach is most beneficial as a fish winter feeding and spawning reach, but offers very little summer rearing. There are opportunities to add cover logs along the pool edges where emergent shrubbery is not evident.

Reach 4 Riparian characteristics are shown in Table 6 below;

Table 6; Reach 4 Riparian Results

Reach	Grandon R4	Ratings
Land Use	28	2
Riparian Slope	8	1
Bank Stability	46	3
% Crown Cover	89	1
% of Reach Accessed	0	0
Average Vegetation Depth	24	1
Totals		**7**

The riparian characteristics of Reach 4 were overall Good. There is an older second growth conifer forest on the river right bank that also covers most of the left bank as well. The forest lacks wood debris on the floor or in the creek. There are several large old growth Red Cedar stumps that provide some bank protection along this reach. There is a farm pasture along the outside of the left bank but there was no encroachment into the creek.

Table 7: Summary and Recommendations for Water Quality Improvement

Grandon Creek Reach 2

Water Quality Impact	Recommended Remedial Action	Comments
Stormwater input.	Monitor stormwater quantity and quality.	A data logger is recommended on this reach to record temperature.
Erosion control.	Review outfall of stormwater input pipes to the creek for better placement to minimize bank erosion.	Streamkeepers have been working with the Town staff on storm water erosion impacts on the sidewalls of Beach Creek since 1997. They have added pipes to cover soft banks or planted willow and native plants for stability.

Grandon Creek Reach 3

Water Quality Impact	Recommended Remedial Action	Comments
Erosion from multiple access points.	Manage people access by blocking or improving of sensitive creek access.	Too many trails, too close and poorly constructed.
Ditch and road run-off input.	The ditch lines and roads need to be assessed for erosion and re-direction of runoff. There may be opportunities to re-establish seasonal wetlands that were drained with the ditches.	Old logging impacts were never repaired, there's a bridge ready to fall in.

Grandon Creek Reach 5

Water Quality Impact	Recommended Remedial Action	Comments
There are historic impacts from the upland farm area that was deforested, ditched, and turned into pasture / agricultural production. However these areas are seeing improvement from current land owners' restoration efforts.	Hilliers Estate farm added over 1.0 km of tree planting as well as dredged sediment, added spawning gravel, upgraded fish passage with large fish friendly culverts, all in the last 5 years	It is hoped this will influence the other farms to take similar restorative actions such as creating small riparian areas along the creek to establish bank stability and shade with native shrubs or trees. It would be good to promote the Environmental Farm Plan program grants to these land owners.

Conclusions

The instream Fish Habitat, Riparian Habitat and Water Quality of Grandon Creek were in quite different states. The Riparian area is the best and most healthy feature of Grandon Creek. There are adequate setbacks and forest type protecting the banks of this stream. The forest is not in perfect shape and some simple actions such as planting, trail management and coarse woody debris development will help it.

The water quality in the stream degrades as you go further upstream and closer to the ditched farm areas. The closed canopy of the three surveyed reaches makes all the difference in Temperature and Oxygen in summer. It is a testament to the resident trout tenacity that they were not completely eradicated when logging and farming historically cleared the watershed. These upper reaches also supported Coho and migratory Trout before the culverts blocked migration.

The instream fish habitat is taking longer to recover from post logging/development, but for the most part, it is recovering. There are setbacks, primarily with storm water inputs creating erosion and sedimentation. The long term recovery of the habitat has been helped by the efforts of the Town Of Qualicum, The Qualicum Streamkeepers since 1997. More recently, since 2011, the Regional District of Nanaimo through its Drinking Water and Watershed Protection Program has been helping Streamkeepers monitor water quality (via the Community Watershed Monitoring Network). The program is very important as it adds a missing component; monitoring and evaluation. While this Habitat Survey identifies the physical characteristics that may impact water quality and points to restoration potential, the water quality data collected with the CWMN can help evaluate if remedial actions recommended in this report are indeed working to improve water quality upon implementation. The information in this survey, coupled with the ongoing water quality monitoring, can be used for future comparisons and restoration planning.

Grandon Creek has had many alterations and changes to its watershed since developments took place. Currently it is in a state of recovery, this is because the riparian area has been set aside for protection along the town area. The upland areas are also seeing improvement as some of the large farm land owners have taken it upon themselves to replant and restore fish habitat on their property. There is much to hope for on this stream.

Yours Truly

David R. Clough RPBio

Figure 1: Reach 2

Figure 2: Reach 3

Figure 3: Reach 4

Appendix 1 – Reach 2 Habitat Data

Stream Name	Grandon	Watershed Code	920-479000	Date	June 11, 2015	Reach Name	Grandon R2			Discharge Depth #1	0.05	Velocity			
Water Quality Information					Field Crew		RDN/QBSK					T1	3.00	Site Length	
Dissolved Oxygen	9.40	pH	7.00	Total Dissolved Solids	0.00	Temp C	14.70	Chainage at Beginning of Reach	0.00	Discharge Depth #2	0.05	T2	3.00		1.00
Velocity (m/s)	0.33	Average Depth (at flow site)	0.05	Wetted Width (at flow site)	2.00	Discharge (m3/s)	0.03	Chainage at End of Reach	144.70	Discharge Depth #3	0.05	T3	3.00		
Habitat Information (All Pool and Cross Section Data)															

Habitat Type	Start (chainage at start)	Finish (chainage at end)	Unit Length	Wetted Width	Pool Area	Wetted Reach Area	%Pool Area	Habitat unit Depth (m)	Percent Gradient	Bankfull Width(m)	Average Percent Wetted Area	Substrate Percent					Percent Instream Cover					PercentCrown Cover	Large Woody Debris	LWD/bank-full channel width	Erosion Sites (length)	Altered Stream Sites (length)	Obstructions (number)	Off-Channel Habitat (length)	Off-Channel Habitat (width)	Off-Channel Habitat (bank side)	Land Use		Vegetation Type		Riparian Slope		Stability		Vegetation Depth		Livestock Access		Photos	Comments
												Bed	Bld	Cob	Grv	Fine	Bold	LWD	Cutbk	Veg	Other										Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left		
Pool	0.00	5.90	5.90	2.90	17.11	17.11		0.30	0.00	6.10		0	15	5	50	30	30	0	0	0	0	90.00	1		0	3	0	0	0	L	Nat	Nat	Mix	Mix	50	70	Med	Med	20	25	0	0	10:08:00	2
Riffle	5.90	11.90		1.20	0.00	7.20		0.07	3.50	4.70		0	0	20	40	40	0	5	0	0	0	90.00	3		0	6	0	0	0	R	Nat	Nat	Mix	Mix	45	70	High	High	25	30	0	0	11:23:00	GPS-51, #3
Pool	11.90	15.10	3.20	3.20	10.24	10.24		0.23	0.00	5.10		0	10	20	30	40	0	5	0	0	0	90.00	4		0	4	0	0	0	R	Nat	Nat	Mix	Mix	45	70	High	High	25	30	5	0	11:35:00	GPS-52, #4
Riffle	15.10	40.00		2.20	0.00	54.78		0.05	4.00	5.40		0	5	25	65	5	0	3	0	0	0	90.00	2		0	0	0	0	0	R	Nat	Nat	Mix	Mix	45	70	Med	Med	30	30	5	0	11:55:00	GPS-53, #5
Pool	40.00	41.90	1.90	4.10	7.79	7.79		0.21	0.00	6.30		0	10	15	30	45	2	3	0	0	0	90.00	1		0	0	0	0	0	R	Nat	Nat	Mix	Mix	45	65	Med	Low	30	30	0	0	13:00:00	GPS-54,
Pool	41.90	48.40	6.50	4.50	29.25	29.25		0.33	0.00	6.70		0	10	15	30	45	0	20	0	0	0	90.00	7		0	0	0	0	0	R	Nat	Nat	Mix	Mix	45	70	Med	Med	30	30	0	0	13:16:00	GPS-55.#9
Riffle	48.90	54.10		2.10	0.00	10.92		0.07	4.00	5.30		0	15	35	40	10	2	0	0	0	0	90.00	1		0	0	0	0	0	R	Nat	Nat	Mix	Mix	45	70	Med	Med	30	30	0	0	13:30:00	GPS56,
Pool	54.10	61.50	7.40	2.40	17.76	17.76		0.20	0.00	5.50		0	20	35	30	15	5	2	0	0	0	90.00	5		0	0	0	0	0	R	Nat	Nat	Mix	Mix	45	70	Med	Med	30	30	0	0	13:35:00	GPS 57
Riffle	61.50	112.20		3.30	0.00	167.31		0.05	5.00	5.70		0	10	40	40	10	3	3	0	0	0	80.00	10		2	0	0	0	0	R	Nat	Nat	Mix	Mix	55	70	Med	Med	30	30	0	0	13:37:00	GPS 58,#8
Riffle	112.20	125.70		1.25	0.00	16.88		0.05	3.50	9.70		0	5	15	50	30	2	0	0	0	0	80.00	3		12	0	0	0	0	0	Nat	Nat	Mix	Mix	65	60	Low	Low	30	30	0	0	14:01:00	GPS-59.#9
Riffle	125.70	143.40		1.70	0.00	30.09		0.06	3.00	6.10		0	5	15	65	15	2	0	0	0	0	90.00	3		2	0	0	0	0	L	Nat	Nat	Mix	Mix	70	60	Low	Low	25	30	0	0	14:28:00	#10
Pool	143.40	144.70	1.30	2.20	2.86	2.86		0.25	0.00	5.50		0	5	20	60	15	0	15	0	0	0	85.00	2		0	0	0	0	0	L	0	Nat	Mix	Mix	70	60	Med	Med	25	30	0	0	14:32:00	DAY
Reach Totals and Averages		144.70	26.20	2.59	85.01	372.19	22.84	0.16	1.92	6.01	43.07	0	9	22	44	25	4	5	0	0	0	87.92	42	1.74	11	9	0	0			11	12			42	54	36	38	27.50	29.58	7	0		

Appendix 2 - Reach 3 Habitat Data

Stream Name	Grandon Creek	Watershed Code	920-427000	Date	12-Jun-15	Reach Name	Grandon R3			Discharge Depth #1		Velocity		
Water Quality Information					Field Crew	RDN/QBSK						T1		Site Length
Dissolved Oxygen	6.50	pH	6.70	Total Dissolved Solids	125.00	Temp C	15.00	Chainage at Beginning of Reach	0.00	Discharge Depth #2		T2		
Velocity (m/s)	.	Average Depth (at flow site)		Wetted Width (at flow site)		Discharge (m3/s)		Chainage at End of Reach	76.90	Discharge Depth #3		T3		

Habitat Information (All Pool and Cross Section Data)

Habitat Type	Start (chainage at start)	Finish (chainage at end)	Unit Length	Wetted Width	Pool Area	Wetted Reach Area	%Pool Area	Habitat unit Depth (m)	Percent Gradient	Bankfull Width(m)	Average Percent Wetted Area
Pool	0.00	10.20	10.20	2.80	28.56	28.56		0.15	0.00	3.00	
Riffle	10.20	21.80	11.60	1.90		22.04		0.10	3.00	3.50	
Pool	21.80	25.40	3.60	1.30	4.68	4.68		0.21	0.00	5.60	
Riffle	25.40	31.20	5.80	1.20		6.96		0.05	1.00	2.80	
Pool	31.20	35.60	4.40	3.00	13.20	13.20		0.20	0.00	4.10	
Riffle	35.60	41.70	6.10	0.90		5.49		0.05	2.00	3.90	
Pool	41.70	47.80	6.10	3.10	18.91	18.91		0.30	0.00	3.70	
Riffle	47.80	51.30	3.50	1.90		6.65		0.05	3.00	2.40	
Pool	51.30	59.20	7.90	2.60	20.54	20.54		0.20	0.00	2.90	
Riffle	59.20	76.90	17.70	1.30		23.01		0.05	5.00	3.80	
Reach Totals and Averages		76.90	76.90	2.00	85.89	150.04	57.24	0.14	1.40	3.57	56.02

Habitat Type	Substrate Percent Bed	Bld	Cob	Grv	Fine	Percent Instream Cover Bold	LWD	Cutbk	Veg	Other	PercentCrown Cover	Large Woody Debris	LWD/bank-full channel width	Erosion Sites (length)	Altered Stream Sites (length)	Obstructions (number)
Pool	0	0	60	30	10		12	3	0	0	95.00	3		4	3	0
Riffle	0	5	35	30	30	2	2	0	0	0	95.00	2		3	0	0
Pool	0	0	0	50	50	0	10	0	0	0	95.00	2		0	0	0
Riffle	0	10	30	30	30	2	0	0	0	0	95.00	0		0	0	0
Pool	0	0	5	10	85	0	15	0	0	0	95.00	1		3	0	0
Riffle	0	0	10	80	10	0	0	0	0	0	95.00	0		0	0	0
Pool	0	0	0	40	60	0	1	10	0	0	75.00	0		0	0	0
Riffle	0	0	60	30	10	0	0	0	5	0	75.00	0		0	0	0
Pool	0	0	10	10	80	0	0	5	0	0	80.00	1		0	0	0
Riffle	0	5	0	40	15	2	0	5	5	0	80.00	0		0	0	0
Reach Totals and Averages	0	2	21	35	38	1	4	2	1	0	88.00	9	0.42	13	4	0

Habitat Type	Off-Channel Habitat (length)	Off-Channel Habitat (width)	Off-Channel Habitat (bank side)	Land Use Right	Land Use Left	Vegetation Type Right	Vegetation Type Left	Riparian Slope Right	Riparian Slope Left	Stability Right	Stability Left	Vegetation Depth Right	Vegetation Depth Left	Livestock Access Right	Livestock Access Left	Photos	Comments
Pool	0	0	0	Nat	Nat	Mix	Mix	10	10	Low	Med	30	30	4	0	1	
Riffle	0	0	0	Nat	Nat	Mix	Mix	10	10	Med	Med	30	30	0	0	1	
Pool	0	0	0	Nat	Nat	Mix	Mix	10	10	Med	Med	30	30	0	0	1	
Riffle	0	0	0	Nat	Nat	Mix	Mix	10	10	Med	Med	30	30	0	0	1	
Pool	0	0	0	Nat	Nat	Mix	Mix	10	10	0	Low	30	30	0	0	1	
Riffle	0	0	0	Nat	Nat	Mix	Mix	15	10	Med	Med	30	30	0	0	1	
Pool	0	0	0	Nat	Nat	Mix	Mix	15	10	Med	Med	30	30	0	0	1	
Riffle	0	0	0	Nat	Nat	Mix	Mix	15	10	Med	Med	30	30	0	0	1	
Pool	0	0	0	Nat	Nat	Mix	Mix	15	10	Med	Med	30	30	0	0	1	
Riffle	0	0	0	Nat	Nat	Mix	Mix	15	10	Med	Med	30	30	0	0	1	
Reach Totals and Averages	0			10	10			10	10	29	32	30.00	30.00	5	0		

Appendix 3 – Reach 4 Habitat Data

Stream Name	Grandon Creek	Watershed Code	920-427000	Date	12-Jun-15	Reach Name	Grandon R4			Discharge Depth #1		Velocity		
Water Quality Information					Field Crew	Julie Pisani, David james, Don Lister, Lauren fegan						T1		Site Length
Dissolved Oxygen	6.50	pH	6.70	Total Dissolved Solids	125ppm	Temp C	15.00	Chainage at Beginning of Reach	0.00	Discharge Depth #2		T2		
Velocity (m/s)	.	Average Depth (at flow site)		Wetted Width (at flow site)		Discharge (m3/s)		Chainage at End of Reach	79.10	Discharge Depth #3		T3		
Habitat Information (All Pool and Cross Section Data)														

Habitat Type	Start (chainage at start)	Finish (chainage at end)	Unit Length	Wetted Width	Pool Area	Wetted Reach Area	%Pool Area	Habitat unit Depth (m)	Percent Gradient	Bankfull Width(m)	Average Percent Wetted Area	Substrate Percent Bed	Bld	Cob	Grv	Fine	Percent Instream Cover Bold	LWD	Cutbk	Veg	Other
Pool	0.00	9.60	9.60	4.00	38.40	38.40		0.42	0.00	6.10		0	2	3	5	90	0	5	0	0	0
Pool	9.60	15.80	6.20	2.40	14.88	14.88		0.30	0.00	4.00		0	1	1	1	97	0	0	5	5	10
Riffle	15.80	17.50	1.70	1.15		1.96		0.03	1.00	4.00		0	0	0	50	50	0	5	0	50	0
Pool	17.50	24.90	7.40	2.20	16.28	16.28		0.20	0.00	4.40		0	0	0	0	100	0	0	0	5	0
Riffle	24.90	33.10	8.20	1.20		9.84		0.04	2.00	4.10		0	0	10	70	20	0	0	3	5	0
Pool	33.10	41.60	8.50	1.65	14.03	14.03		0.14	0.00	4.30		0	0	0	50	50	0	5	5	0	0
Riffle	41.60	61.60	20.00	1.00		20.00		0.05	1.00	2.70		0	0	5	60	35	0	0	0	60	0
Pool	61.60	79.10	17.50	1.45	25.38	25.38		0.20	0.00	2.40		0	1	0	49	50	0	0	1	10	0
Reach Totals and Averages		79.10	79.10	1.88	108.96	140.76	77.41	0.17	0.50	4.00	47.03	0	1	2	36	62	0	2	2	17	1

Habitat Type	PercentCrown Cover	Large Woody Debris	LWD/bank-full channel width	Erosion Sites (length)	Altered Stream Sites (length)	Obstructions (number)	Off-Channel Habitat (length)	Off-Channel Habitat (width)	Off-Channel Habitat (bank side)	Land Use Right	Land Use Left	Vegetation Type Right	Vegetation Type Left	Riparian Slope Right	Riparian Slope Left	Stability Right	Stability Left	Vegetation Depth Right	Vegetation Depth Left	Livestock Access Right	Livestock Access Left	Photos	Comments
Pool	80.00	1		0	0	0	0	0	0	Nat	Nat	Mix	Mix	2	3	High	High	15	0	0	0		
Pool	85.00	1		2	0	2	0	0	0	Nat	Nat	Mix	Mix	1	10	Med	Med	30	20	0	0		
Riffle	75.00	0		0	0	0	0	0	0	Nat	FG	Mix	Mix	1	10	Med	Med	30	10	0	0		
Pool	95.00	1		0	0	0	0	0	0	Nat	FG	Mix	Mix	1	10	Med	Med	30	105	0	0		
Riffle	95.00	0		0	0	0	0	0	0	Nat	FG	Mix	Mix	1	10	Med	Med	30	5	0	0		
Pool	95.00	1		9	0	0	0	0	0	Nat	FG	Mix	Mix	1	10	Med	Low	30	5	0	0		
Riffle	95.00	1		0	0	0	0	0	0	Nat	FG	Mix	Mix	1	10	Med	Med	30	5	0	0		
Pool	90.00	1		0	0	0	0	0	0	Nat	FG	Mix	Mix	1	10	Med	Med	30	5	0	0		
Reach Totals and Averages	88.75	6	0.30	13	0	2	0			8	20			8	8	22	24	28.13	19.38	0	0		

Appendix 4 –Grandon R2/R3/R4 June 2015 Habitat Summary

Stream Name	Grandon			**Watershed Code**		920-479000							
Habitat Parameter	**Grandon R2**	**Ratings**	**Grandon R3**	**Ratings**	**Grandon R4**	**Ratings**		**Ratings**		**Ratings**		**Ratings**	**Total**
% Pool Area	22.8	5	57.2	1	77.4	1							**7**
Large Woody Debris/Bankfull Channel Width	1.7	3	0.4	5	0.3	5							**13**
% Cover in Pools	8.4	3	8.0	3	21.8	1							**7**
Average% Boulder Cover	3.8	5	0.7	5	0.0	5							**15**
Average % Fines	25.0	5	38.0	5	61.5	5							**15**
Average % Gravel	44.2	not rated	35.0	not rated	35.6	not rated							**--**
% of Reach Eroded	11.1	5	13.0	5	13.3	5							**15**
Obstructions	0.0	0	0.0	0	2.0	2							**2**
% of Reach Altered	9.0	3	3.9	1	0.0	1							**5**
% Wetted Area	43.1	5	56.0	5	47.0	5							**15**
Dissolved Oxygen	9.4	1	6.5	3	6.5	3	.		.		.		**7**
pH	7.0	1	6.7	1	6.7	1							**3**
Totals		**36**		**34**		**34**							**104**
Off-Channel Habitat as % of Reach	0	5	0	5	0	5							**15**
Reach Lengths	145	not rated	77	not rated	79	not rated		not rated		not rated		not rated	**300.7**

Riparian Ratings													
Reach	**Grandon R2**	**Ave. Ratings**	**Grandon R3**	**Ave. Ratings**	**Grandon R4**	**Ave. Ratings**		**Ave. Ratings**		**Ave. Ratings**		**Ave. Ratings**	**Total**
Land Use	23	1	20	1	28	2							**4**
Riparian Slope	48	2	10	1	8	1							**3**
Bank Stability	74	3	61	3	46	3							**9**
		Ratings		**Ratings**		**Ratings**		**Ratings**		**Ratings**		**Ratings**	**--**
% Crown Cover	87.9	1	88.00	1	88.75	1		0		0		0	**3**
% of Reach Accessed	17.3	3	13	3	0	0							**6**
Average Vegetation Depth	28.5	1	30	1	24	1		0		0		0	**3**
Totals		**11**		**10**		**7**		**0**		**0**		**0**	**28**