

Nanaimo River Chinook Salmon Recovery Plan Habitat Assessment Report

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Habitat Assessment Report

By

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Introduction

This study was contracted by the Department of Fisheries and Oceans (DFO) for the collection of habitat information and recovery strategies related to the Recovery Potential for the Nanaimo Spring Run Chinook, which COSEWIC has designated as Endangered. The biological impacts were highlighted in the recent Habitat Status Report of the Nanaimo River Watershed¹ (M.C. Wright 2019) as well as the Nanaimo Summer Chinook Risk Assessment Tables².

The Habitat Status report used published and aerial information to provide the habitat pressures on Chinook Salmon. This study was designed to provide the ground based field assessment component. This ground based habitat assessment was the next step in the recovery plan. We were to ground truth habitat concerns and provide restoration plans. Our information will be used to collect both habitat data and restoration plans. The river mainstem from Estuary to Fourth Lake will be reviewed with prioritization to Chinook spawning and rearing habitat.

The outcome will be to provide restoration plans on prioritized areas to be used as recovery options for SARA documents, as well as provide projects for the Nanaimo River Watershed Roundtable (NRWR).

In order of Tasks

- Field component to check priority sections of Chinook Spawning and Rearing Habitat on the river that were identified in the Habitat Status Report. The field measurements of habitat were to be collected using standard RISC parameters in a comparable data format (ie USHP³)
- Identify restoration plans and activities for the NRWR committee or members they may consider undertaking. Restoration prescriptions will follow standard methods used on coastal watersheds⁴ and as explained and as implemented by us on the Haslam Creek Fish Habitat Assessment⁵.
- Present to the Nanaimo River Watershed Roundtable (NRWR) the results of field inspections , habitat measures and restoration opportunities identified in the Habitat Status Report and Risk Tables.

The Urban Salmon Habitat Assessment (USHP) methodology was used to measure the habitat condition in representative reach areas throughout the watershed. The report presents a ranked summary of fish and riparian habitat characteristics of reach segments of Nanaimo River. It summarizes the current health of the stream, provides comparison to other streams on Vancouver Island and guidance on recovery and protection of the vital stream habitats.

¹ *Wild Salmon Policy Fish Habitat Status Report For The Nanaimo River Watershed. Dec. 11, 2019 by M.C. Wright and Associates Ltd. Nanaimo B.C.*

² *Nanaimo Risk Assessment Worksheet – Summer Chinook, unpubMS prepared by DFO and Nanaimo River Watershed Roundtable.*

³ *Urban Salmon Habitat Program, Assessment Procedures for Vancouver Island, 2001, MOELP Nanaimo BC V9T6J9*

⁴ *Fish Habitat Rehabilitation Procedures, 1997, Watershed Restoration Program, MOELP UBC Vancouver BC*

⁵ *Haslam Creek Fish and Fish Habitat Assessment, R. Hanelt & D.R. Clough, 2010, for Nanaimo Fish and Game Protective Assn.*

Methods

Timing

The survey was conducted from December 14, 2020 to May 13, 2021. Winter weather opportunities for safety and substrate visibility would determine the days of survey.

Personnel

The survey was conducted by David Clough, RPBio and Brad Remillard, RPBio, and Chelsea April, BSc. of D.R. Clough Consulting (DRC). Project planning, coordination, (gate keys) and report review were all done by Steve Baillie (Fisheries and Oceans, Retired).

Equipment

The habitat survey included the following equipment;

- Chest Waders with non slip grips (non felt preferred)
- 2.0 m measuring staff (2)
- Field/viz vests for each participant, first aid kits, PFD for high water
- Bushnell Prime optical range finder
- Retractable tape measures (2)
- Clinometer
- Flagging tape & markers
- Field Book, waterproof paper, pencils
- iPad © with Avenza Maps ©
- GIS enabled Ortho maps of watershed (provided by Mosaic Forest management and Regional District Nanaimo)

USHP Survey Method



The Urban Salmon Habitat Program (USHP) survey⁶ was utilized. This method of survey was developed in 1997 by the Ministry of Environment to accommodate the Urban Salmon Program that sponsored Vancouver Island stewardship groups. The survey methodology measures the features of habitat units (i.e. pools and riffles) that exist within a reach or segment. Within the reach segment, the survey objective is a minimum of 10 habitat units or to survey at least 10% of the reach, with more done as time permits. The surveys generally start at the downstream area of a reach and walk in an upstream direction. The river was surveyed by walking along the banks and then inspecting each habitat unit at the shoreline and entering with waders to look at features such as substrates or off channel habitats on the far bank. We snorkel surveyed the upper Reach 14 in February to look at the spawning habitat at the outlet of first lake during the high flows.

The USHP survey method involves stream habitat, riparian as well as water quality assessment. The habitat and riparian data collection items and their definitions are shown in the USHP Field Survey Card (Figure 1). Fish habitat was measured using staffs, tapes, rangefinder and clinometers. The sites were identified with a georeferenced place mark and a site photograph. The field data was recorded on an iPad © or iPhone © using a customized file (pdf schema) written by D.R. Clough Consulting. We used the application Avenza PDF © and a GIS enabled PDF map. The captured data is then exported off the device as *.csv and *.kml files for data entry in the USHP program and Google Earth ©. The locations in each reach are referred to by

⁶ 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.

the Placemark created by Avenza Pdf for the site. The significant Placemarks are shown in each reach map, they can also be found in the Reach date appendices and the *.kmz file.

Fig. 1 USHP Survey Habitat And Riparian Data Card

Stream Name	<i>Fish C.</i>	<p>Habitat and Riparian Card Instructions</p> <ol style="list-style-type: none"> 1. Measure <u>all</u> habitat parameters at the <u>beginning</u> of the reach and <u>every 200 meters</u>. Measure all parameters twice if the reach is less than 200 meters long; 2. Measure riparian parameters (black boxes) <u>every 100 meters</u>; 3. Measure the start, finish & wetted width for <u>pools only</u>; take data for all other shaded boxes along <u>entire stream length</u>. <p>Abbreviations and Definitions</p> <p>A/E/O: Altered sites, Erosion sites, Obstructions</p> <p>Bankfull Width: the horizontal distance from rooted terrestrial vegetation to rooted terrestrial vegetation.</p> <p>Crown Cover: streamside vegetation at least 1 meter above water surface that provides shade over the habitat unit.</p> <p>Gradient: slope of the stream, measured with a clinometer</p> <p>Habitat Type: P=pool or R=riffle</p> <p>Instream Cover: B=boulder C=undercut banks LWD=large woody debris O=other V=instream vegetation (includes algae)</p> <p>Land Use: C=commercial I=industrial EX=exposed L=lawns FC=farms/cattle N=natural FG=farms/grass R=roads or residential GC=golf course</p> <p>Livestock: note the length, in meters, of the site where any type of livestock have access to the stream.</p> <p>LWD: deadwood >10cm in diameter and >2m. long and stable in the <u>wetted</u> channel</p> <p>Obstructions: BD=beaver dam CV=culvert X=log jam D=dam EBB=other F=falls</p> <p>Off-Channel: includes ponds and lateral channels; note the bank side,¹ channel length and width</p> <p>Riparian Slope: the slope of the bank above the high water mark to the far end of the riparian vegetation or break in slope; include distance if on floodplain</p> <p>Stability: H=high; M=medium; L=low</p> <p>Vegetation: Br=broadleaf forest Mix=mixed Con=coniferous forest Sh=shrub Gr=grasses</p> <p>Wetted Width: the width of the water surface measured at right angles to the direction of flow</p> <p>¹ NOTE: Bank side is determined when facing downstream</p> <p> measure along stream length; note start and end for pools only  measure every 100 meters</p>
Reach / pg. #	<i>R2/pg1</i>	
Habitat Type (P/R)	<i>P</i>	
Start (m)	<i>10 m</i>	
End (m)	<i>20 m</i>	
Wetted Width	<i>2 m</i>	
Bankfull Width	<i>3 m</i>	
Average Depth	<i>0.5 m</i>	
% Bedrock	<i>20%</i>	
% Boulders	<i>20%</i>	
% Cobble	<i>30%</i>	
% Gravel	<i>20%</i>	
% Fines	<i>10%</i>	
Instream Cover (type/%)	<i>C-10% B-2%</i>	
% Crown Cover	<i>60%</i>	
Gradient	<i>2%</i>	
# LWD	<i>10</i>	
A/E/O	<i>E-10m A-20m</i>	
Off-Channel Habitat	<i>L/bank 20*2m</i>	
Land Use (L/R)	<i>N/R</i>	
Vegetation (L/R)	<i>CF/G</i>	
Vegetation Depth (L/R)	<i>30+2</i>	
Riparian Slope (%) (L/R)	<i>10/15</i>	
Stability (L/R)	<i>M/L</i>	
Livestock Access (L/R)	<i>20m/0</i>	
Photos	<i>1,2,3</i>	
Comments	<i>1,2</i>	

Survey Area

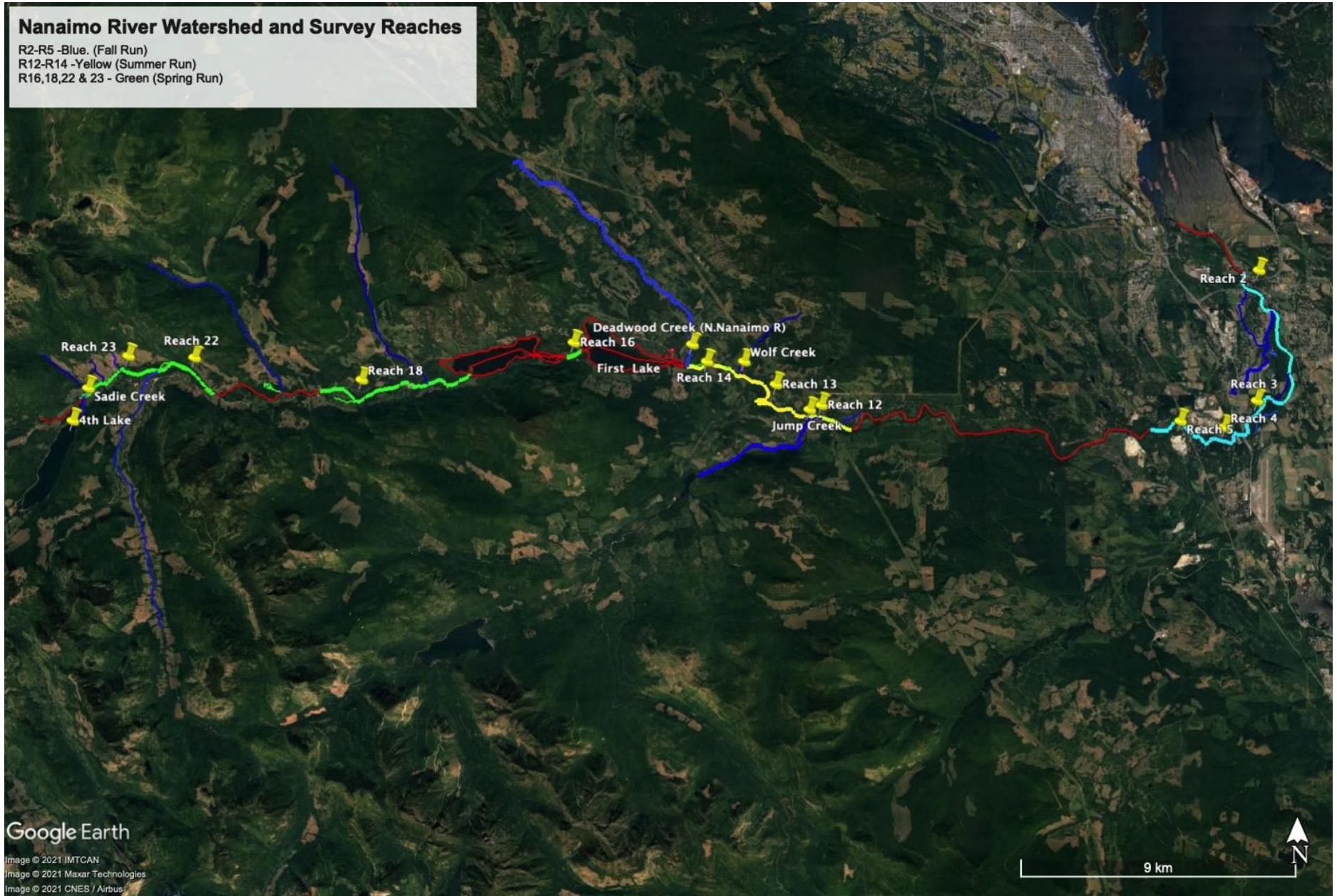
The Nanaimo River chinook populations have migratory access along the mainstem for approximately 35 km ending near Fourth Lake. The river has recently been identified in its Habitat Status report as having 25 reaches (M.C. Wright 2019) to the end of anadromous access. The reach length is measured from the distances between points using gps in the field or measurements from aerial imagery with both methods using Google Earth © as the platform.

The objectives of this report were to look at the reaches that were identified as priority reaches for Chinook salmon, specifically the Spring/Summer stock and to a lesser degree the Fall run according to the research completed by M.C. Wright (2019) on the historical use of Chinook stocks. The total reaches and prioritized Chinook reaches to be surveyed are listed below (Table 1).

Table 1 – Nanaimo River Reach Lengths and Chinook Reaches.

Reach	Reach Length (m)	Chinook Reach Migration Type	Description
Reach 1	2990		Estuary to Riffle below Cedar Bridge, not surveyed
Reach 2	5424	Fall	Cedar Bridge to Haslam Creek entrance
Reach 3	2245	Fall	Haslam confluence upstream to TC Highway
Reach 4	1515	Fall	TC Highway to Hub City Gravel Pit
Reach 5	2486	Fall	Through Bore Hole canyon
Reach 6	497		Not surveyed
Reach 7	1511		Not surveyed
Reach 8	1562		Not surveyed
Reach 9	4497		Not surveyed
Reach 10	1528		Not surveyed
Reach 11	3041		Not surveyed
Reach 12	1609	Summer	Below Jump Creek
Reach 13	3564	Summer	Above Jump Creek
Reach 14	2013	Summer	Below First Lake
Reach 15	3486		First Lake, 243 ha
Reach 16	522	Spring	Between 1 st and 2 nd Lakes
Reach 17	3528		Second Lake, 199 ha
Reach 18	5595	Spring	Above 2 nd Lake to TP Bridge
Reach 19	1080		Not Surveyed
Reach 20	1691		Not surveyed
Reach 21	1035		Not surveyed
Reach 22	2347	Spring	To Green Creek
Reach 23	3038	Spring	Green Creek up to 4th Lake
Reach 24	933		Not Surveyed
Reach 25	814		Ends at Anadromous Barrier by 4 th Lake
Total	58551		

Figure 2. Nanaimo River Survey Reach Map



Habitat Survey Results

The fish habitat and riparian data was summarized for each reach following the USHP format. The survey areas were divided into the three mainstem Nanaimo River Chinook Salmon specific habitat areas identified in the Habitat Status Report (M.C. Wright 2019):

- Fall Chinook Spawning Areas: Reach 2 – 5
- Summer Chinook Spawning Areas: below First Lake in Reach 12-14
- Spring Chinook Spawning Areas: Reach 16,18,22 & 23
- Tributaries/sidechannels: Inspections for effects on the mainstem affecting spawning, rearing as well as Alterations, Erosion and Obstructions. These areas discussed in each reach segment include; valley wall tributaries (i.e Reach 23), the North Nanaimo River (Deadman Creek) entering Reach 14, and floodplain sidechannels (R2,3,4,12,13,14, 18, 22 & 23).

The results for each reach are portrayed in summary tables of Habitat and Riparian characteristics. There were 14 habitat and riparian parameters summarized from of a total of 30 parameters collected in each habitat unit. The entire habitat data collection is in reach tables in the appendices. The appendices present all the data collected, in reference to habitat unit and location. These tables include sums and averages of the USHP parameters including such values as average channel width, total wetted area, LWD total and locations of specific Alteration, Erosion or Obstructions.

The complete field survey data collection is stored in a spreadsheet file. The files referenced to this document include;

- Spreadsheet File (*.xls) from the USHP macro enabled program.
- Georeferenced file (*.Kmz) of each survey reach, with USHP data and photos.

The data collection and assessment follows the B.C. Environment and DFO fish habitat assessment standards (Johnston & Slaney 1996⁷). The field data was transcribed into the USHP excel program, which uses macros to collate and rate the data to published habitat standards⁷. The reach habitat parameters were summarized, rated and scored using the macro enabled excel program created by the USHP. Scoring is based on the Fish Habitat Assessment Procedures (Johnston & Slaney 1996). This method converts the results into numbers thus offering a scoring system that can compare reaches or other streams (Table 2).

Table 2 – Example Diagnostics of Salmon Habitat Condition - LWD/Bankfull Channel Width

Parameter	Rating	Fish Habitat Result
<1	1	Good
1-2	3	Fair
>2	5	Poor

The USHP program summary scores each reach on (9) instream, (2) water quality and (5) riparian habitat parameters. Ratings are rounded to whole numbers. The results will show the lower the score, the better the habitat. The habitat/water quality summary and riparian summary rating scores can range from 11-55 and 5-25 for Good to Poor respectively. The data was scored according to the USHP methodology and presented in the results below for each survey reach.

⁷ Johnston ,N.T. & P.A. Slaney,1996. Fish Habitat Assessment Procedures. WRP Tech Circ.#8, MOELP & MOF

The USHP program is set up to assess the habitat units as Pools or Riffles. Since Glides were common in this river, they were entered as Riffles in the USHP program as both lack residual depth. Thus in the assessment results, the USHP program compares only Pools with residual depth. The Glides that were entered as riffles are noted in the Appendices.

Finally, all the data is reviewed in a summary of the overall stream condition and comparison with other streams follows. Restoration opportunities are summarized in tables. The Watershed Restoration Summary identifies the topics for each reach:

- Riparian Habitat
- Spawning Habitat
- Rearing Habitat
- Obstructions
- Erosion
- Alterations
- Water Quality
- Education/Awareness

The habitat survey of the Nanaimo River began in late December and continued into the spring. The field dates began December 15, 2020 on Reach 12 and ended at Reach 2 on May 13, 2021. Generally, the upper reaches were surveyed in mid winter during periods of low flow. The larger lower reaches were surveyed later as water levels dropped. The last area was Reach 2 done in May when wading was possible. Due to COVID 19 pandemic restrictions, Reach 1 on the Snuneymuxw Reserve at Raines Road was never accessed.

Reach 1

This reach was not surveyed as it was not identified in the Chinook planning as a spawning reach. It is a migration corridor and is tidal. It is approximately 2990m from the foreshore estuary along Raines Road ending at the gravel bar below the Cedar Bridge. Our winter visual inspection was restricted due to COVID 19 end of access halfway down the road on Snuneymuxw First Nation reserve lands. A tributary, York Creek flows parallel to the road 100m inland but is diverted through a pasture ditch to the north side of the estuary near Holden Creek. The river right bank has rural residential houses and the river left bank is less developed and features a mixed second growth forest 30 to 100m deep. There are no migration barriers in this reach. The banks are low on the left side and were generally vegetated with no significant erosion. The right bank features bedrock outcrops that taper to a low gravel bank further downstream. The area is a high use recreational and cultural fishing area. The banks are well trod by anglers. Addressing localized erosion from angler access is a possible restoration project. The entire reach has a wide active annual floodplain. There is a 1984 B.C. Water Management floodplain map showing the extent⁸. Management of any fish species habitat needs to take into consideration the floodplain effect.

Reach 2 Habitat Survey Results

Reach 2 is approximately 5424m long. It goes from just below the Cedar Bridge upstream to the Haslam Creek confluence. Our habitat survey was conducted in May 13, 2021 along approximately 1679m for 31% of the reach. We measured nine habitat units (four Riffles, three Glides and two Pools). Water levels were dropping and the bankfull stage was less than 20%. The survey was done by wading and walking the river left bank upstream from the Morden Colliery Trail towards Haslam Creek ending adjacent farm pastures on the opposite bank. The left bank has several channels supplied by floodplain and Thatcher Creek that discharge below the trail.

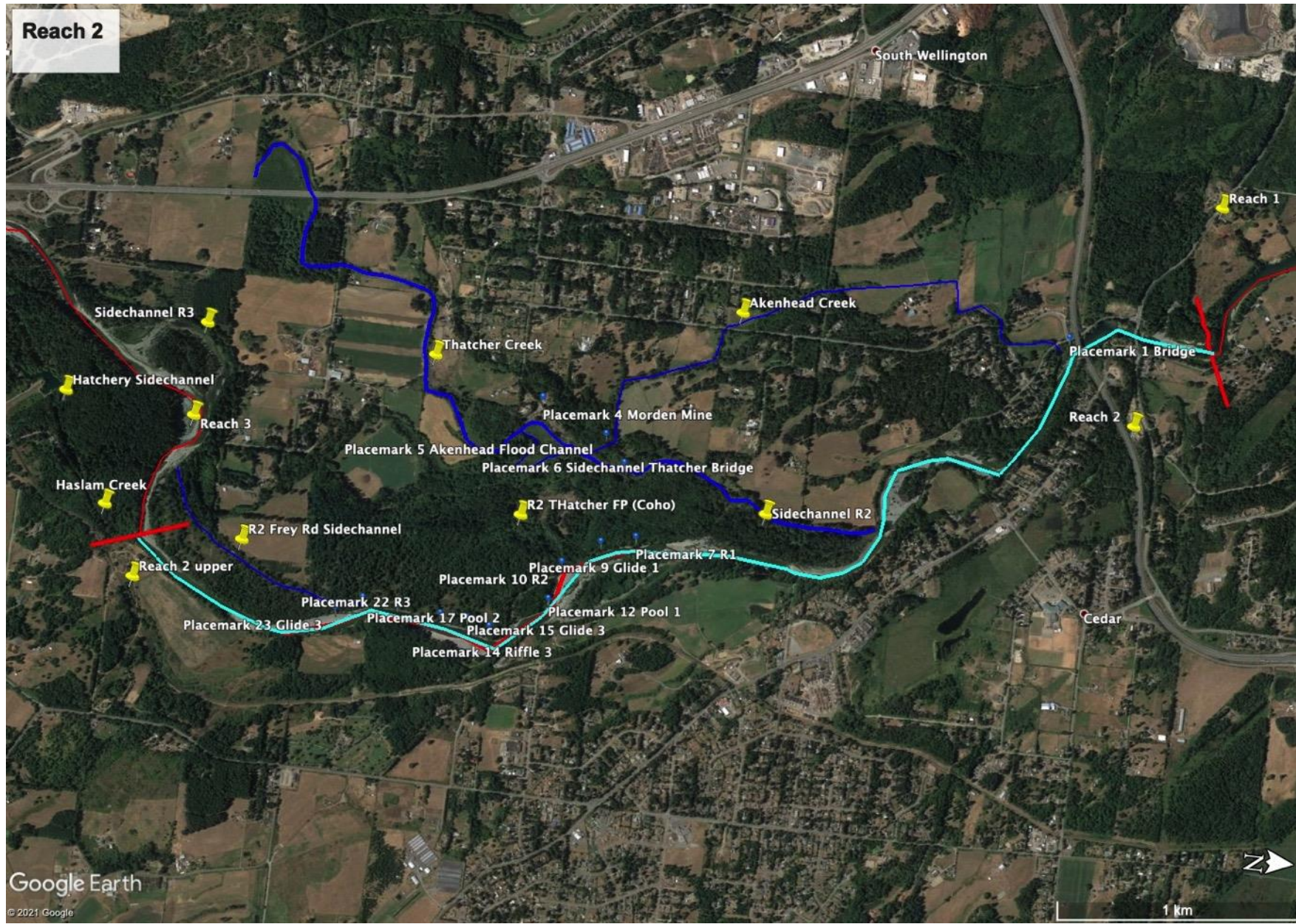
This reach had an average channel width of 83.7m and a wetted width of 49.3m. The reach average gradient was 1.1%. No fish were observed in the channel during the survey but there were invertebrates on boulder substrates. The results are shown in the table below. Figure 4 shows the reach with the placemarks 7-23 from the survey with the iPad.

Table 1 - Reach 2 Habitat Summary Results

Habitat Parameter	Result	Ratings	Result
% Pool Area	40	5	Poor
Large Woody Debris/Bankfull Channel Width	0	5	Poor
% Cover in Pools	1	5	Poor
Average % Boulder Cover	0	5	Poor
Average % Fines	2	1	Good
Average % Gravel	56	not rated	
% of Reach Eroded	55	5	Poor
Obstructions	0	0	Good
% of Reach Altered	0	1	Good
% Wetted Area	59	5	Poor
	Mean Score	3.6	Fair

⁸ BC Water Management 1984, Floodplain Mapping Nanaimo River, File 0305030

Figure 4.) Nanaimo R2 Survey Area with Placemarks



Reach 2 Habitat Photos (May 2021) Page 1



1.) Riffle 1 Placemark 7, Morden Trail head, clean gravel



2.) Glide 1 Placemark 9, poor instream cover, erosion along LB



3.) Riffle 2, right bank island with dry flood channel and LWD.



4.) Pool 1: Placemark 12 -317m long 53m wide 2-3m deep, lacks cover.

Reach 2 Habitat Photos (May 2021) Page 2



5.) Riffle 3 Placemark 14, clean gravels no boulders/LWD



6.) Glide 2 is 55m wide, 115m long, no instream cover



7.) Pool 2 is 309m long with good riparian depth but poor instream cover



8.) Glide 3 (Placemark 23) near top of Reach 2, has 220m RB bank erosion

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

Table 2 - Reach 2 Riparian Results

Riparian Ratings	Result	Ratings	Result
Land Use	34	2	Fair-Good
Riparian Slope	32	2	Fair- Good
Bank Stability	70	4	Fair-Poor
% Crown Cover	39	5	Poor
% of Reach Accessed	9	3	Fair
Average Vegetation Depth	203	1	Good
Mean Score		2.8	Fair

The USHP habitat survey results of Reach 2 for instream habitat (Table 1) were rated Fair. The USHP Riparian Rating for Reach 2 (Table 2) resulted in a fair result as well.

The fish habitat characteristics that were good are;

- Average % Fines (Good)
There was a very low amount of fines in surface substrates which was accompanied by 56% gravel, this reach offers good spawning substrates.
- % Reach Altered (Good)
The river channel is relatively un-altered, there was no bank armouring (RipRap/Concrete), signs of dredging or structures in this survey area. The Morden Colliery trestle once crossed in this reach but has been removed with the route now a RDN trail to the river. There is a 1.0 m layer of coal slag under the trail on the river right bank terminus. Downstream the Cedar Road and Duke Point Bridges cross the river.
- Riparian Vegetation Depth (Good)
An average vegetation depth of 203m on both sides is good. There is much deeper (358m) forest cover on the river left floodplain than on the river right side (47m) which is farm/rural residential. Despite this good average, there are sites where there is almost no riparian vegetation on river right bank (Site 23) in the upper reach.

Sidechannels: This reach has two left bank sidechannels and two tributaries Thatcher & Akenhead Creek) that offer flood refuge habitat and rearing habitat (Coho fry observed).

The Reach 2 fish habitat characteristics that were poor are;

- Large Woody Debris Cover (Poor)

A lack of LWD. There were only five second growth fir/cedar washed on to bars (Photo 3) in the 1679m survey length. These logs offer bar stability but little fish cover. No old growth size logs were observed.

- **Instream Cover (Poor)**
Lack of all types of instream cover; logs, undercuts, vegetation and boulders. The minor sources of cover were poorly positioned logs and overhanging vegetation. The wide-open pool areas expose fish to predation.
- **Erosion (Poor)**
The Reach 2 survey area had almost 1.0 km of bank erosion (55%). Two sites with high concern; 1.) The Morden Trail river bank for approx. 500m length. 2.) River-right bank along 430m.
- **Boulder Cover (Poor)**
There is a lack of boulders in the riffles to offer aeration and habitat for invertebrates and fry throughout the reach.
- **Riparian Crown Cover (Poor)**
The riparian area was historically logged and is regenerating in a mixed deciduous and coniferous forest approximately 60-80 years old and approximately 30m average canopy height.
- **Riparian Condition Invasives**
While not rated, there were invasives scattered throughout on the river bank (mostly Broom) that could be removed and replaced with native plants.

Reach 3 Habitat Survey Results

Reach 3 of the Nanaimo River was inventoried on February 12, 2021 during moderate/low winter water levels. We surveyed the entire 2245m length. It has 14 habitat units, four pools and five Riffles and Glides. The reach starts at Haslam Creek and we walked to the end at the Highway 1 pool. Reach 3 has approximately 75% of its riparian area within a protected Nanaimo River Land Conservancy owned by Nature trust and managed by the Regional District of Nanaimo. The riparian area also has the Nanaimo River Hatchery on land shared with Nanaimo Forest Products. The reach also has a power line, highway, farmland and community trail. The average channel width was 79m and wetted width of 48m on a 1.7% gradient. The results are shown in the table below.

Table 3 - Reach 3 Habitat and Water Quality Summary Results

Habitat Parameter	Result	Ratings	Result
% Pool Area	22	5	Poor
Large Woody Debris/Bankfull Channel Width	1	5	Poor
% Cover in Pools	5	5	Poor
Average % Boulder Cover	2	5	Poor
Average % Fines	4	1	Good
Average % Gravel	16	not rated	
% of Reach Eroded	33	5	Poor
Obstructions	0	0	Good
% of Reach Altered	13	5	Poor
% Wetted Area	61	5	Poor
	Mean Score	4.0	Fair-Poor

The Riparian features of Reach 3 are shown in the table below taken from the USHP summary tables.

Table 4 - Reach 3 Riparian Results

Riparian Ratings	Result	Ratings	Result
Land Use	40	1	Good
Riparian Slope	34	1	Good
Bank Stability	142	4	Fair-Poor
% Crown Cover	43	3	Fair
% of Reach Accessed	16	3	Fair
Average Vegetation Depth	112	1	Good
Mean Score		2.2	Fair-Good

The USHP habitat survey results of Reach 3 for instream habitat (Table 3) were rated Fair-Poor. The fish habitat characteristics that were good are;

- Average % Fines (Good)

There was a very low amount of fines in surface substrates, but there was less gravel in Reach 3 (16%) than in Reach 2 (56%).

- Obstructions

There are no fish migration obstructions. The river channel is open and flat with virtually no logs to form jams. The gradient is gentle at 1.7%.

The USHP Riparian Rating for Reach 3 (Table 4) resulted in a Fair-Good result. The Riparian Characteristics that were good were;

- Land Use

The river right bank is an undeveloped forest in a protected area.

- Riparian Slope

There are no steep slopes on the stream bank other than the dyke area on the left bank.

- Average Vegetation Depth (Good)

An average vegetation depth of 112m is due to the right bank forest over 203m deep. The left bank is only 30m deep due to the highway and property development. The two banks are quite dissimilar but fortunately the treed area is on the south side.

Sidechannels: There are many sidechannels and floodplain routes in Reach 3. The mainstem channel changed significantly in 2004 when the river abandoned the left bank meander and cut through a forested area beside the Nanaimo River Hatchery on the right bank. This event shortened (700m to 400m) and steepened the river along this reach. The eroded sediments from the new channel are deposited throughout the lower reaches and significantly at Reach 2 near the Morden Colliery crossing. The Reach 3 side channel offers fish habitat with perennial pools along its lower area and a gravel riffle at the top. It is unprotected and seasonally flooded over a wide willow vegetated bar and the lower reach is connected to the river. It offers flood protection, rearing and some spawning habitat.

Downstream of the abandoned meander there is now a sharper bend that delivers increased pressure to the river left bank beside Frey Road. It floods below Frey Road in a 1067m sidechannel that is fed by this overflow with its entrance is currently protected by a debris jam. It exits in Reach 2 where it is described.

The right bank along Reach 3 has several seasonal side channels running across the forested floodplain activated only during high water. During the habitat survey we observed four active entrances to the right bank riparian area. They head through the forest as 3-6m wide gravel scours and enter along the lower portion of the Napoleon Creek sidechannel.

The Napoleon Sidechannel is a constructed channel that begins at Haslam Creek and goes 1400m upstream through the fishway at the Harmac well pond and continues in the forest past the hatchery. This channel is fed by Nanaimo River Hatchery as well. Napoleon Channel has year round water flow, deep pools and LWD cover where Coho and Trout fry are observed year round.

Almost all the Reach 3 fish habitat characteristics were poor;

- Pool Area/Wetted Area (Poor)

There are 4 pools in the 2.2 km reach which has 13 glides and riffles. The low number of pools limits holding and rearing space. The overall wetted channel area (61%) is low, despite winter levels. The habitat has been replaced with glides and longer riffles.

- Large Woody Debris Cover (Poor)

There was only one log touching the water in the entire reach to offer any scour or cover. The LWD was routinely moved by water. The LWD is washed out of the river into the high flood area on the right bank. Many trees along the right bank are fallen over from erosion or pushed from flood pressure. They do offer some flood protection to the riparian forest. No old growth LWD was found in this reach.

- Instream Cover (Poor)

The wetted cover for adult and juvenile fish is lacking. There was small amounts of Boulder Cover (to 5% of wetted area in some pools). The degraded channel has eroded under the tree roots and left them suspended above mean water levels not offering cover.

- Erosion (Poor)

The Reach 3 survey area had 740m of bank erosion (33% of total length). There are three significant sites; 1 & 2) along the right bank above and below oxbow bend and 3.) beside the dyke further upstream on the left bank. The right bank erosion is alongside the regenerating second growth forest of the land conservancy. The left bank erosion is above the armoured area protecting the Nanaimo Forest Products pumphouse powerline.

- Boulder Cover (Poor)

There is no midwater boulder cover offering habitat for fish. There were some large pieces fallen in from the bank offering cover in the pools.

- Alterations

There is 200m of rock armour along the left bank beside the pumphouse power line. This material is settling into the river. The rock material is creating short rock spurs that scour the channel and provide boulder cover.

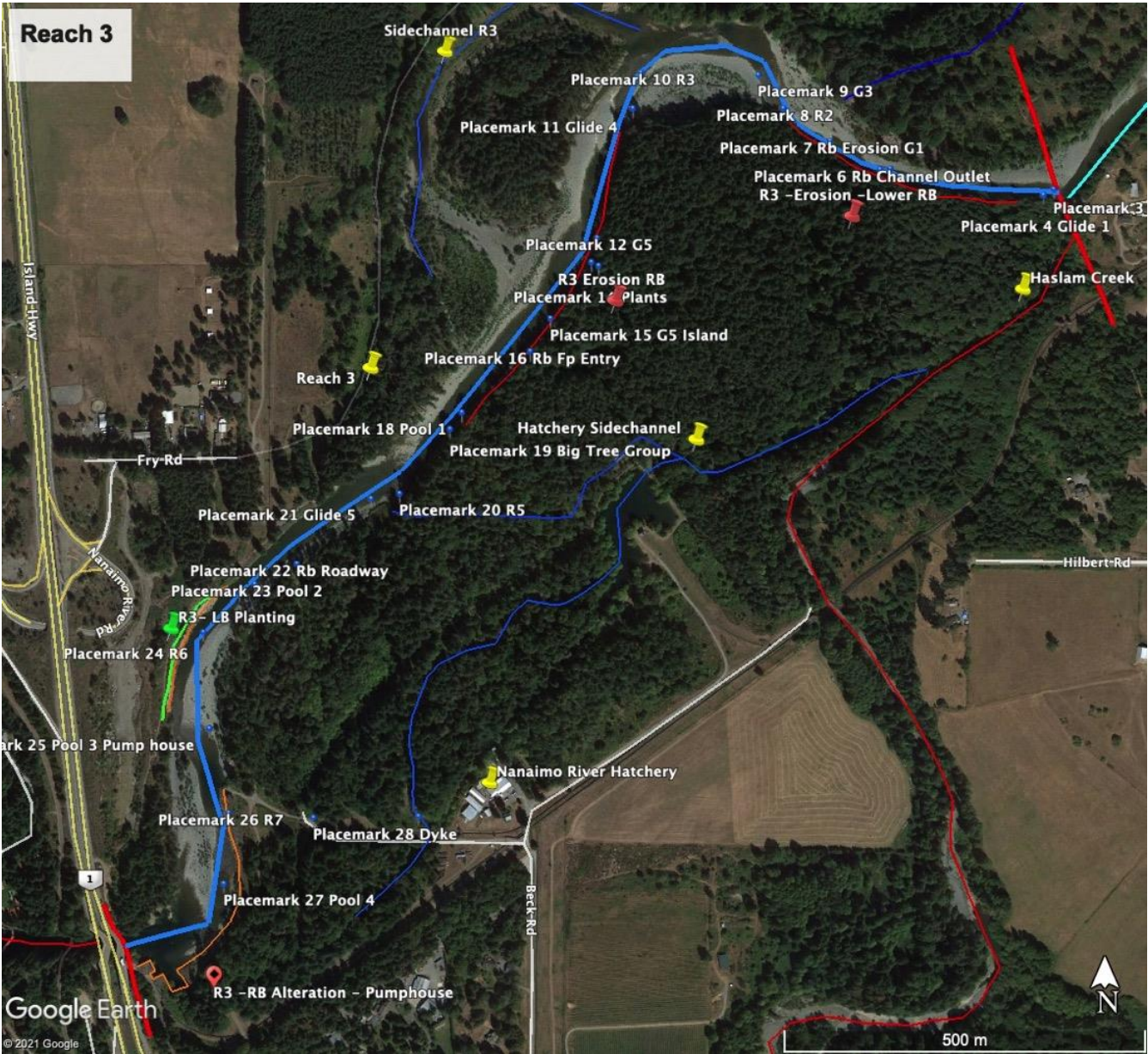
- Alterations

The upper reach has a water intake for the pulp mill (and hatchery). The right bank has a concrete pumphouse and blast rock armour along 430m. There are rock placement areas that have the potential for riparian vegetation planting.

- Riparian Crown Cover (Fair)

There is 43% canopy closure this rates Fair. The reach drains to the north east. The south side is protected but it is exposed to afternoon sun from the west.

Reach 3 Survey Area with Placemarks



Reach 3 Habitat Photos Page 1



1.) Riffle 1 looking downstream with Haslam Creek on right



2.) Glide 1 looking upstream



3.) Corner Glide - left bank spills into Frey Rd Sidechannel



4.) Glide 4 in new route - tree/LWD swept aside.

Reach 3 Habitat Photos Page 2



5.) Glide 5 looking at LB sidechannel entrance



6.) Pool 2 – also showing LB erosion under trail/powerline



7.) Pool 3 tailout is cobble and boulder limited gravel



8.) Riffle 8 and Pool 4, pump house at end R4 at Hwy 1.

Reach 4 Habitat Survey Results

Reach 4 is approximately 1516m long. It begins at the Hwy 1 Bridge and goes upstream in a confined canyon that has many bedrock and boulder features. The entire reach was surveyed on Feb. 19, 2021 walking along the river left bank. It had three pools, four riffles and two glides. The Reach 4 in the canyon has a significantly narrower channel width 53.5m than Reach 3 below at 79m. The Reach 4 wetted width in February was 35m. The average gradient was 1.75%. The main features of this reach are its bedrock featured narrow canyon, where we noticed water scour marks and debris more than 5.0m above the mean winter water level. The banks below high water featured little vegetation. The left bank is alongside a gravel quarry the entire length. The right bank has rural developments industrial and residential. The results are shown in the table below.

Table 5 - Reach 4 Habitat Summary Results

Habitat Parameter	Result	Ratings	Result
% Pool Area	67	1	Good
Large Woody Debris/Bankfull Channel Width	0	5	Poor
% Cover in Pools	5	5	Poor
Average % Boulder Cover	5	5	Poor
Average % Fines	2	1	Good
Average % Gravel	13	not rated	
% of Reach Eroded	0	1	Good
Obstructions	0	0	Good
% of Reach Altered	2	1	Good
% Wetted Area	66	5	Poor
	Mean Score	2.7	Fair

The Riparian features of Reach 4 are shown in the table below taken from the USHP summary tables.

Table 6 - Reach 4 Riparian Results

Riparian Ratings	Result	Ratings	Result
Land Use	24	2	Fair-Good
Riparian Slope	72	5	Poor
Bank Stability	16	1	Good
% Crown Cover	63	3	Fair
% of Reach Accessed	0	0	Good
Average Vegetation Depth	64	1	Good
Mean Score	Mean Score	2.0	Fair-Good

Reach 4 habitat results indicate a Fair-Good result. The fish habitat characteristics that were good are Pool area, lack of alterations and water quality;

- High percentage of Pool area.

The reach had 67% pool area. It has deep bedrock controlled pools that offer year round rearing habitat. The mean depth of the pools was estimated at 3.0m.

- Fines; Only 2% fines in the substrates. This result is evident from the lack of erosion in this reach. There was one observed source of sediment in the reach; the outflow of a drainage from the gravel quarry braids over an old roadway to the river.
- Erosion; there were no locations of recent bank erosion on the mainstem river which has bedrock walls or boulder/cobble terraces with no soil along the banks.
- No Alterations; Reach 4 has no significant alterations; there are old logging skid roads in the riparian area that have grown over with vegetation. The Bungy Zone recreation site has a narrow bridge over the lowest pool. There is a seasonal access ramp installed at the shoreline as well. There is an Environment Canada real time hydrometric station midway in this reach (Stn 08HB034)

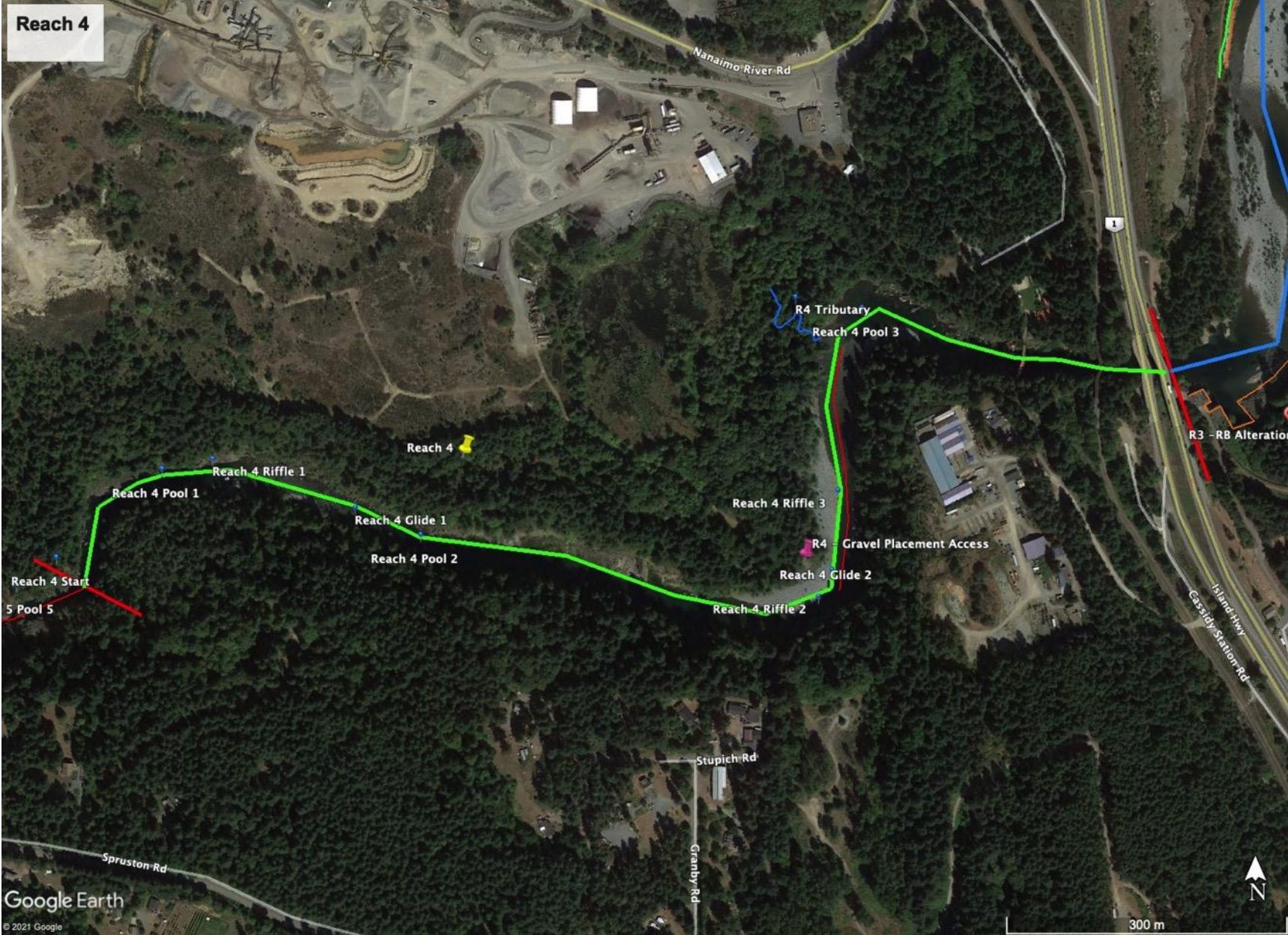
Reach 4 Riparian Characteristics that were rated Good.

- Land Use; there are few developments along the river and they are set back from the top of bank. The land use on the left bank is a gravel quarry but there is a 30 -100m treed buffer to the river bank. The right bank land use has an industrial fabrication (steel box plant) as well as a small subdivision off Granby Road of houses that are set back 30m or more
- Bank Stability; there were no areas of slides or significant erosion. The river banks is bedrock, boulder and cobble. There is very little erodible soil below the highwater line.
- Average Vegetation Depth: The riparian zone average depth was 64m. It consists of a second growth forest of Douglas Fir as well as Western Red Cedar. There were few old trees observed as it was entirely logged 60-100 years ago. There are a few gaps where the riparian area is not 30m from top of bank, along the left bank by the pit and where property owners on right bank have cleared views.
- Crown Cover: At 63% crown closure, Reach 4 scored a Fair Rating. While not a Good rank (75% or better) it is much better than the lower reaches. Most of the reach lies east/west permitting the 30-50m deep canyon and similar height trees to provide good protection from the south side summer sun.

The Reach 4 fish habitat characteristics that were poor are;

- Cover;
There is a lack of LWD and Cover for fish in the reach; one log was counted in the entire length. The confined reach results in higher water levels, velocities and turbulence; all factors that limit anchoring of LWD. The lack of LWD can also be attributed to the young riparian forest that lacked large trees as a source and the steep bedrock areas where trees do not grow.
- Wetted Area
The wetted area is only 66% of the channel area (taken at winter low flow) but the confined canyon has bedrock controlled pools that change little over the year.
- Spawning Gravel; The substrates had less than 5% spawning gravels. The pool tailouts were made of larger cobble and boulder materials. Gravel, if historically present may have been washed away. There were also very few fines in the substrate.

Reach 4 Survey Area



Reach 4 Habitat Photos Page 1



1.) R4-Pool 3 looking downstream to Bungy Zone/Hwy.



2.) R4- Accessible tributary enters Pool 3 from pit side



3.) R4 – Glide 2 at potential spawning gravel site.



4.) Pool 2 is 280m long, at Water Survey Stn., with snowmelt

Reach 4 Habitat Photos Page 2



5.) R4-Glide 1 along steep but stable riparian zone left bank



6.) R4-Most trees are 60-100 yrs with occasional vet. (shown)



7.) R4-One of two old logging roads on left bank along the trail.



8.) Reach 4 – Pool 1 at top end has steep banks.

Reach 5 Habitat Survey Results

Reach 5 is located along the Nanaimo Lakes Road in a deep bedrock canyon. The reach is 2486m long; it starts at the top of Reach 4 adjacent a large gravel quarry on left bank and ends upstream of the River Terrace subdivision along Nanaimo River Road. The Vancouver Island Transmission Corridor crosses the river in the middle of Reach 5. The entire reach is confined in a 35-50m deep gully. The Bore Hole is a bedrock gorge located just upstream of the power line crossing. The bedrock gorge resulted in the reach being partially inaccessible. Stark Creek drains the White Rapids Road area and enters at the Bore Hole near the Gas Line crossing over a steep bank that is a fish migration barrier. This tributary is lake fed but has limited flow in summer (it is used as a water supply with licenses from 1948).

Our survey began at the power line and we walked down the river left bank over approximately 1048m distance to end at Reach 4. The surveys were taken from the top of the canyon bank as well as from point access at habitat breaks in the lower locations where there were trails.

Reach 5 was surveyed on Feb. 19, 2021. It had six pools and three riffles. The average channel width is narrowest of the lower reach 1-5 segments at 50.1 m. The wetted width in February was 37.6m. The average gradient was 2.4%. The narrow canyon has water scour marks and debris to more than 5.0m above the mean winter water level. The bank walls along water line are primarily bedrock, there is very little vegetation in the floodplain. There are many large boulders that fill the wetted areas of riffles and pools. The boulder and bedrock formations result in pools to 3.0m deep.

Habitat results are shown in the table below.

Table 7 - Reach 5 Habitat Summary Results

Habitat Parameter	Result	Ratings	Result
% Pool Area	39	5	Fair
Large Woody Debris/Bankfull Channel Width	0	5	Poor
% Cover in Pools	6	3	Fair
Average % Boulder Cover	6	5	Poor
Average % Fines	0	1	Good
Average % Gravel	3	not rated	
% of Reach Eroded	0	1	Good
Obstructions	0	0	Good
% of Reach Altered	9	3	Fair
% Wetted Area	75	3	Fair
	44	2.9	Fair

The Riparian features of Reach 5 are shown in the table below taken from the USHP summary tables.

Table 8 - Reach 5 Riparian Results

Riparian Ratings	Result	Ratings	Result
Land Use	46	3	Fair
Riparian Slope	86	5	Poor
Bank Stability	18	1	Good
% Crown Cover	56	3	Fair
% of Reach Accessed	12	3	Fair
Average Vegetation Depth	46	3	Fair
Mean Score		3.0	Fair

Reach 5 habitat results indicate a Fair result. The fish habitat results are representative of the boulder/bedrock reach. The Good habitat characteristics were;

- Fines %;

There were no detectible fines on the surface of the substrates. We dug and rolled rocks and there were no puffs of dirt and no fine sands between interstices. There was an afternoon cloudiness to the water that appeared after the sun melted snow in the upper river. We observed it began upstream of First Lake and swept through the entire river in a few hours. Then clearing with overnight freeze up. The material stayed in suspension and did not form deposits on any of the substrates we inspected. We observed this on several days in February.
- Erosion %;

There were no locations of recent bank erosion in the reach. It had almost solid bedrock sidewalls in this reach which would not permit erosion.
- Alterations;

There are no significant impacts to Reach 5 fish habitat from alterations, but the area does have many man made features. The Vancouver Island BC Hydro Transmission line crossing is located at mid reach. Immediately upstream is the Fortis Gas mainline crossing. Both are well above the water level. There is clearing of the riparian area associated with these crossings. At the Hydro Line a parking area leads to an unmaintained trail on river left bank. The site is well used. There is a wooden box staircase down the 40m canyon to the river bed. The escarpment has a foot trail that goes downstream along the river left bank. Upstream at a gorge viewpoint and rock climbing wall there are human impacts on the thin soils where quads riders have removed the forb and moss vegetation down to bedrock. At the top of the reach are remnant concrete abutments of the old logging railway that crossed here. They are concrete and set back offering only a historic feature.
- Barriers:

There are no log jams, debris jams, dams or manmade features in the waterway. There are many rock outcrops and narrow points along Reach 5 as it is in a bedrock gorge. The Bore

Hole is a particularly energetic boulder cascade between the Hydro Line and Gas Line crossings with velocity and drops. It is a migration barrier to Chum or Pink Salmon.

The Reach 5 fish habitat characteristics that were scored poor are;

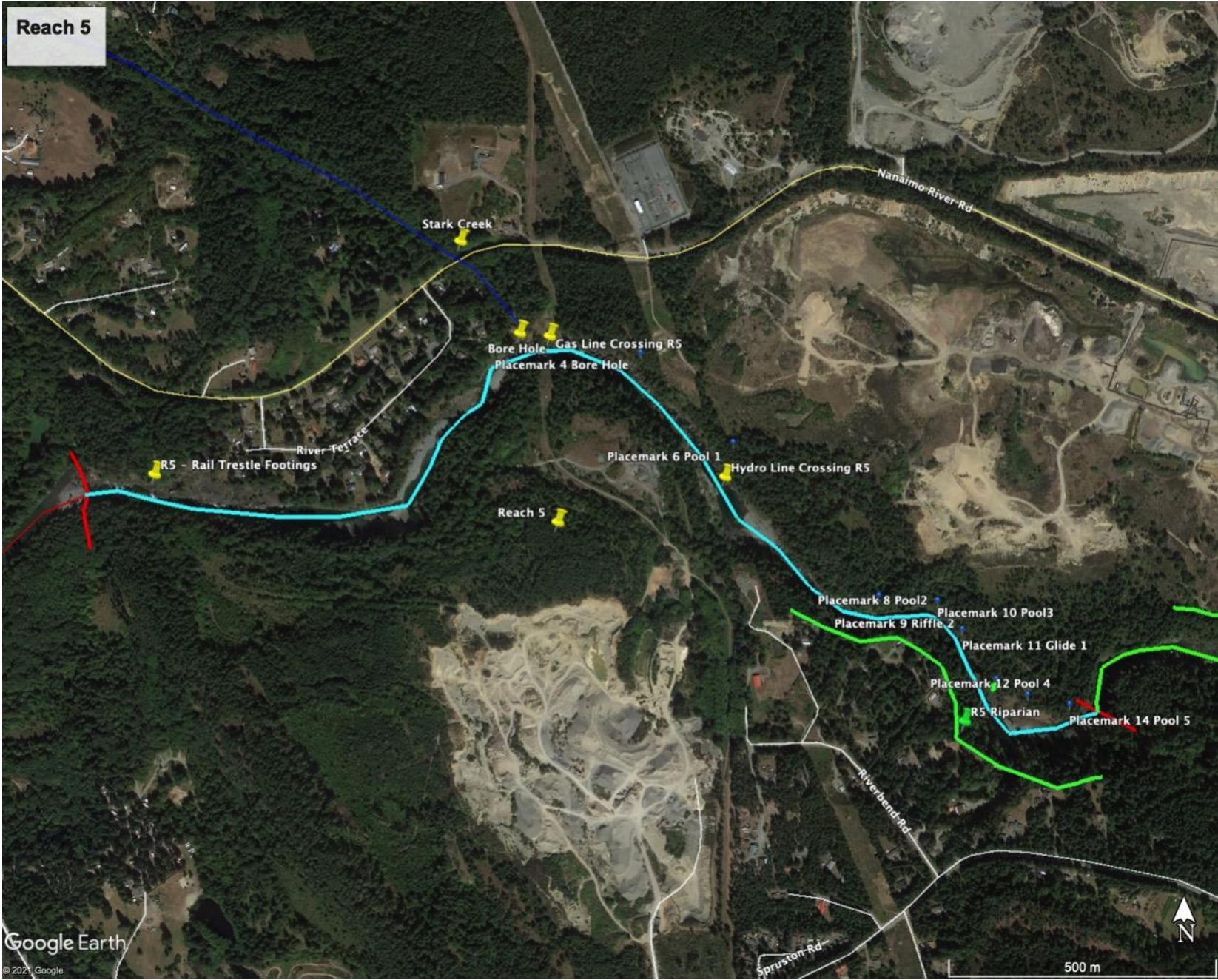
- Cover;
There is a lack of LWD Cover for fish in the reach with the exception of boulders. Boulders scored 6% of wetted area. Combined with the deep pools in the canyon there may be adequate cover for adults fish during migration. Juvenile fish will likely suffer with rearing habitat quality being poor due to the lack of cover.

Reach 5 Riparian Characteristics that were scored good:

- Bank Stability was the only Good scoring Riparian characteristic in this reach. There were no areas of slides or significant erosion. The river has bedrock sidewalls.
- There is a small Garry Oak grove at Placemark 12 on a south facing bedrock slope. This was the only Reach 5 occurrence and has value as a significant riparian ecological feature.

There were many Reach 5 characteristics for instream and Riparian Habitat that scored Fair. The moderate rating for the reach is due to the resilient bedrock substrate. Where other reaches have eroded and lost their channel and riparian areas, this site has not. Fish habitat characteristics in this reach are likely the least changed from human impact of the reaches surveyed due to the bedrock structure. The habitat offered is not particularly good, the confined areas are subject to high flood velocity and debris exposure. Pool 1 below the Hydro Line had the widest (73m) channel in the reach. The average of 50m and as narrow as 23m. Flood debris scour was 15m above the water levels in February. There are few places to hold in winter. Summer habitat is much better, the bedrock and boulders have pool crests that have not been beaten flat by flood debris. Pool depths of 2-4m exist in this reach in summer. There is likely poor primary food production in this reach; there was no allochthonous debris. Additionally the shaded deep bedrock limits algae production as an invertebrate food source.

Reach 5 – Survey Area



Reach 5 Habitat Photos Page 1



1.) R5. Bore Hole From Hydro Line looking upstream



2.) R5 Pool 1 (below Hydro line) heading downstream – widest pool (73m) in R5



3.) R5 –Riffle 1 start has cobble/boulder crest, no gravel, no silt.



4.) R5 – Pool 2 more typical narrow (42m) pool in R5.

Reach 5 Habitat Photos Page 2



5) R5 – Pool 3, note 15 m high scour line on bedrock walls



6) R5 - Glide 1 is 100m long narrow (23m) confined in bedrock.



7.) Pool 4 is coloured after snow melt.



8.) Garry Oak bench along left bank (Placemark 12)

Reach 6-11

These mid reaches of Nanaimo River represent a 12.6 km length. They were not surveyed as they were outside the scope of the project. They were not identified as spawning habitat use for Chinook. These reaches would be difficult to inspect as they are in a confined bedrock gorge starting at Reach 5. While confined, they are not noted for any permanent barriers. White Rapids in Reach 6 has a fish way structure (concrete steps) installed to aid the passage of fish.

The habitat survey restarted where the river opened up below Jump Creek and First Lake at Reach 12.

Reach 12 Habitat Survey Results

Reach 12 was surveyed in February 2021 during a cold period with light snow on the ground. Water levels were at bank full width but low and clear. The reach has Nanaimo Lakes Road on the river left bank and the right bank has Mosaic Forest Management logging roads. The Nanaimo Regional District water supply from Jump Lake Reservoir and the Vancouver Island Hydroelectric Transmission line cross the river in this reach. Reach 12 starts at a gradient change (3% to 1%) above a long boulder riffle in Reach 11. Reach 12 ends upstream at the Jump Creek confluence pool. The entire reach was surveyed walking in the river and further upstream on an old rail grade on river left bank. The reach is approximately 1609m. Reach 12 has one pool, four riffles and four glides. The average bankfull channel width is 56.1m. The wetted width in February was 46.7m. the average gradient was 1.6%. There is active floodplain erosion of the riparian area and a large side channel (900m total) on the left bank in the lower reach. The Jump Creek entrance on right bank is flood plain forming a channel through the narrow riparian area. The remaining sides of the reach are confined with treed banks. The results are shown in the table below.

Table 9 - Reach 12 Habitat and Water Quality Summary Results

Habitat Parameter	Result	Ratings	Result
% Pool Area	7	5	Poor
Large Woody Debris/Bankfull Channel Width	0.0	5	Poor
% Cover in Pools	4	5	Poor
Average % Boulder Cover	4	5	Poor
Average % Fines	2	1	Good
Average % Gravel	6	not rated	
% of Reach Eroded	5	1	Good
Obstructions	0	0	Good
% of Reach Altered	5	1	Good
% Wetted Area	83	3	Fair
	Mean Score	2.9	Fair

The habitat features that were good in Reach 12 are related to the scoured channel, which now has low erosion features and few sediments. The power line and water line are alterations that are relatively benign with some loss of shade but stable banks.

The Poor habitat scores relate to Pool Area, LWD and Cover. There is one pool in the reach at the top end at Jump Creek confluence. The large pool is formed by a large left bank bedrock outcrop.

The substrates in this reach are 4% Bedrock, 71% Boulder, 17% Cobble with only 6% Gravel and 2% Fines. The channel has degraded with a 0.5m to 1.0 m drop below the tree root line along most of the reach. Any other pools were historically washed out to form Glides. There was one piece of anchored LWD in the entire reach.

The Riparian features of Reach 12 are shown in the table below taken from the USHP summary tables.

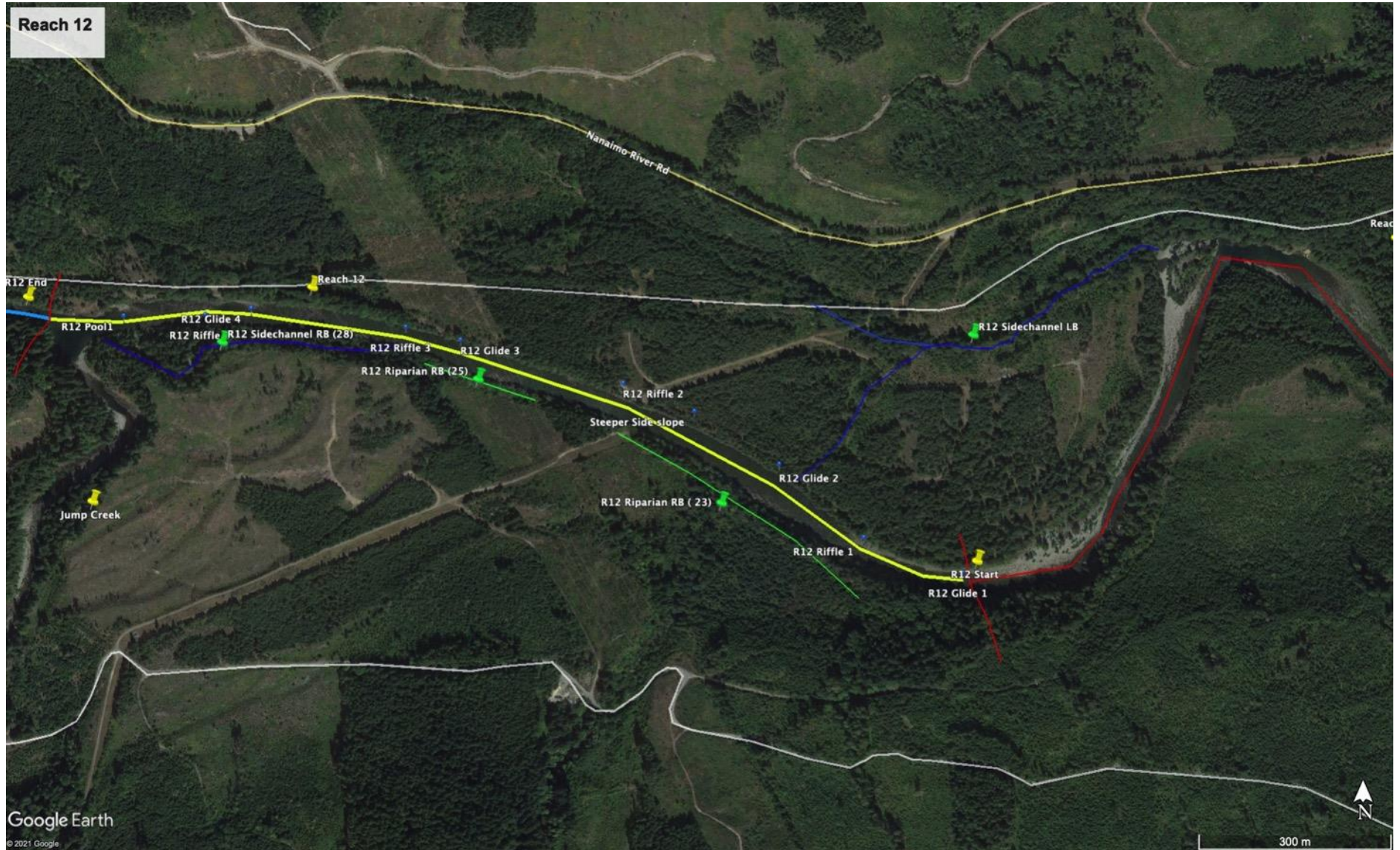
Table 10 - Reach 12 Riparian Results

Riparian Ratings	Result	Ratings	Result
Land Use	22	1	Good
Riparian Slope	38	2	Fair/Good
Bank Stability	38	2	Fair/Good
% Crown Cover	45	3	Fair
% of Reach Accessed	19	3	Fair
Average Vegetation Depth	26	5	Poor
Mean Score		2.7	Fair

The Riparian area of reach 12 is a historically logged forest. The south bank has some small but functional groves of veteran trees that may have been spared as they were on a steep bank. The riparian zone is an average of 26m wide. Some habitat units had as little as 5.0m on either side. The widest riparian area was at the Jump Creek confluence pool (50m).

There were no active slides or excessively steep banks in the reach, average slope was 38%. The bank stability was rated overall Fair/Good, but it was evident the channel had endured significant historic channel scour erosion, degrading the elevation and removing the gravels and LWD. There is one old slide track off the rail grade in Glide 4 (Placemark 28) that is not vegetated. Flood water levels do encroach into the riparian areas. Reach 12 has two areas of floodplain overflow; a left bank overflow Glide 2 feeds a 700m long sidechannel. The floods also track through the thin riparian area for 200m parallel to the river. This left bank riparian area is 30m wide second growth Douglas Fir showing some mortality from the flood pressure.

Reach 12 Survey Area



Reach 12 Habitat Photos Page 1



1.) R12- Glide 1 Boulder/cobble upstream at south bank



2.) R12 –R1-Riffles were 0.5m deep, some boulder cover



3.) R12- Glide 2 -LB riparian is flooded to 1.0m, uprooting trees.



4.) R12 – Glide 4 -start of Rail grade in riparian

Reach 12 Habitat Photos Page 2



5.) R12- Slide track along rail grade needs planting



6.) R12- R2 Hydro Line crossing, Riparian is shrubbery/Alder.



7.) R12- Pool 1 (Jump Ck) looking downstream at reach.



8.) Pool 1 Tail out lacks spawning gravel.

Reach 12 – Sidechannel Photo Page 1/1



9.) Sidechannel top end near inlet is seasonal and 5-6m wide



10.) Sidechannel goes across old road.



11.) Midreach seasonal pool formed at junction



12.) Outlet joins mainstem in corner pool Reach 11.

Reach 13 Habitat Survey Results

Reach 13 is located along the Nanaimo Lakes Road from Jump Creek confluence upstream 3564m to the outlet of Wolf Creek. The reach is entirely owned by Mosaic Forest Management. There is an old logging railway along the entire length of river left bank. The Jump Creek mainline bridge passes over the lower reach. We surveyed the entire length of the reach. The meander pattern is limited and head cut similar to Reach 12. The reach is confined, there were no significant floodplains on either side of the treed riparian area. The stream bed had dropped approximately 1.0 m along the shoreline leaving the bank with a plated cobble surface. A significant physical feature is a midreach 180 degree meander around a bedrock outcropping. The river is diverted over 300m east then west. This peninsula of land was historically logged but its sides are re-established in second growth Conifer, it has an RV trail down to waters edge of Pool 1.

Our survey started at Wolf Creek walking downstream to end at the Jump Creek Pool. We surveyed along the river left bank on the old rail grade. Each pool or riffle habitat feature was inspected from the trail or in the river from the left bank. Reach 13 was surveyed on Feb. 4, 2021. It had four Pools, five Glides and eight Riffles. The average channel width was 41.5 m. The wetted width was 32.6m. The average gradient was 1.7%.

Table 11 – R13 Habitat Summary Results

Habitat Parameter	Result	Ratings	Result
% Pool Area	14	5	Poor
Large Woody Debris/Bankfull Channel Width	0.1	5	Poor
% Cover in Pools	4	5	Poor
Average % Boulder Cover	5	5	Poor
Average % Fines	3	1	Fair
Average % Gravel	14	not rated	
% of Reach Eroded	1	1	Good
Obstructions	0	0	Good
% of Reach Altered	0	1	Good
% Wetted Area	78	3	Fair
	Mean Score	2.9	Fair

The habitat summary results in a Fair score. The Good rating for erosion is due to the fact the river bed is washed down to hard substrates. There are rail culvert washouts (Placemark 9 & 10) that are eroding off steep slopes into the river that need remediation. The Good rating for Obstructions such as log jams is because they must have been removed or historically washed away as none exist. Some residual log debris is observed in the narrow floodplain trapped amongst tree stems. The Alterations to the river are historic: the logging railway ceased operation approximately 60 years ago. The rail bed is in surprisingly good condition given there has been no sign of maintenance. Erosion was low for the overall length but two sites were observed along the rail grade. There is a plugged culvert at Placemark 9 has that needs cleaning. Downstream at Placemark 10 there is a bank failure approximately 30m wide eroding sand down to the river.

This reach offers Poor habitat due to a lack of Pools, Spawning gravel, LWD and Cover. The confinement of the reach results in in a lack of refuge habitat. Pool 4 in the lower reach is a large

bedrock controlled pool that is the deepest (over 4m) in the reach and likely offers the best summer holding.

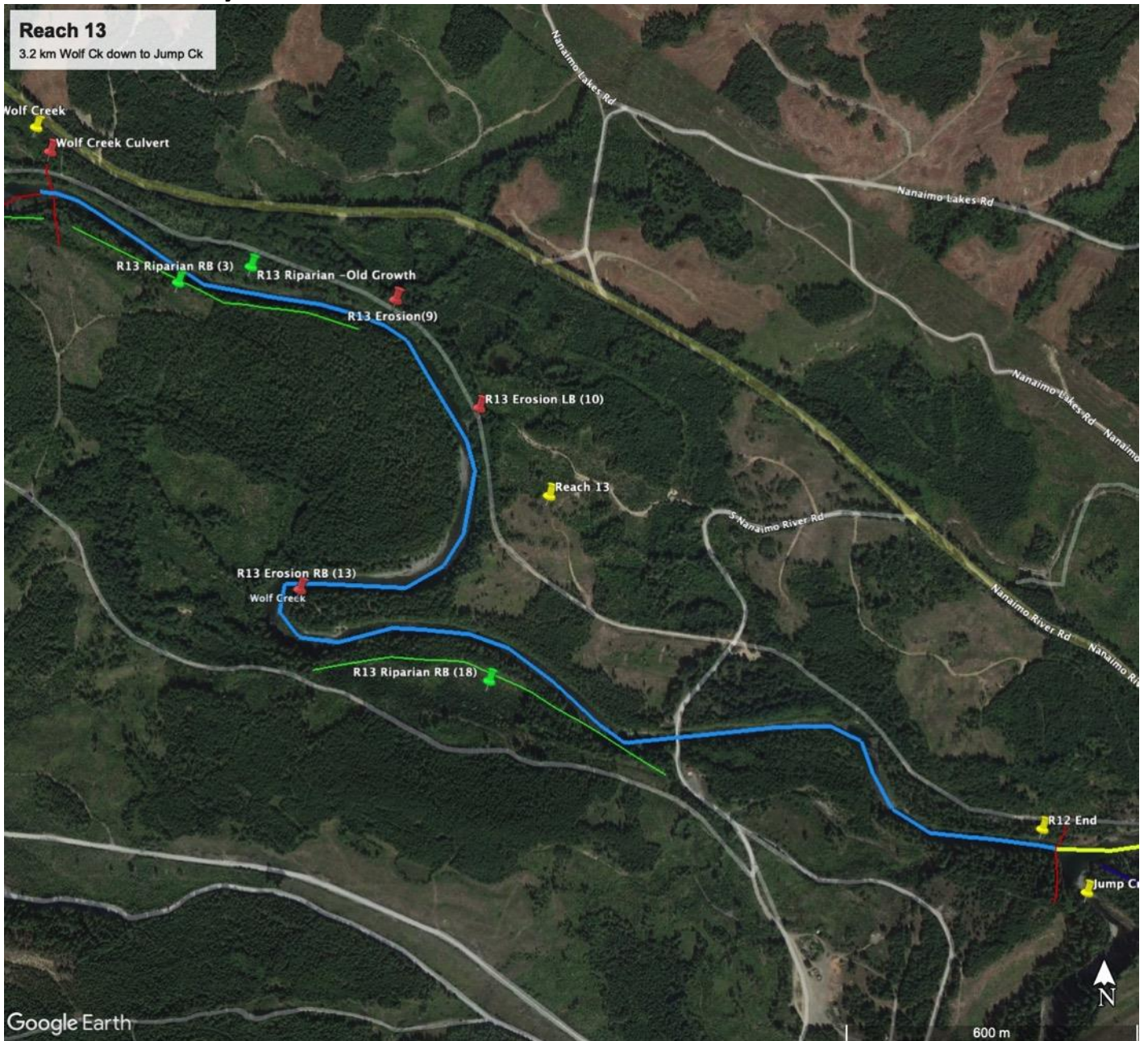
The Riparian features of Reach 13 are shown in the table below taken from the USHP summary tables.

Table 12 – R13 Riparian Results

Riparian Ratings	Result	Ratings	Result
Land Use	26	1	Good
Riparian Slope	46	2	Fair-Good
Bank Stability	54	2	Fair-Good
% Crown Cover	53	3	Fair
% of Reach Accessed	11	3	Fair
Average Vegetation Depth	36	3	Fair
Mean Score		2.3	Fair-Good

The riparian condition scores better than instream habitat. The vegetation depth along this reach is an average of 36m. The areas beyond have been recently logged and trees are in various states of regeneration. The riparian area is primarily Douglas Fir with Red Cedar closer to the shoreline. The regenerating trees are approximately 60-80 years old, with small groups of older Red Cedar observed near the river bank. Additionally, Red Alder form a single line the along the shores of the reach. The Alder were older and decaying providing a source of debris we observed along the river bank.

Reach 13 Survey Area



R13 Habitat Photos Page 1



1.) R13- Pool 4 above Jump CK is deepest pool in reach (4m)



2.) R13 – At Jump Mainline Bridge looking at lower reach



3.) R13 confined reach with steep slopes



4.) R13 – Riffle 3 below Wolf Creek in big bend

R13 Habitat Photos Page 2



1.) R13- flood debris deposited high in riparian area



2.) R13 – Placemark 10 slide track from rail line



3.) R13 Placemark 9 culvert under rail grade



4.) R13 – Wolf Creek plugged culvert

Reach 14 Habitat Survey Results

Reach 14 is located along the Nanaimo Lakes Road from Wolf Creek upstream to the outlet of First Nanaimo Lake just above the North Nanaimo River on the left bank. The reach is approximately 2013m long. The reach lies on land owned by Mosaic Forest Management. An abandoned railway grade follows along the left bank from 5 to 50m from waters edge. This old rail grade is an active recreational trail. An active forestry road runs the length of the right bank and is set back 40 to 400m from the river.

The reach is confined up to the North Nanaimo River outlet just below the lake. The majority of the channel has 5-30m banks on slopes of 17-19%. The stream channel along the reach shows signs of degrading from high flows and scour. The channel has dropped approximately 1.0 m below the tree root line leaving the bank with a plated cobble surface.

We surveyed the entire length of the reach. Our survey started at Nanaimo Lake walking downstream to end at the Wolf Creek confluence. We surveyed along the river left bank on the old rail grade. We also snorkel surveyed the upper reach lake outlet. Each pool or riffle habitat feature was inspected from the trail or in the river from the left bank. Reach 14 was surveyed on Feb. 4, 2021. It had seven Pools, six Glides and seven Riffles. The average channel width was 53.1 m. The wetted width was 38.2m. The average gradient was 1.7%.

Table 13 –R14 Habitat Summary Results

Habitat Parameter	Result	Ratings	Result
% Pool Area	45	3	Fair
Large Woody Debris/Bankfull Channel Width	0.1	5	Poor
% Cover in Pools	5	5	Poor
Average % Boulder Cover	3	5	Poor
Average % Fines	12	3	Fair
Average % Gravel	34	not rated	
% of Reach Eroded	8	3	Fair
Obstructions	0	0	Good
% of Reach Altered	0	1	Good
% Wetted Area	72	3	Fair
	Mean Score	3.1	Fair

The Reach 14 habitat summary results in a Fair score. The fish habitat aspects that were good are;

- Obstructions; there were no obstructions to fish passage along this reach. There were no debris jams, falls or cascades. The gradient is gentle (1.7%).
- Alterations: there are no active alterations in the reach. There is a historic rail line along the left bank that is generally benign.
- Boulder Riffles; these structures are important chinook and steelhead rearing habitat; while not meeting the criteria based on total area; Riffle 5 and 6 were examples functional structures. The boulders were 1-2m diameter.

Fish habitat aspects that were Fair or Poor were more common in Reach 14;

- Pool Area was Fair. The seven pools in this reach were scour pools. The average pool was no greater than 3.0 m depth, and approximately 120m long.

- LWD was Poor; only 20 pieces of functional wood cover in over 2 km. The majority of the logs were poorly anchored and small. Pool 2 had 9 LWD but they were mostly blowdown second growth attached poorly to the bank. Pool 3 had the highest LWD cover (10%) from 4 pieces on the left bank at the outlet of the sidechannel.
- Instream fish cover was Poor. Lacking LWD, Boulders, Undercuts or Vegetation throughout. The incised nature of the channel reduces the opportunity for overhanging vegetation or LWD attachment.
- Spawning habitat is Fair, it requires low fines with stable gravel placements. The substrates of this reach were 34% spawning gravel and 12% fines. The North Nanaimo River is the main source of substrates, both gravel and fines. The spawning deposits are largest at the lake outlet where Riffle 1 and Riffle 2 are full spanning gravel bars. The entire reach has gravel bars at pool tail outs. There are consistently more gravel deposits in Reach 14 over the lower reaches as it is less confined (53m vs 41m) and closer to the gravel supply. Protecting and Improving the spawning habitat in this reach is recommended.
- Erosion and Bank Stability scored Fair. There was 160m of bank erosion in this 2km reach (8%). The main type was trees falling in from undercut banks (i.e. Glide 2 Big Cedar) . The trees were lesser strength second growth (60-80 yrs) and it was more evident in areas where the channel had head cut. The old rail grade culverts are sources of sediment; there was a failure at Pool 3 with loss of fill. Wolf Creek culvert is a concern.

The Riparian features are shown in the table below taken from the USHP summary tables.

Table 14- R14 Riparian Results

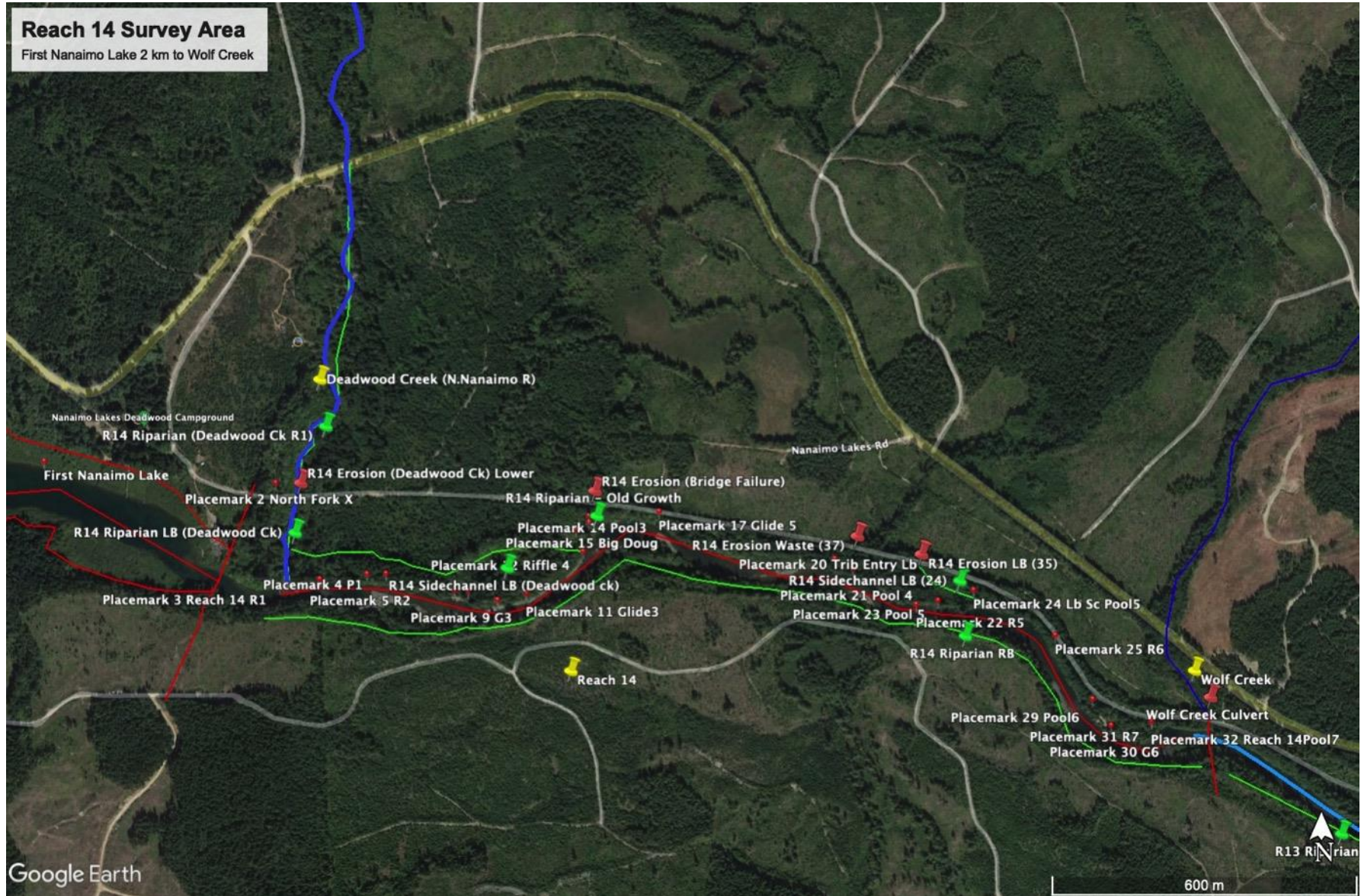
Riparian Ratings	Result	Ratings	Result
Land Use	34	1	Good
Riparian Slope	36	1	Good
Bank Stability	106	3	Fair
% Crown Cover	51	3	Fair
% of Reach Accessed	11	3	Fair
Average Vegetation Depth	41	3	Fair
	Mean Score	2.3	Fair-Good

In Reach 14, the riparian canopy is dominated by the historic Douglas Fir forest that is in its second or third cut from logging. Solitary Old Growth trees (>1.0m diam.) were occasionally observed. A small cluster (4) was found including Red Cedar and a 1.8m diameter Douglas Fir on the left bank near the outlet of the sidechannel at Pool 3. These trees appeared in good shape with no excessive lean, root erosion or flood scars.

The results of the Riparian Assessment were overall Fair to Good.

- Land Use is all forestry with the exception of the left bank has on summer cabin linked to the upstream lake campground. There are no road or utility crossings.
- The riparian slope is steeper in the lower areas but less so in the upper areas. The lower slope on left bank results in a 590m long sidechannel.
- The Crown Cover (51%) is lacking, mostly on the south side (right bank). The Average Vegetation Depth of 41m is Fair as well. Both could be improved by increasing the riparian depth in gap areas on the south side. There were a few areas mid reach where it was 10-20 m wide where at least 30m is recommended.

Reach 14 Survey Area



Reach 14 Habitat Photos Page 1



1.) R14 Riffle 5 has functional Boulder (1-2m diam) cover structures



2.) R14 P6 Right bank (south side) featured older trees.



3.) R14 – Pool 3 had the highest LWD Count (4)



4.) R14 – Riffle 1 North Nanaimo R contributes spawning gravel

Reach 14 Habitat Photos Page 2



1.) Wolf Creek culvert



2.) Wolf Creek culvert log Jam



3.) North Nanaimo overflows left bank to 590m channel



4.) Sidechannel near entrance to mainstem is fish accessible.

Reach 14 Habit Photos Page 3



5.) R14-Glide 2 – 20m left bank erosion



6.) R14-P5 Offchannel is 200m low gradient refuge



7.) P4- Plugged culvert along rail grade with old car body debris



8.) North Nanaimo River is a major spawning gravel supply to R14

Reach 15 First Nanaimo Lake – Not Surveyed



Reach 16 Habitat Survey Results

Reach 16 lies between First and Second Nanaimo Lakes. It is approximately 522m long. It is confined by bedrock outcrops and a 10m bank on either side. There are logging roads on both sides of the reach. The mid reach is crossed by a 40 m bridge with a concrete pedestal mid-channel. The reach was surveyed Feb. 2, 2021 during moderate flows. The short reach consists of two glides and a riffle. The average channel width was 34.3m over a 2.3% gradient. The habitat characteristics are shown in the table below.

Table 15 –R16 Habitat Summary Results

Habitat Parameter	Result	Ratings	Result
% Pool Area	0	5	Poor
Large Woody Debris/Bankfull Channel Width	0	5	Poor
% Cover in Pools	7	3	Fair
Average % Boulder Cover	7	5	Poor
Average % Fines	0	1	Good
Average % Gravel	10	not rated	
% of Reach Eroded	2	1	Good
Obstructions	0	0	Good
% of Reach Altered	30	5	Poor
% Wetted Area	66	5	Poor
	Mean Score	3.3	Fair

The Riparian features are shown in the table below taken from the USHP summary tables.

Table 16- R16 Riparian Results

Riparian Ratings	Result	Ratings	Result
Land Use	14	2	Fair-Good
Riparian Slope	14	2	Fair-Good
Bank Stability	6	1	Good
% Crown Cover	40	3	Fair
% of Reach Accessed	0	0	Good
Average Vegetation Depth	10	5	Poor
	Mean Score	2.2	Fair-Good

The Reach 16 habitat survey show a Fair result overall. It had the following Poor attributes;

- Pool Area- no pools, but the lakes are nearby.
- LWD – the reach lacks LWD. The banks are flush with bedrock and boulders and not likely to collect LWD.
- Alterations – the bridge is in the channel. There is a 10m tall bridge pedestal on a 3-4 m wide concrete base mid channel. The top end of the reach has blast rock on the banks and streambed. The reach appears to have been dredged and blasted to accommodate the bridge.

- Spawning Habitat –Gravel deposits in the mid reach are absent and flushed out by high flow and debris. The reach is confined with no floodplain to reduce velocity.

The Good habitat attributes were;

- Erosion – the reach was made of bedrock and boulders limiting bank erosion. There is an older slough of gravel deposits to the river on left bank. There is an active gravel surface logging road along the reach. The road sediment runoff is directed by ditches and berms to rock or vegetation swales with no flow to the river observed.

Riparian Habitat: This reach has only 10m of average riparian depth due to the close proximity of the logging roads which are located against a bedrock bluff. The canopy is currently only 40% in the reach, but the young healthy trees are growing well and combined with their location on a high bank could offer 75% canopy closure in 20 years. The riparian trees are 5-10m ht second growth Douglas Fir and Red Cedar with a thin band of Red Alder along the shoreline. A small gravel slip face off the road is the only exposed erosion but there are pioneering saplings growing on it. This site could be helped along with shrubby plantings.

Reach 16 Discussion

This reach is unique as it is the connector between First and Second lakes. It has been altered. The outlet of Second Lake in Reach 16 was altered by blasting, dredging, rock armour placement as well as debris torrents. The purpose may have been for bridge installation, log transport or to reduce cabin flooding in Second Lake. The historic alterations to the channel appear to have lowered (estimate 1-2m) the elevation of second lake; losing the spawning gravel, reducing summer water volume and drying shoreline riparian areas. These alterations have reduced high value spawning habitat.

Spawning Gravel Restoration

Lake outlets are prime areas for Salmon spawning habitat; they filter sediments and buffer flood surges. First Lake outlet is the current primary spawning area for early run Chinook. Second Lake outlet offers the potential to be an important additional spawning site. The post-glacial gravel deposits lost to disturbance require replenishment.

The potential spawning improvement area is from the bridge upstream approximately 150m by 20m (3000m²) depending on depth and access. There is a nearby road and potential river access for a ramp on the south side just upstream of the bridge site. The ramp would permit the easiest material and machinery access to the site. Other more limited delivery options include spreading gravel from the bank with an excavator or gravel slinger if rock sizes can be accommodated. The spawning sites may require boulders for gravel anchoring and habitat complexity. The site needs to be measured for depth and width to accurately determine material needed.

Other Restoration Activities:

There are no other significant opportunities observed in the reach but small restoration activities that could be done with stewardship groups given the high public use in the area; such as water quality sampling, garbage clean up and planting disturbed areas at angling sites (Table 25).

Reach 16 Survey Area



Reach 16 Habitat Photos Page 1



1.) R16- Glide 1 looking down to 1st Lake



2.) R16 – Riffle 1 looking off Bridge



3.) R16 R1 looking up at Bridge with centre span in channel



4.) R16 – Glide 1 (Spawning Gravel Site)

Reach 16 – Habitat Photos Page 2



1.) Spawning Gravel placement – possible access site.



2.) Exposed slope – planting opportunity

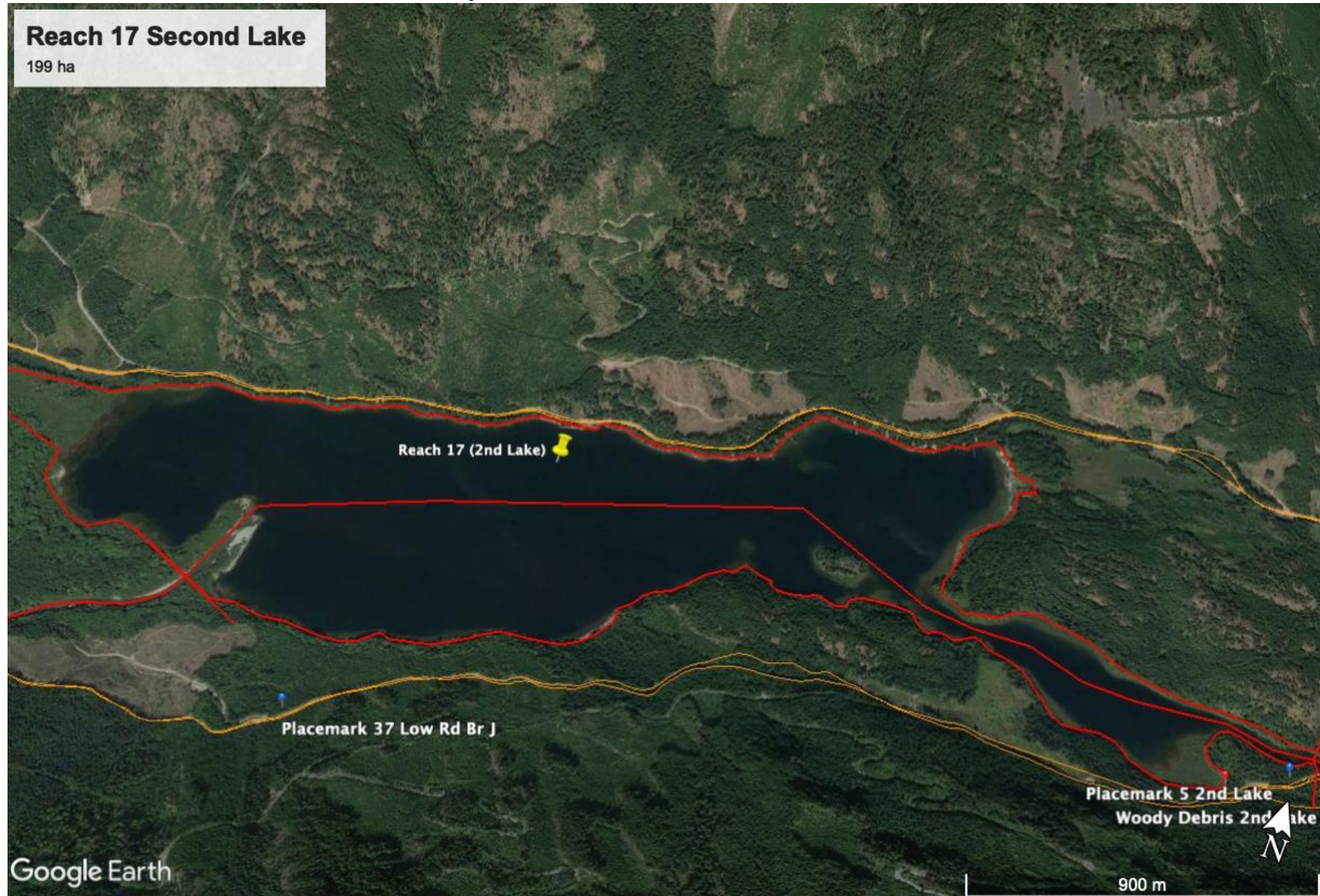


3.) Road is 10m from river, note grader berm on river side



4.) Popular angler site and trail in R16, site cleanup of gear.

Reach 17 – Second Lake, not surveyed.



Reach 18 Habitat Survey Results

Reach18 is approximately 5595 m long from Second Lake upstream to the TP Bridge at the start of bedrock-controlled Reach 19. The reach was surveyed Feb. 2, 2021 in moderate winter flows along the river right bank accessed from Branch F and J. The habitat survey was approximately 1515m long and started mid reach ending upstream at the TP Bridge. In the habitat survey were 4 Glides, 3 Riffles and 1 Pool. The average bankfull channel width was 41.4m, wetted width was 36.6m and the gradient was 1.6%. The habitat characteristics are shown in the table below.

Table 17 –R18 Habitat Summary Results

Habitat Parameter	Result	Ratings	Result
% Pool Area	5	5	Poor
Large Woody Debris/Bankfull Channel Width	0	5	Poor
% Cover in Pools	3	5	Poor
Average % Boulder Cover	3	5	Poor
Average % Fines	9	1	Good
Average % Gravel	23	not rated	
% of Reach Eroded	0	1	Good
Obstructions	0	0	Good
% of Reach Altered	3	1	Good
% Wetted Area	89	3	Fair
	Mean Score	2.9	Fair

The Riparian features are shown in the table below taken from the USHP summary tables.

Table 18- R18 Riparian Results

Riparian Ratings	Result	Ratings	Result
Land Use	16	1	Good
Riparian Slope	16	1	Good
Bank Stability	48	3	Fair
% Crown Cover	56	3	Fair
% of Reach Accessed	0	0	Good
Average Vegetation Depth	28	5	Poor
	Mean Score	2.2	Fair-Good

The results of Reach 18 habitat survey show a Fair overall result. The survey found the following Poor attributes;

- Pool Area- only one pool in 1500m survey length (formed by a bedrock outcrop) representing 5% of the wetted area. The historic pools are now glides as they are filled with sediment due to over-wide channels that lack LWD and bedrock outcrops. Riparian restoration is key to long term recovery of pools as trees reduce channel width and add LWD.

- LWD – the reach lacks LWD (0) due to historic logging effects. The lack of LWD results in a lack of cover for fish along the long glides. There is the opportunity to add LWD to the banks to protect eroding areas and create cover. Both banks are relatively low and accessible.
- Cover – Lack of cover throughout the reach was evident. The only cover was found in exposed Boulders not buried by sediments. Addition of cover that is flood proof is recommended and benefit juvenile fish greatly in this reach. Boulder habitat is evident in the reach but access to distribute boulders from bank areas is limited to the few roads near the banks.

The R18 Good habitat attributes were;

- Erosion – There are no large slides or long exposed bank erosion pockets. The banks are vegetated with second growth conifers, most of the Red Alder has died out. The trees are not mature size and prone to failure in floods; they are often pushed over by the river into the forested floodplain on the right bank, in many cases this forms a tight matrix of log debris among living trees that provides improved erosion protection. Assisting the trees in the battle with the river would include infill planting exposed areas with trees and shrubbery. There also may be some opportunity to cable the log matrices in place to improve stability in the treed floodplain. Note the floodplain is likely elevated in this aggraded reach due to sediment depositions.
- Spawning Habitat/Insect Habitat – there appears to be plenty of spawning gravel (23%) in this reach. There was little sediment deposition in the interstices of the rocks. The substrate supports aquatic insect habitat with Stonefly, Mayfly and Caddisfly larvae found routinely under the rocks in this reach.

The Riparian area of reach 18 is entirely on private forest land. The reach was historically logged and no old growth was observed. The riparian trees are estimated between 40 to 80 years age. The species are Douglas Fir, Red Cedar, Red Alder with Hemlock and Grand Fir contributing as well. Riparian habitat is summarized in Table 18. This reach has a regenerating forest that scored Fair-Good overall.

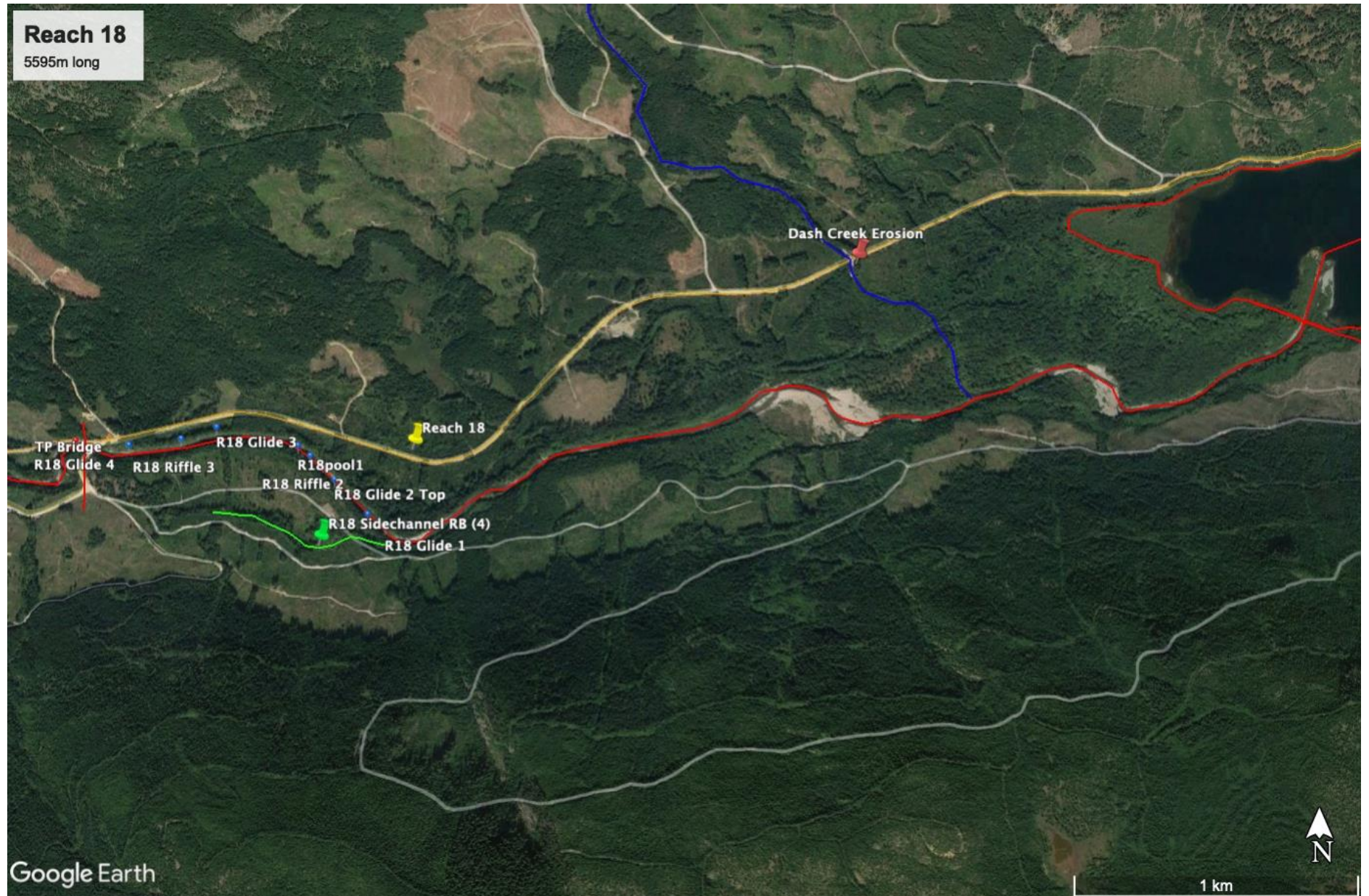
Riparian Features (Good)

- Land Use, Slope and Access all scored Good. The reach does not have any development other than logging activities; it has no steep slopes or vehicle trail crossings. There is a gravel river access at the upper TP Bridge.

Riparian Features (Poor);

- Crown Cover (58%), the streamside second growth trees are not yet tall enough yet to shade 75% of this reach, which runs east-west.
- Vegetation Depth (28m) is less than the width of the river (41m) along the 1500m survey area. There was no logging on stream banks in this 5.0 km long reach. The treed riparian depth varied from 10m to 30m along the survey area. Other areas of Reach 18 had up to 100m of riparian depth. A riparian depth of 50m is recommended especially in south facing aspects. It was observed that the second growth trees are providing erosion protection along the banks.

Reach 18 Survey Area



Reach 18 Habitat Photos Page1



1.) R18- Glide 1 looking 130m downstream 39m wide channel



2.) R18 – Riffle 1 is 108m long in a 45m wide channel



3.) R18 Pool 1 – is 92m long and 3-4m deep, no LWD



4.) R18 – Glide 3 is 318m long, shallow no cover, small erosion pockets as trees fall in

Reach 18 Restoration Photos Page 2



1.) R18- Sidechannel on south bank



2.) R18 – Flood plain on south (right) bank



3.) R18 Gravel Bar below Dash Creek.



4.) R18 – Dash Creek sediment deposits at road crossing

Reach 19– Not Surveyed

Reach 19 was not surveyed, this reach is approximately 1080m long. It starts upstream of the TP Bridge with the river left bank following along the mainline. The main haul road is paved in this section and does not have any sediment concerns.

Reach 19 map



Reach 19 Photos Page 1



1.) Reach 19 looking up from TP Bridge (February 2021)



2.) R19 with paved road alongside the confined reach

Reach 20– Not Surveyed

Reach 20 was not habitat surveyed. It is approximately 1961m long. Third Lake drains into this reach, as does Rush Creek. Both are significant tributaries that offer salmon access.

Reach 20 Map



Reach 20 Photos



1.) Third Lake

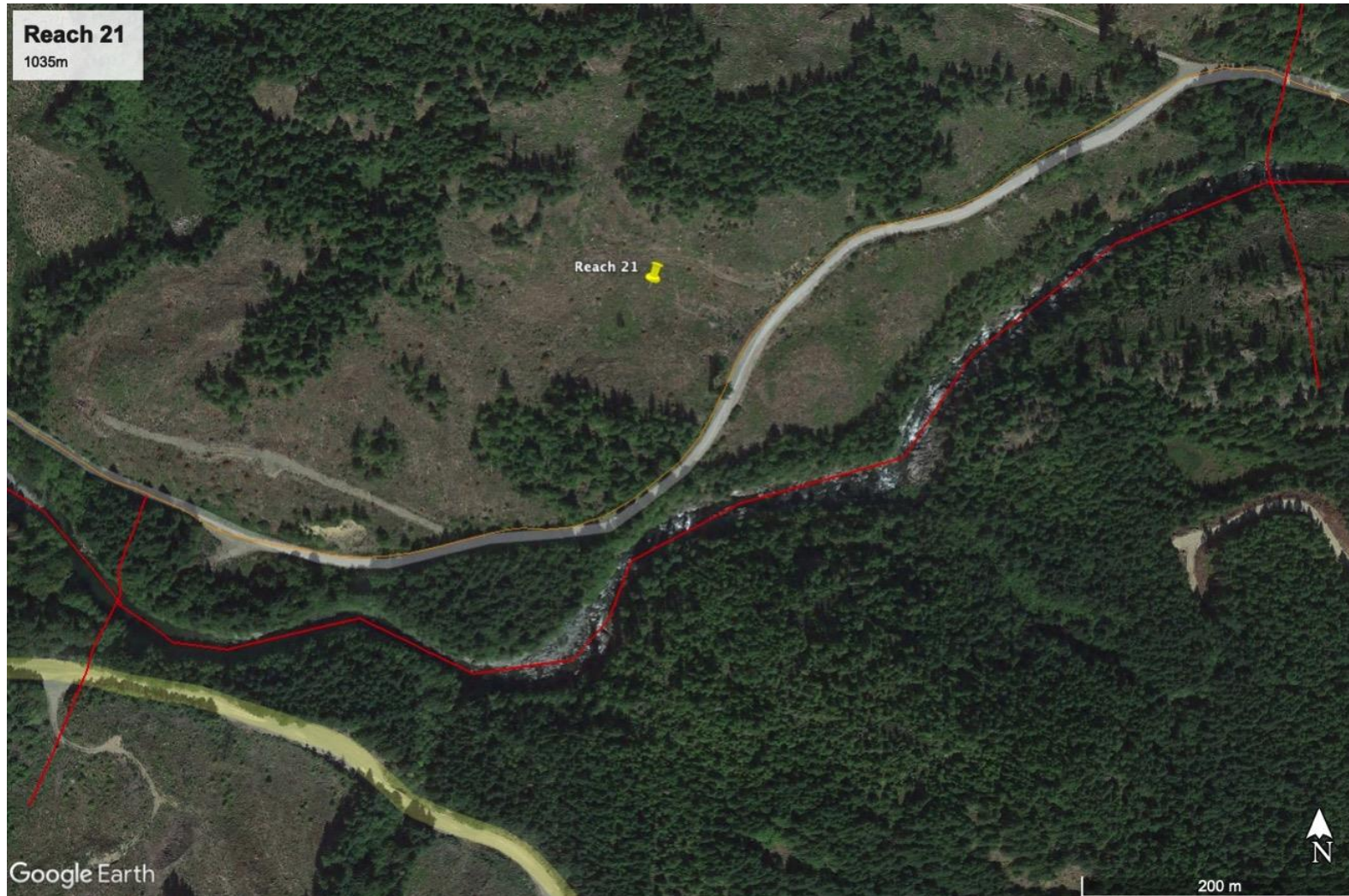


2.) Rush Creek at mainline crossing.

Reach 21– Not Surveyed

This reach was not habitat surveyed. It is approximately 1035m long and lies in a confined 10-30m deep gully with bedrock walls or steep treed banks.

Reach 21 Map



Reach 21 Photos



1.) R21 – looking down 30m from edge of mainline



2.) R21- sidehill tributary (no fish access) on right bank (J Main)

Reach 22 Habitat Survey Results

Reach 22 is approximately 2347 m long. It ends at the exit of Green Creek on the south bank. This reach is less confined than the lower reaches. It has large gravel fans and treed floodplains with sidechannels. The reach was surveyed Feb. 2, 2021 in moderate winter flows along the river left bank accessed from the mainline. The habitat survey was approximately 947m long and went along side the large alluvial to end just below Green Creek. In the habitat survey were 3 Glides, 3 Riffles and 1 Pool. The average bankfull channel width was 69.6m, wetted width was 31.6m and the gradient was 1.4%. The habitat characteristics are shown in the table below.

Table 19 –R22 Habitat Summary Results

Habitat Parameter	Result	Ratings	Result
% Pool Area	13	5	Poor
Large Woody Debris/Bankfull Channel Width	0	5	Poor
% Cover in Pools	4	5	Poor
Average % Boulder Cover	4	5	Poor
Average % Fines	8	1	Good
Average % Gravel	32	not rated	
% of Reach Eroded	20	5	Poor
Obstructions	0	0	Good
% of Reach Altered	0	1	Good
% Wetted Area	45	5	Poor
	Mean Score	3.6	Fair-Poor

The Riparian features are shown in the table below taken from the USHP summary tables.

Table 20- R22 Riparian Results

Riparian Ratings	Result	Ratings	Result
Land Use	16	1	Good
Riparian Slope	20	1	Good
Bank Stability	58	4	Fair-Poor
% Crown Cover	51	3	Fair
% of Reach Accessed	0	0	Good
Average Vegetation Depth	40	3	Fair
	Mean Score	2.0	Fair-Good

The results of Reach 22 Habitat Survey show a Fair-Poor overall result. The survey found the following Poor attributes;

- Pool Area- there was one outside bend scour pool along an eroding gravel bank. It was 130m long and represented 13% of the habitat area. The lack of pools is due to lack of LWD or bedrock outcrops.
- LWD – the reach lacks anchored LWD. There were numerous second growth trees falling into the river but they are too small to anchor. These trees hung on the banks until the next

flood and washed away. Anchoring the felled trees in LWD groups to provide fish habitat and bank protection is a potential restoration activity in this site.

- Cover – Lack of cover throughout the reach was evident. The only functional cover was Boulders.
- Erosion – There is significant bank failure in the upper reach area resulting in loss of riparian forest and a 400m long deposition bar. There is bank erosion on 20% of the survey length. The erosion is caused by flood scour into weak gravel banks. There are many trees along the banks but the second growth Douglas Fir do not have adequate root development to resist the erosion. Several old growth Red Cedar stumps still remain on the river left bank as examples of the greater flood erosion resistance that old trees have.
- Erosion - The large deposition fan is the product of several influences; Green Creek enters 100m upstream and the trail of debris from the creek makes it an obvious supply of sediment. The main fan in the reach is 400m long and over 100m wide. The sediment deposition is increasing the erosion on the right bank of the mainstem. The fan is recommended to be live staked and planted to stabilize the sediment.

The R22 Good habitat attributes were;

- Spawning Habitat – there appears to be plenty of spawning gravel (32%) in this reach and sediment was less than 10%.
- Alterations/Obstructions – this is a flat gravel bed reach with no fish migration barriers.

The Riparian area of Reach 22 was historically logged and no old growth was observed. The riparian trees are estimated between 40 to 80 years age. The species are primarily Douglas Fir, Red Cedar, Western Hemlock on the drained slopes with groves of Red Alder and Broadleaf Maple on floodplain areas. Riparian habitat is summarized in Table 20. This reach has a regenerating forest that scored Fair-Good overall.

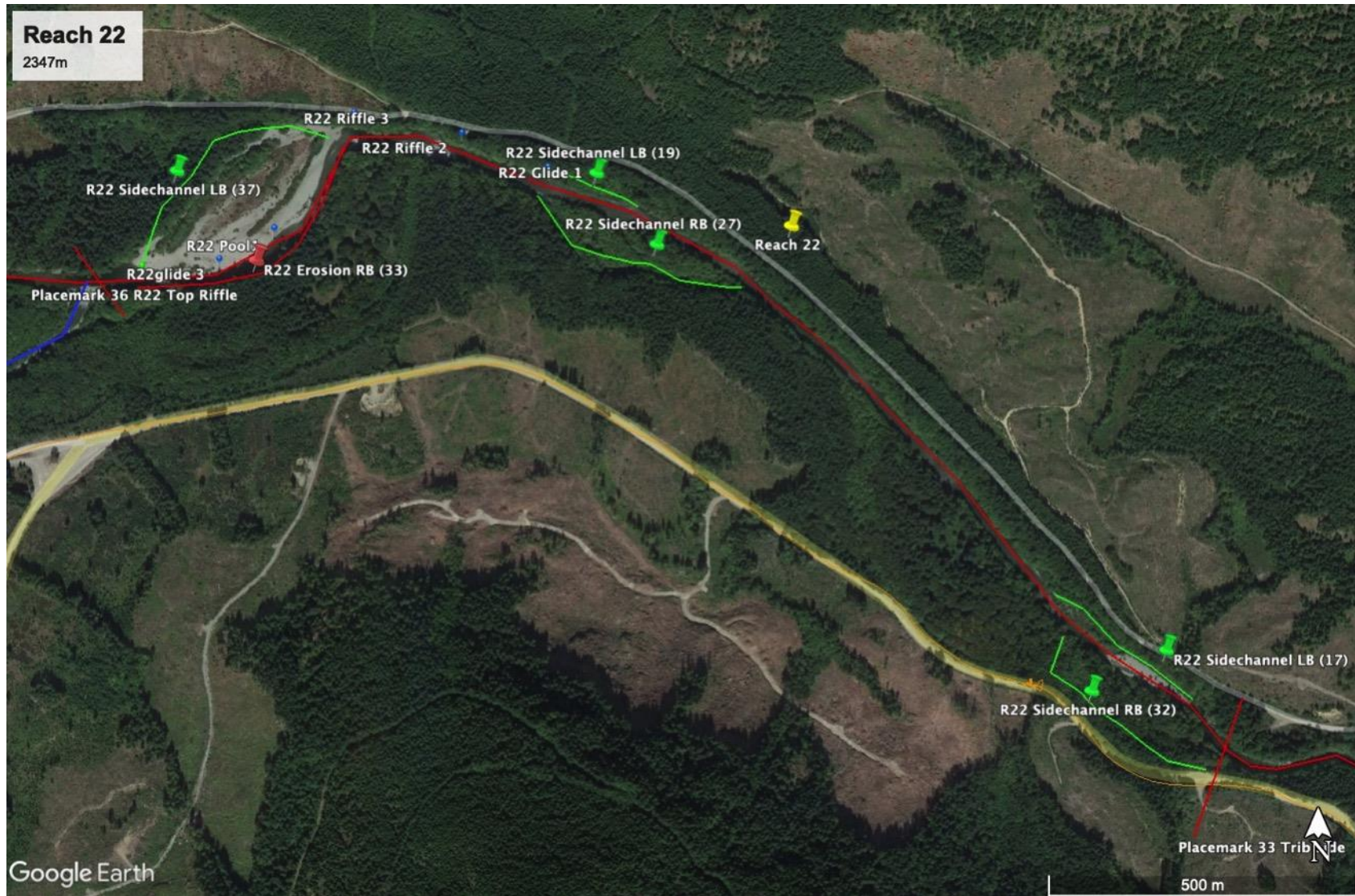
Riparian Features (Good)

- Land Use, Slope and Access all scored Good. The reach does not have any development other than logging activities; it has no steep slopes or vehicle trail crossings.

Riparian Features (Poor);

- Crown Cover (51%), the south side has a wide low bank for most of the survey area. The steep south side of Green Mountain helps shade in summer.
- Vegetation Depth averages 40m to first opening. Increasing this to an average over 50m will improve the bank stability and crown cover.

Reach 22 Survey Area



Reach 22 Habitat Photos Page 1



1.) R22 – Riffle 1 is 180m long and 0.3m deep. 2.) R22 – Glide 2 features a big rock



3.) R22 Pool 1 formed by meander scour on right bank erosion 4.) R22 Glide 3 erodes right bank along the alluvial fan

Reach 22 Habitat Photos Page 2



1.) R22 - Riffle 3- gravel bar needs planting



2.) R22 – Gravel bar looking downstream 400m



3.) R22 Right bank (Stn 33) erosion and undercutting trees.



4.) R22- Sidechannel 4 (stn27) offers fish habitat

Reach 23 Habitat Survey Results

Reach 23 is approximately 3038m long. It starts at the confluence of Green Creek goes upstream past Rocky Run Creek and ends at the confluence of Sadie Creek, which drains the Fourth Lake dam. This reach is more confined than the lower Reach 22 as the steep valley walls close in on either side. The sidewall tributaries offer short fish access generally ending at the location of the logging road bridge crossings 50m to 250m upstream. The reach was surveyed Feb. 2, 2021 in moderate winter flows along the river left bank accessed from the mainline. The habitat survey was 642m long. We started mid reach where the mainline was within 50m of the reach. We surveyed 3 Glides, 2 Riffles and 1 Pool. The average bankfull channel width was 35.0m, wetted width was 29.3m and the gradient was 1.4%. The habitat characteristics are shown in the table below.

Table 21 –R23 Habitat Summary Results

Habitat Parameter	Result	Ratings	Result
% Pool Area	12	5	Poor
Large Woody Debris/Bankfull Channel Width	0	5	Poor
% Cover in Pools	2	5	Poor
Average % Boulder Cover	2	5	Poor
Average % Fines	10	3	Fair
Average % Gravel	13	not rated	
% of Reach Eroded	0	1	Good
Obstructions	0	0	Good
% of Reach Altered	0	1	Good
% Wetted Area	84	3	Fair
	Mean Score	3.1	Fair

The Riparian features are shown in the table below taken from the USHP summary tables.

Table 22- R23 Riparian Results

Riparian Ratings	Result	Ratings	Result
Land Use	12	1	Good
Riparian Slope	12	1	Good
Bank Stability	24	2	Fair-Good
% Crown Cover	61	3	Fair
% of Reach Accessed	0	0	Good
Average Vegetation Depth	43	3	Fair
	Mean Score	1.7	Fair-Good

The results of Reach 23 Habitat Survey show a Fair overall result. The survey found the following Poor attributes;

- Pool Area- there is one scour pool in the reach created by a bedrock outcrop at a river bend. It was 41m long and represented 12% of the survey area. It is shallow (2m) and while generally lacking cover, had the only LWD feature in the reach survey area.

- LWD – the reach lacks LWD. One rooted undercut in Pool 1.
- Cover – Lack of cover throughout the reach was evident. The only functional cover were a few Boulders.
- Tributary Erosion- On the river left bank there are two steep sidehill tributaries that have recently avulsed with sediment. The first is located entering glide 3 in the habitat survey areas. It had a channel avulsion delivering sediment in a broad fan from the lower logging road crossing (Stn 23) downstream to the river (70m). Fortunately most of the material has dropped out into the forest in a 10m wide fan up to 1.0 m deep. Along the same road, at the next wood box culvert crossing is another eroded channel with some recently stockpiled channel sediments. This material also appears to have dropped out most of its contents prior to the mainstem. These channels are seasonal flow.

The Reach 23 Good habitat attributes were;

- Erosion – there was no bank erosion in the survey area. The banks were made up of bedrock/boulders and trees roots. There was no undercutting or exposed banks in this survey area.
- Alterations/Obstructions – None, the reach

The Riparian area of Reach 23 was historically logged and no old growth trees were observed. The trees in the riparian area are estimated between 40 to 80 years age. The riparian tree species are primarily Douglas Fir, and red Alder with some Red Cedar and Western Hemlock. Riparian habitat is summarized in Table 22. This reach has a regenerating forest that scored Fair-Good overall.

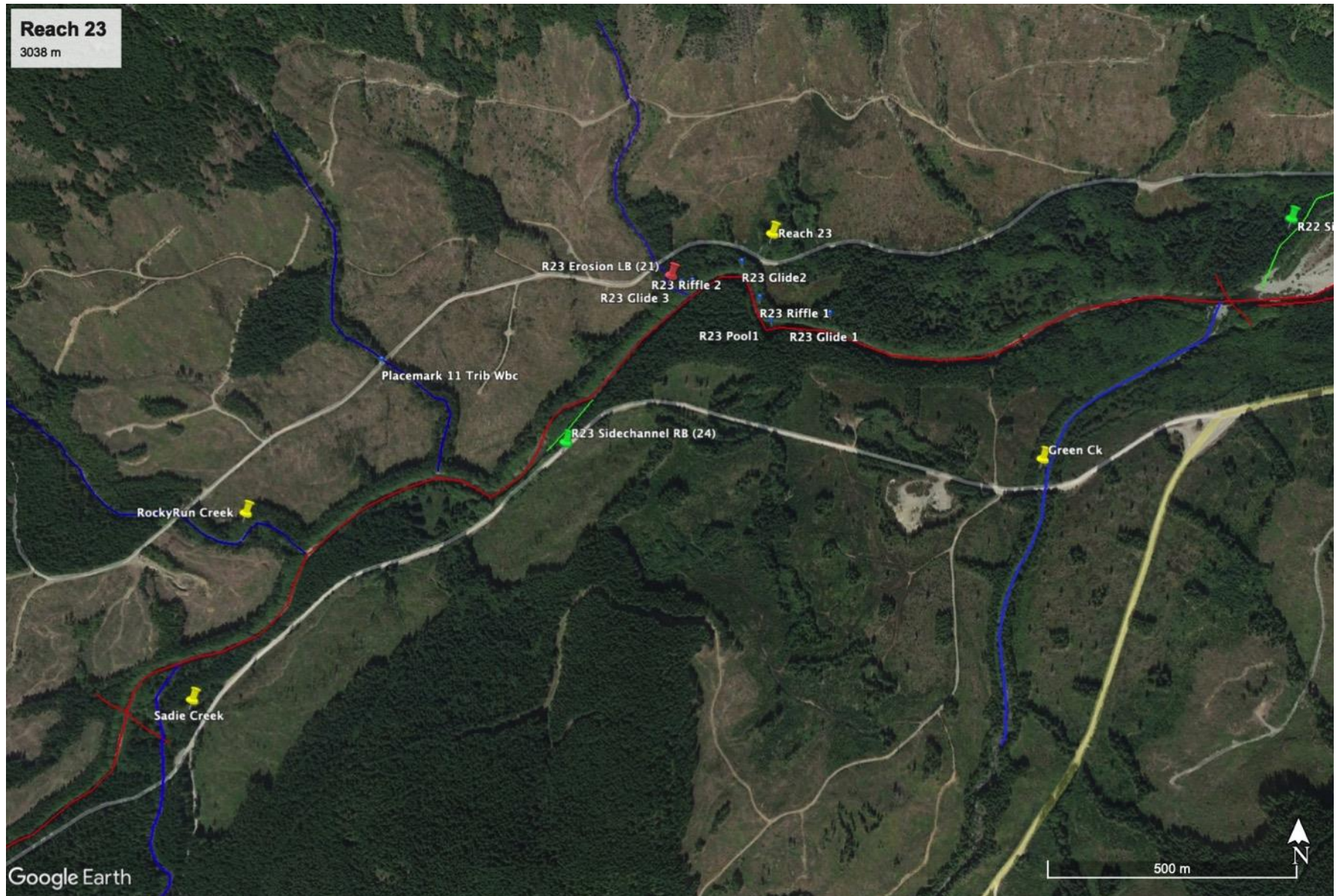
Riparian Features (Poor);

- Crown Cover is 61% where the desired is 75%. The shade is generated from regenerating Douglas Fir (est. 30-50 yrs). These trees appear to be growing well and will likely be tall enough in 10 years to score better.
- Vegetation Depth – the riparian tree depth is an average of 43m to first opening. Infill planting and protection to the desired 50m is recommended.

Riparian Features (Good)

- Land Use, Slope and Access all scored Good. The reach does not have any development other than logging activities, it has no steep slopes or vehicle trail crossings.

Reach 23 Survey Area



Reach 23 Habitat Photos Page 1



1.) R23- Riffle 1 was very productive with aquatic insects



2.) R23 – Pool 1 is the only pool and lacks cover.



3.) R23 Glide 2 with Boulder cover and limited LWD



4.) R23- Riffle 2 showing relatively stable banks

Reach 23 Restoration Photos Page 2



1.) R23- Green Creek passes under this bridge then enters R23



2.) R23 – Left bank Tributary channel disturbance (Site 21)



3.) R23 Braid at Stn 24 .



4.) R23 – Sadie Creek at Bridge is flowing through floodplain.

Discussion – Nanaimo River Habitat Assessment

Survey Efficiency and Limitations

The detailed salmon habitat survey covered eleven reaches of the Nanaimo River. Reaches 2-5 in the lower river, reaches 12-14 below First Lake and reaches 16,18,22 and 23 above First Lake in the upper watershed. These reaches were prioritized based on the historic and potential use for the Chinook salmon. The total length of the identified reaches was approximately 30,358m. The total habitat survey length was 17,295m (Table 23).

Table 23 – Nanaimo River Reach Survey Length Summary

Reach	Length Reach (m)	Length Reach (m)	Surveyed Length (m)	Chinook Migration Reach Type	Description
Reach 1	2990	0	0		Estuary to Riffle below Cedar Bridge
Reach 2	5424	5424	1679	Fall	Cedar Bridge to Haslam Creek entrance
Reach 3	2245	2245	2245	Fall	Haslam confluence upstream to TC Highway
Reach 4	1515	1515	1515	Fall	TC Highway to Hub City Gravel Pit
Reach 5	2486	2486	1047	Fall	To Hydro Lines at Bore Hole canyon
Reach 6	497	0	0		Not surveyed
Reach 7	1511	0	0		Not surveyed
Reach 8	1562	0	0		Not surveyed
Reach 9	4497	0	0		Not surveyed
Reach 10	1528	0	0		Not surveyed
Reach 11	3041	0	0		Not surveyed
Reach 12	1609	1609	1609	Summer	Below Jump Creek at Hydro/Water X
Reach 13	3564	3564	3564	Summer	Above Jump Creek/Wolf Creek
Reach 14	2013	2013	2013	Summer	Below First Lake
Reach 15	3486	0	0		First Lake, 243 ha
Reach 16	522	522	522	Spring	Between 1 st and 2 nd Lakes
Reach 17	3528	0	0		Second Lake, 199 ha
Reach 18	5595	5595	1512	Spring	Above 2 nd Lake to TP Bridge
Reach 19	1080	0	0		Not Surveyed
Reach 20	1691	0	0		Not surveyed
Reach 21	1035	0	0		Not surveyed
Reach 22	2347	2347	947	Spring	To Green Creek
Reach 23	3038	3038	642	Spring	Green Creek up to Sadie Creek
Reach 24	933	0	0		Not Surveyed
Reach 25	814	0	0		Ends at Anadromous Barrier by 4 th Lake
Total	58551	30358	17295		

The objectives of the survey were to do a minimum of 10 habitat units or to survey at least 10% of the reach, with more done as time permits. With 172965 m out of 30358m results in 57% of the habitat with detailed survey. Reaches 3,4,12,13,14 and 16 were 100% surveyed. Generally access dictated the reach survey coverage; in the lower reach private property limited access and further upstream the steep banks and deep water limited access. In each reach we walked along the shore and routinely waded into the reach. There were no safety issues we worked in pairs and

avoided deep or fast water. The outlet of first lake was inaccessible by foot so we inspected it by snorkel survey. This method afforded a close inspection of the substrates in an important spawning area.

We drove and walked most of the Nanaimo watershed and visually inspected all the reaches up to end of salmon Access (Reach 25). Tributaries were inspected for alterations, erosion or obstructions along each reach. This included the North Nanaimo River, Dash, Jump, Green and Sadie Creeks. We made comments about them in their respective reach entries.

The survey was completed with the assistance of the Mosaic Forest Management (David Vey), Steve Baillie (representing DFO, and Nanaimo River Stewardship Society (Brian Banks, Brian Hermann).

Habitat Condition Review

Reach summaries show which reaches fared the best or worst. In the next section the type of habitat deficiency is shown. The summary tables identified a numeric score for Good (1), Fair (3) and Poor (5). Converting the values into a numeric score permits reaches to be compared amongst each other or over time.

The table below shows a comparison of the 11 reaches surveyed by habitat and riparian scores of the Nanaimo Watershed. This table shows which reach was healthiest and which was in poorest condition.

Table 24 –Reach Habitat and Riparian Score Comparison

Reach	Habitat	Result	Riparian	Result
Reach 2	3.6	Fair-Poor	3.0	Fair
Reach 3	4.0	Fair-Poor	2.2	Fair-Good
Reach 4	2.7	Fair	2.0	Fair-Good
Reach 5	2.9	Fair	2.9	Fair
Reach 12	2.9	Fair	3.0	Fair-Good
Reach 13	2.9	Fair	2	Fair-Good
Reach 14	3.1	Fair	2	Fair-Good
Reach 16	3.3	Fair	2	Fair-Good
Reach 18	2.9	Fair	2	Fair-Good
Reach 22	3.6	Fair-Poor	2	Fair-Good
Reach 23	3.1	Fair	2	Fair-Good
Mean Score	3.2	Fair	2.3	Fair-Good

Table 24 shows the summary results for the Nanaimo River are instream Habitat is Fair (3.2) and the Riparian results are Fair – Good (2.3).

The overall results for the Nanaimo River mainstem were compared to Haslam Creek USHP survey in Table 28. Breaking down the habitat score to individual reaches results draw attention to the deficiencies. Instream Habitat was best in Reach 4 with a 2.7 score. Reach 3 scored poorest instream habitat (4). Riparian characteristics were poorest in Reach 2 and Reach 12.

Habitat Comparison –Haslam Creek

The USHP survey of the Nanaimo River can be compared to Haslam Creek. The Haslam Creek survey was completed in 2010⁹. The Haslam Creek is the largest tributary to the Nanaimo River it was surveyed using the same methods. Table 25 below compares it to the Nanaimo River results;

Table 25 Fish Habitat Comparison Nanaimo River (2021) and Haslam Creek (2010)

Habitat Ratings/Reach	Nanaimo River (2021)	Haslam Creek (2010)
Pool Area %	4	2
LWD/Bankfull Channel Width	5	4
Cover in Pools	5	2
Boulder Cover	5	4
Average Fines	1	2
% of Reach Eroded	2	2
Obstructions	0	0
% of Reach Altered	2	3
Riparian Ratings/Reach		
Land Use	1	2
Riparian Slope	2	2
Bank Stability	2	2
% Crown Cover	3	4
Average Vegetation Depth	3	3
Average Score	2.7	2.5

With Ratings of 5 being Poor and 1 being Good, the comparison shows Nanaimo River is similarly afflicted with impacts as the Haslam watershed but slightly poorer. The results indicate the Nanaimo River has less cover habitat and pool area than Haslam Creek. The Nanaimo had less sediment and slightly better crown cover. These watersheds were historically logged at the same time and the effects were similar.

Restoration of the Haslam Creek channel has been underway since 2007 addressing the key habitat deficiencies outlined in the assessment. The restoration work was undertaken by the Nanaimo Airport Commission (NAC), The Nanaimo Fish and Game Protective Association (NFGPA), The Nanaimo River Stewardship Society (NRSS) in addition to grants from the Pacific Salmon Foundation (PSF) and the DFO Recreational Fisheries Program. The final reports and plans are available to share strategies for the Nanaimo River¹⁰.

⁹ Hanelt Rob & D.R. Clough 2010, Haslam Creek Fish and Fish Habitat Assessment, commissioned by the Nanaimo Fish and Game Protective Association.

¹⁰ Haslam Creek Restoration projects 2007, 2008,2009, 2010, ,2014,2015, D.R. Clough, NFGPA,NAC.

Reach Habitat Comparison

In each reach, the overall habitat parameters were a mixed result scoring in the Fair range with no Poor or Good results collectively. To determine the reasons for poor or good scores for the reaches is necessary to look at the individual habitat condition. That was not the case when looking at individual parameters of habitat condition. Table 26 compares the key habitat parameters.

Table 26.) USHP Habitat Results, Survey Reaches (2021) Nanaimo River.

Habitat Ratings/Reach	R 2	R 3	R 4	R 5	R 12	R13	R14	R16	R18	R22	R23	Avg
Pool Area %	5	5	1	5	5	5	3	5	5	5	5	4.5
LWD/Bankfull Channel Width	5	5	5	5	5	5	5	5	5	5	5	5
Cover in Pools	5	5	5	3	5	5	5	3	5	5	5	5
Boulder Cover	5	5	5	5	5	5	5	5	5	5	5	5
Average Fines	1	1	1	1	1	1	3	1	1	1	3	1
% of Reach Eroded	5	5	1	1	1	1	3	1	1	5	1	2
Obstructions	0	0	0	0	0	0	0	0	0	0	0	0
% of Reach Altered	1	5	1	3	1	1	1	5	1	1	1	2
% Wetted Area	5	5	5	3	3	3	3	5	3	5	3	4
avg score	3.6	4.0	2.7	2.9	2.9	2.9	3.1	3.3	2.9	3.6	3.1	3.1
Riparian Ratings/Reach	R 2	R 3	R 4	R 5	R 12	R13	R14	R16	R18	R22	R23	Avg
Land Use	2	1	2	3	1	1	1	2	1	1	1	1
Riparian Slope	2	1	5	5	2	2	1	2	1	1	1	2
Bank Stability	4	4	1	1	2	2	3	1	3	4	2	2
% Crown Cover	5	3	3	3	3	3	3	3	3	3	3	3
% of Reach Accessed	3	3	0	3	3	3	3	0	0	0	0	2
Average Vegetation Depth	1	1	1	3	5	3	3	5	5	3	3	3
avg score	2.8	2.2	2.0	3.0	2.7	2.3	2.3	2.2	2.2	2.0	1.7	2.8

*Good (1), Fair (3) Poor (5)

Habitat Condition continued

The individual habitat parameters in each reach varied significantly and are discussed in the reach results (Table 25). The following habitat parameters scored (5) Poor in reaches;

- 1.) Pool Area
- 2.) LWD
- 3.) Cover in Pools
- 4.) Boulder Cover
- 5.) Erosion
- 6.) Alterations
- 7.) Wetted Area
- 8.) Riparian (Slope, Crown Cover, Depth)

An overview of the Poor Habitat Conditions is discussed below.

1.) Pool Area Habitat

Pool Area scored poor (<40% wetted) throughout the survey except for Reach 4. Pools are made up of residual depth against a crest through scour or dam effects. The deepest pools observed in the survey were formed from bedrock found in canyon areas of Reach 4 and 5 not in the open alluvial areas of the other reaches.



Deep Bedrock controlled Pools in Reach 4 and 5

Channel meander and bed scour produced most of the pools in the other reaches. The scour pools were shallow (2-3m deep) and most lacked any permanent device to maintain depth or hold the crest in place (Bedrock, Rooted cutbank, LWD).



Reach 2 shallow gravel scour pool above Morden Trail Reach 13 corner Pool 1 at 180° bend in river.

Many historic pools in the reaches have become glides. Alluvial scour pools are vulnerable to changes in location and depth during flood events. Flood debris can scour out the crest or fill sediments into the pool residual depth. Generally glides are a sign of degraded habitat. Glides are defined as habitat that has no residual depth and substrates do not penetrate the surface at normal flows. They are unlike Riffles that are shallower to have substrates that are close to or penetrate the water surface. Glides do not offer the cover of Pools or the spawning/cover/food production of Riffles. There was degrading of Riffles and aggrading of Pools.

Pool habitat has changed to Glide habitat due to degradation of channels. Reaches 12, 13 and 14 below First Lake all had channel sections that are degraded to long glides. In glide areas the surface gravels had washed out down to larger cobble and boulder, with the river bed drop of 1.0m below the water line of older tree roots.

Pool area has been lost to sedimentation. In Reach 2,3 and 22, many pools were filled in by sediment deposition. There are locations in these reaches where the channel sediment deposits are now the same height as the banks forcing flood waters to migrate into the floodplain resulting in more erosion.



Reach 3, Glide too shallow to be a pool. Reach 12 Glide once a riffle before the gravels washed away.

Restoration of pools would require devices to scour or trap and hold substrates. Pools are created by installation of logs, rock groynes or rock crests in the channel. The instream devices have to be able to sustain against such forces as buoyancy, water velocity and debris impacts. The reaches of the Nanaimo River certainly require more and deeper pools but creation/improvements to pools would first require a hydrological assessment by river engineers. Standard biological prescriptions used for smaller/healthier streams are not applicable to the Nanaimo River due to its size and condition. The Nanaimo River appears to be in a state of flux on pool and riffle habitat. The upstream areas are degraded and lack structure to rebuild, while the lower reaches are aggraded with excess gravel. These impacts are in similar locations on the east coast of Vancouver Island in rivers such as the Cowichan, Koksilah and Chemainus. Restoration along these rivers included the removal of sediments and stabilization of banks. These prescriptions first require the river engineering studies of the river.

2.0) Large Woody Debris (LWD) Habitat

LWD is significantly lacking in all the reaches. Logs provide scour to create pools that increase the perennial wetted areas. LWD provides cover for fish of all life stages. It is one of the most common

and important types of fish cover found in healthy river. The USHP standards call for 1-3 pieces of LWD per channel width and the results found 0.0-0.7 pieces/channel width. The standard is for channels less than 15.0m wide. The Nanaimo ranges from 85m to 35m at the top, so the LWD can be expected to be lower in a larger river. The amount of LWD is directly correlated to fish survival and habitat quality. Anchored LWD stops gravel from migrating and creates spawning habitat. It offers control over degrading of river profiles by locking in the substrates. LWD protects channels from erosion and maintains meander patterns creating more habitat diversity.

The reaches (R3 & R22) that had the higher counts of LWD, were found in unconfined areas where the eroding banks had dense stands of second growth fir. Unfortunately the LWD recruited from the forest is poorly anchored and passing through with flood events. The mid and upper reaches were less populated with LWD. Reaches with more confined banks of bedrock, boulder and cobble with less meander lack the conditions to trap or hold LWD. High water level/velocity easily cleans the banks of any LWD. Old growth LWD is heavier and longer and would have offered more functional cover but it was not observed anywhere in the river.



LWD is rare, small and poorly anchored throughout the river; observed in Reach 3 & Reach 22

Restoration of LWD was identified as an opportunity in Reach 3 and 22 where there are low eroding treed banks. Stabilizing the second growth felled trees along these wide reaches was ranked medium. The prescriptions for LWD anchoring would involve burying and/or rock ballasting the trees along the banks.

3.) Cover Habitat in Pools

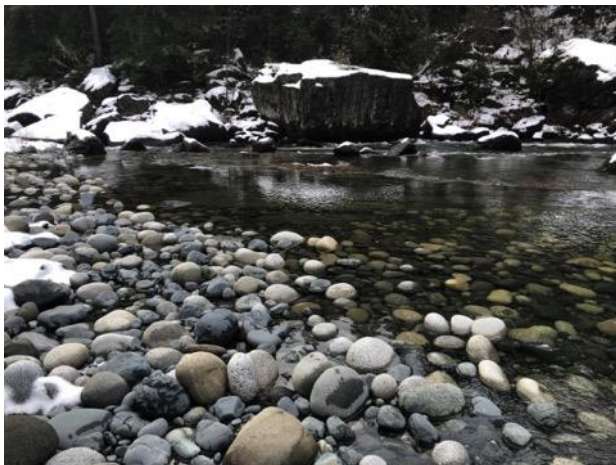
Cover in pools was ranked by percent wetted area with expected ranges of 5-20% of wetted area. Cover components included LWD, Vegetation, Rooted Bank undercuts and Boulders). The results of the survey were 2-7% total cover with a Poor rating in all but reaches 5 and 16 due to small amounts of Boulder cover. Cover in pools offers juvenile and adult salmon refuge as well as food supplies as the surfaces support invertebrates. The lack of cover is for the same reason as discussed above in the LWD section; the material has washed away. During our survey, despite higher water levels, pools were visible to the bottom, there was no cover blocking the view. Restoration efforts to improve cover include addition of LWD, Vegetation, Boulders or planting Vegetation. These items are best done in pools with high fish use and opportunity for success. Installation of LWD in Reach 3 and 22 is recommended. The Nanaimo hatchery (Napoleon) sidechannel was not included in the assessment but visual observations suggest the need for more LWD and/or brush bundles.



Reach 3 Pool 3 and Reach 18 Pool 1 have a lack of cover (LWD, Veg. Undercuts, Boulders)

4.) Boulder Cover Habitat

Boulder cover is important habitat for juvenile Chinook and Steelhead. Boulders were the most common type of cover in the river but there was a low amount (0-7%) scored Poor with an expected range of 5 to 30% . Reach 2 was an aggraded area where no Boulders were observed in the reach. They were likely buried in the sediments. Reach 4 and 5 in bedrock canyon areas had the most boulders. Boulders offer substrates for invertebrates and their weight and strength makes them more permanent habitat than LWD. Boulders may contribute to habitat in other ways; arranged at pool outlets to maintain residual depth, lock in spawning substrates that would otherwise be washed away (Reach 14). They naturally or artificially may be arranged as scour/thalweg controls as rock groynes, spurs and bend way weirs. The addition of boulders to improve the above functions is recommended in Reach 2 (Spurs), Reach 3, 12, 13 14 18 (Cover), and spawning habitat (R14 & 16). Installation of boulders is limited to areas with road access to permit an excavator to place. Flying in boulders by helicopter is should be investigated as it would permit a greater opportunity of placement.



Reach 4 Boulder Riffle in canyon



Reach 14 Boulder grouping offering cover and food production

5.) Erosion of Habitat

Reaches 2, 3 and 22 had Poor scores for erosion. They had 55%, 33%, and 20% respectively of their reach lengths with bank erosion. These reaches had banks of gravel with inadequate tree root protection. The banks were weak as they were not intertwined with tree roots that bind healthy stream banks offered by old growth trees. Old growth trees were very limited but we observed none that were undermined and failing. Exposed gravel banks and sediment deposits are sources of sediment that affect spawn success and fill in pools. The eroded banks Reaches 2,3 and 22 are considered high priority for restoration. The methods to restore the sites is different in each reach. Reach 2 has trail and agriculture erosion. Reach 3 is losing the Nature Trust Park area to a long eroding bank. Reach 22 has both an eroding bank and a large sediment deposit (as does Reach 18). Erosion can be amended with vegetation planting seedlings and Willow stakes as well as LWD and rock placements.



Reach 2 erosion at RDN trail head



Reach 22 erosion/deposition bar

6.) Alterations to Habitat

Alteration features in the river were relatively few but significant (Poor) in Reaches 3 and 16. Reach 3 has a 435m long alteration of the south bank from the concrete and rock Pulp Mill water intake infrastructure. This site has virtually no trees and no natural stream bank. Reach 16 above First Lake has a bridge footing and associated dredging and 80m of bank armoring.



Reach 3 has over 400m of armoured bank



Reach 16 has 80m armoured bank at bridge.

7.) Wetted Habitat Area

The wetted area of Reaches 2,3,4,16 & 22 scored Poor. The wetted area is a comparison of bankfull channel width to wetted width. Reduced wetted area directly affects the living space and

food production of fish. Wetted widths were taken from February to May 2021 when flows are well above base low flow. None of the reaches scored better than Fair most were Poor. At base low flow in summer (August/September) there will be insufficient wetted area in all reaches with the possible exception of Reach 5 with canyon pools. The Poor rating is partly a result of bank erosion increasing the width. In Reach 22 the river was over 90m wide in some eroded sections with a 45% wetted area, while nearby Reach 23 had 84% wetted area in an average of 35m wide channel. Reducing the bank erosion is key to maintaining water in summer. Wetted area can also be increased in summer by increasing the number and size of pools. One of advantages for the Nanaimo Watershed is having First, Second and Third Lakes accessible to anadromous salmon. The lakes increase the total wetted area significantly and offer refuge, holding and rearing habitat for salmon.



The only Pool in R12 is Jump Creek confluence pool



Reach 22 – Dry river bar in winter.

8.0) Riparian Habitat

A proper functioning riparian reserve area is the key to health of the Nanaimo River. In Table 25; the riparian scores for the reaches were generally better than the habitat scores. Riparian Depth and Crown Cover were the impacted habitat parameters in the Riparian survey. The riparian area was historically damaged but is regenerating and there are currently few areas were cleared right to the river bank; they are noted in Alterations (in Reach 2 & 3).

The USHP result for parameters for a Good rating in Vegetation Depth are 30m and 75% for Crown Cover. The Poor ratings were in Reach 12 (26m Depth, 45% Crown), Reach 16 (10m depth, 40% Crown) and Reach 18 (28m Depth 56% Crown).

The average riparian depth and crown cover in the three habitat groups of lower, mid and upper were;

Lower Reaches 2-5	Depth 106m	Crown Cover 50%,
Middle Reaches 12-14	Depth 34m	Crown Cover 50%,
Upper Reaches 16,18,22 & 23	Depth 30m	Crown Cover 52%.

Comparing other regulations to the results: the Riparian Areas Protection Regulation¹¹ would require a 30m reserve area from top of bank. The 2020 Mosaic Riparian Classification¹² results in a

¹¹ <https://www2.gov.bc.ca/gov/content/environment/plants-animals-ecosystems/fish/aquatic-habitat-management/riparian-areas-regulation>

¹² *Riparian Management Strategy Implementation Handbook, May 2020. Mosaic Forest Management*

20 m reserve and 10m management zone. The results show that the average vegetation widths in the reaches meet or exceed the 30m standard in both regulations.

There are Reach areas (i.e. Reach 2,3,12 16,18) where the riparian is less than 30m. they are identified in the survey details. The first restoration objective should be to ensure all areas where possible are meeting the 30m minimum riparian depth. Some difficult to restore areas such as the R3 Pumhouse and R16 logging road could be compensated in area at other sites.

There is concern that the 30m reserve is not sufficient to compensate for the historic impacts. The Nanaimo Watershed was extensively logged and cleared in its historic first pass. These effects may not be accounted for in the minimum reserve width. Increasing the riparian width to compensate for the historic effect is recommended. For examples of regulations that use more reserve; the B.C. Forest and Range Practices Act¹³ and the Clayoquot Scientific¹⁴ panel both recommend a 50m reserve width for larger rivers. This extra width would help compensate for the historic impacts and is recommended as a future target. The survey did identify many areas where property owners are exceeding 30m or more. Communication and collaboration with the property owners is key.

Old growth trees were rarely found in the survey, generally each reach had a few solitary trees or small groups of veterans, they were all Douglas Fir and Red Cedar. These trees were approximately 40 to 55m in height and had diameters of 1.0 to 2.2m. The loss of old growth trees along the riparian area results in bank instability, loss of LWD inputs, reduced canopy closure also losses to wildlife habitat, nutrient supply and cultural use. The old growth tree shortage will take several hundred years to restore. A healthy riparian forest is needed for climate change resilience. Climate change related flood events increase the frequency of flooding. There were flood evacuations of homes in the lower reaches the last two out of three years. Riparian vegetation needs help to be resilient. Riparian restoration, protection and preservation is the most important long term objective we can recommend.



Reach 2- Young trees pushed over by floods Reach 14 - Old Growth (1.8m Douglas Fir) holding on

¹³ <https://www2.gov.bc.ca/gov/content/environment/natural-resource-stewardship/laws-policies-standards-guidance/legislation-regulation/forest-range-practices-act>

¹⁴ <https://www.for.gov.bc.ca/hfd/library/documents/bib12571.pdf>

Discussion – Reach Restoration Prescriptions.

Below is a discussion of the habitat condition and restoration prescriptions of each of the survey reaches as well as a summary table.

Reach Restoration Categories

Restoration prescriptions were created for each surveyed reach of the Nanaimo River. As habitat was measured, restoration plans were noted. The restoration prescriptions were categorized by the following USHP habitat assessment into the following categories

- Alterations
- Erosion
- Obstructions
- Cover Habitat
- Spawning Habitat
- Off Channel Habitat
- Riparian Habitat
- Access/Encroachment
- Water Quality
- Garbage
- Education/Partnerships

A Restoration Prescription Summary (Appendix 1) was created with the above categories for each reach including a ranking of priority.

The ranking of High, Medium or Low was based on a combination of factors; the ecological hazard and the benefit (cost, access, partnerships) of doing the activity. The risk assessment matrix for this survey is developed by the Watershed Restoration Program for prioritization of restoration activity.¹⁵

A review of the habitat condition resulted in 133 restoration prescriptions with a range of Low to High in priority. They are presented in Appendix 1 as well as for each reach in the section below.

¹⁵ Warttig, W, D.R. Clough, M. Leslie, 2001. Restoration Plan -Kennedy Flats. Watershed Restoration Program, MWLAP, Nanaimo B.C.

Reach 2 Restoration Prescriptions

Reach 2 is the lowest non-tidal reach in the Nanaimo river. The location means it is habitat for all salmon species for migration, spawning and/or rearing. The protection of this habitat is vital. It is relatively un-developed by industrial and urban pressure. It has a wide floodplain which has not been dyked or channelized. In the left bank floodplain, the second generation of forest vegetation has been undisturbed in most areas. Most agricultural developments lie further out in the floodplain (i.e. Akenhead Creek) and are buffered by riparian vegetation. There is one streamside agriculture area in this reach (Figure 4, Placemark 23) and the lack of riparian protection has resulted in loss of pasture and river bank erosion.

Bank erosion protection incorporating habitat and riparian improvements is the highest recommended remediation. There are many locations of varying size and level of effort. The area along Morden Trail is the only public land and a good place to start. The other areas will require property owner approval and likely more detailed prescriptions. The top restoration opportunities in Reach 2 (see table below) include the following;

Bank Erosion – There is right bank erosion along Glide 3 beside a now treeless pasture. The bank is crumbling away with no riparian protection. The erosion rate in this straight run is slower than in the meander areas offering time for plants to take hold. Restoring the 430m long right bank requires the property owner permission. The initial prescription suggested along this straight run is to establish a planted riparian buffer. The restoration plan would be to establish tree and shrubs along the top of bank. These species should be a mix of fast growing deciduous and firmer rooting conifer. The gravel banks have opportunities for staking with willow cuttings. A fence, top soil, mulch coarse woody debris and watering schedule would have to be worked out with the owners.

Placements of LWD and/or rock would add more protection and fish habitat. Bank revetments of stumps and rocks have been successfully prescribed on similar reaches of Haslam Creek. These prescriptions require more assessment and engagement with the property owner.

Bank Erosion – The RDN Trail terminates at the river bank. The bank has no vegetation and is eroding into the river from human access. The site requires restoration planting of shrubbery and trees, improved fencing and signage. Placements (plants, rock, gabion) are needed on the bank to harden it from erosion from people.

Riparian Restoration –Planting bank areas and replacing invasive species along both banks. They consist of Scotch Broom, Daphnia, English Holly and Himalayan Blackberry. Removal, disposal and replanting is recommended. The reach is mostly privately owned riparian areas with any activity done by private property owners or in partnership with stewardship groups. The native plants observed nearby to consider for replanting include Douglas Fir, Red Cedar, Pacific Plum, Oregon Grape and Pacific Crabapple.

Sidechannel Habitat– The river left floodplain is very active in this reach. There are channels on the left bank near Frey, Thatcher, Morden and Akenhead Roads. They are all interconnected through floodplain channels in a wide undeveloped left bank. They remained wetted in May with Coho fry present. At the top, the Frey Road channel is fed by left bank overflow in Reach 3. Next is the Thatcher Creek channel fed by the creek and river. There are machine dug ponds through the floodplain above Morden Trail. The outlet channel is recorded as the Polkinghorne Sidechannel in DFO escapement records. Another branch of the floodplain crosses the RDN Trail to feed Akenhead Creek and carries on for over 1.5km. The aggregate length of the floodplain channels is over 4.0 km. They offer significant fish habitat currently as flood refuge, spawning and rearing habitat. All the channels appear lacking in regular water supply and fish habitat. The quality of

habitat depends on the stability of the water supply. Installation of water monitoring stations to determine water elevation and water quality are recommended. There is potential to excavate sediments, add LWD and plant riparian areas. These channels are all on private property. The Akenhead and Thatcher/Polkinghorne channels are the wettest and most protected. They offer the best habitat for fish and further restoration opportunities.

Reach 2 Restoration Prescription Summary

Reach 2	Habitat Issue	Location	Prescription	Priority
R2	Alterations/Erosion	RDN Trail Morden Trail Access (Placemark 7)	The public use this for river access and go around the fence and down the bank. There is erosion and loss of riparian. The site needs to be better fenced and planted to contain people from wandering off the trail and into the sensitive river riparian areas.	M
R2	Erosion/Planting	Morden Trail and upstream on River Left Bank to Placemark 12.	Plant (500m) eroding bank, 1-3m high. Prescribe shrub cuttings (Willow, Red Osier) on sides and trees (Cedar, Doug Fir, Spruce, on top)	H
R2	Erosion/Planting	Right Bank – along pasture at Placemark 23	Restore (430m) actively eroding low bank along farm pasture. With property owner permission; bank planting (cuttings, trees), this could start immediately in fall. More planning for bank protection/fish habitat rock spurs, bendway weirs and LWD cover (w P.Eng.).	H M
R2	Obstructions	None	No barriers, no large log jams.	L
R2	Cover Habitat – Rock Spurs	Throughout	Addition of fish cover habitat (LWD) in this reach is limited due to high velocity and scour impacts; simple LWD placements will not hold up. Consider installation of rock spurs/bendway weirs to push the thalweg away from the bank (ie Tsolum River, Englishman River examples).	L M
R2	Spawning Habitat	Mainstem. Offchannel Areas	The spawning gravel is clean but it is vulnerable to floods and debris . The river profile is dropping as pool crests are washed out. Spawning habitat improvement is limited in the mainstem. Off channel/sidechannel sites offer protected spawning habitat with improvement.	L M
R2	Riparian Planting	Throughout R2	Underplanting opportunities in many areas. Infill poorly stocked/damaged riparian. Primarily planting seedling conifers i.e. Douglas Fir, Red Cedar etc. Participating property owners will determine locations. Highest priority is south and west sides of river .	M-H
R2	Riparian Invasive removal/Native Planting	Scattered throughout	Remove invasives and/or add native plants.	M-H

R2	Off Channel Habitat	Thatcher Creek Morden Road Frey Road Akenhead Road	Sidechannels in Reach 2 can be improved with water supplies, flood protection, sediment removal. They require water quality monitoring, through the summer	M
R2	Water Quality	R2	Water quality monitoring of the reach and sidechannel habitats is recommended to gain information on habitat quality and trends. The Thatcher sidechannel may be anoxic in summer.	H
R2	Garbage	Throughout	There was no high accumulations of garbage along this reach	L
R2	Education/Partnerships	Throughout	Potential river stewardship & education activity sites, at RDN Morden trail – repair bank, fence, add signage, planting.	M-H
R2	Access/Encroachment	Throughout	Repair banks from RDN trail eroding to river, fence and repair site (plantings)	M

Reach 3 Restoration Prescriptions

Reach 3 has undergone a significant habitat change in the last 17 years. In 2004, a 750m long river left bank meander was cut off during a winter flood. This shortened the reach by 10% and increased the mainstem gradient resulting in the loss of habitat features such as deep pools and LWD cover. The old meander was heavily used for spawning by Chum Salmon. After the storm; DFO personnel acted to keep the reach wet through the incubation period by machine trenching and pumping a water supply back into the site for the year. Currently the abandoned river-bed offers rearing and refuge habitat but the flow is reduced considerably such that spawning is restricted to gravel bars near the confluence. When the river re-routed, it went through a regenerating riparian area estimated to be 80 -100 years age. The trees were not large enough to provide the habitat benefits of protecting the bank or providing functional LWD. There is very little evidence of LWD deposition in the lower reaches as the logs were not large enough to anchor or jam. The lack of old growth in the riparian area was evident during the survey, there were less than a dozen old growth (1.0m +) diameter trees observed in the survey along the river bank. With climate change related storms, the increased intensity puts a healthy forest at a higher premium for resisting these forces.

The habitat restoration opportunities (see table below) should prioritize on minimizing loss of the exaggerated meanders into forested floodplain. Riparian planting of the impacted areas is recommended.

Erosion/Riparian - There is approximately 1.0 km of bank erosion in the 2.2 km reach. The recent channel diversion left an instable river bank against a vulnerable second growth forest. As described in the habitat section, falling trees are tearing out holes in the bank. They lack the size and weight to resist. Stabilization and protection of the undercut and overhanging forest along the river right bank is a restoration activity priority in this reach. An arborist and biologist could start with inspecting the leaning and vulnerable trees to review the opportunity to cut, prune or anchor them for stability as well as future contribution as CWD or LWD.

Riparian – The opposite bank (river left) riparian area along the hydro pole clearing and public trail along 200m (near Pool 2) is eroding and crumbling into the river. It lacks vegetation and needs plant polygons established.

Boulder Cover – The river left bank below the Hydro Line at Pool 2 has 200m of rock armour. Some boulders from the rock wall have settled into the Pool contributing the only instream fish cover in the site. There may be opportunity for additional fish habitat with the boulder placements along this reach. This work could be done in conjunction with bank armour repair with the property owner.

Riparian – The river left mainstem was abandoned and is now a 750m sidechannel. The riparian community is young and not well developed. There are long exposed gravel bars with some willow and young Red Alder. These areas can be improved with Willow staking the lower bars and planting conifer seedlings under the higher ground Red Alder.

Spawning Gravel – The reach lacks stable spawning areas. The pumphouse pool tailout offers the most stable crest as it is bolstered by riprap. This is a good site for spawning habitat improvement by adding more gravel to the crest. The site is poorly seeded with gravel. There is a roadway nearby for material and equipment access.

Stewardship – In 1994 the forested area where the mainstem Nanaimo River now flows through was scheduled to be logged. It is certain that if it had been logged there would have been a larger

catastrophe. Fortunately the property owner was consulted by The Land Conservancy and agreed to sell these sensitive floodplain areas. There were many persons and organizations that helped. The property was purchased for approximately 1.0 million dollars. It is now owned by Nature Trust and operated by the Regional District of Nanaimo. The purchase of this land protected it from logging and from the vulnerability of floods. Land purchase or covenant protection of the riparian area is the most important form of environmental protection to recommend for the Nanaimo River. Most of Reach 3 is now protected by park land or public land holdings as well as Nanaimo Forest Products all with a vested interest in clean water. No action is required, but this is an important example of stewardship success in purchase and protection of valuable riparian area.

Water Quality – The highway and bridge are potential sources for pollution from runoff and spills. The bridge area catch basins drain straight into the Nanaimo above the pumphouse and hatchery intake. Installation of curtain drains to settling areas is recommended. particularly a concern.



Hwy 1 Bridge drain pipes go direct to pool.

Reach 3 Restoration Prescription Summary

Reach 3 (Hatchery Run)	Habitat Issue	Location	Prescription	Priority
R3	Alterations/ Riparian	Pumphouse Area RipRap/Intake area	Lack of vegetation along the right bank on the armoured rock. Create plant polygons on the back side of riprap (it floods over the rock here)	H
R3	Erosion/ Riparian	Three large locations 1.) Right Bank Lower 2.) Left Bank along trail 3.) Right Bank below pumphouse	1.) Lower RB has 350m length – undercutting and collapsing. High velocity /Floodplain area. Review leaning trees with arborist, to mitigate tree loss on bank . 2.) Along trail/power pole Dyke (200m). Contact land owner about repair of rock voids where eroding into river. 3.) Upper RB (470m) undercutting and collapsing. High velocity /Floodplain area. Stabilize leaning trees to mitigate tree loss on bank . Installation of Rock Spurs, Bendway Weirs and Groynes should be considered after stabilization of the riparian area.	H H H L-M
R3	Obstructions	None	No LWD jams in channel	L
R3	Cover Habitat	Throughout	Boulder Placement – consider placement in location of existing LB rock dyke where several already provide cover. LWD Placement – avoid placement in high velocity mainstem, placement in protected pools of left bank Oxbow.	M M
R3	Spawning Habitat	Throughout Pumphouse Pool	Lack of stable protected spawning beds. Augment gravel in the pumphouse pool outlet crest, has road access, potential for many species use. (may require routine replenishment)	L M
R3	Riparian Habitat	R3 – LB/RB Hydro Lines Pumphouse Left Bank gravel bar	- Plant LB along hydro lines approx. 200m. This will shade the west exposure. The area is a public park trail way with good access but poor soils. - Establish Plant polygons at Pumphouse on the bare armoured right (south) bank below the pump house for shade. - Plant bare gravel bar areas with willow stakes. Plant Red Alder areas on bar with conifer seedlings for stability.	M M-H M-H
R3	Off Channel Habitat	Several locations 1.) Old River channel (LB)	1.) The old river channel offers a ready made off channel that requires a protected water supply and more cover habitat.	M M

			<p>2.) Hatchery Sidechannel – a good coho producer, it should be assessed for wild production – fry /smolt fence.</p> <p>3.) River floodplain –Right Bank – there are many overland floodchannels, they do not offer reliable fish habitat and are harming the riparian forest and bringing sediment into the hatchery channel. The recent mainstem redirect degraded the profile, reducing the flood pressure into the riparian. Repairing these semi active flood routes is worth consideration – replanting , plugging with CWD and /or filling and planting the entrances.</p>	M
R3	Water Quality	R3	Water quality monitoring program - this may be already in place with the RDN Water Smart program.	H
		R3	Review Highways Road runoff treatment – eliminate direct drains to the river with bioswales. Need to talk to highways manager about modernizing the storm water system for the bridges.	H
R3	Garbage	Pumphouse Recreational area	Recreational users at beach are littering every year, install more signage.	M
R3	Education/Partnerships	R3	Nanaimo River Hatchery, Nature Trust Nanaimo River property. Nanaimo Forest Products all have interest in this reach. Restoration plans must include property owners at initial set up. More land purchase protection of remaining riparian area.	H
R3	Access/Encroachment	Trails	Both sides have trails set back from edge that are not creating erosion or harming riparian	L

Reach 4 Restoration Prescriptions

Reach 4 has the best riparian characteristics of the lower reaches. The average riparian depth is over 60m wide. The steep bedrock canyon protects it from flood damage. While historically logged 60-100 years ago, it is in recovery and providing important shade to the reach.

Riparian - The Riparian vegetation appears healthy and fairly dense generally, but there are some exposed gaps by old logging along the quarry side and residences on the right (south) bank. Contacting the land owners and working out plant prescriptions is recommended. The left bank trails are very scenic and well used yet there are no parks or preserves in this reach. The area has ecologically rare south facing rock bluffs with some supporting Garry Oak trees. This area is recommended to be established as a lineal park land/covenant area.

Access - The riparian area is getting recreational pressure with pedestrian trails being converted into quad trails that do considerably more damage. Restricting Quads and deactivating some trails is needed to protect the vegetation. This must be done in partnership with the landowners

Spawning Gravel - Spawning gravel has been displaced by floods and debris over the years and lacks adequate replenishment. The reach is restricted by canyon but there is a road from the pit to a wide cobble bar in the lower reach. There is access at the end of a gravel road to a spawning gravel placement site. The area is a 250 m long and 55-60m wide. The cobbles and boulders could be augmented with more gravel. Access is good with gravel available nearby. It would be a good partnership with the gravel pit operator.

Offchannel- Only a small channel exists in this reach. It is at the lower end, fed by old quarry ponds, a seasonal stream erodes over an old skid trail. There is a 30-50m length that is braided with no connected channel. The lower reaches of this channel are likely used by a few salmonids for spawning, rearing or refuge. Restoration work would decrease erosion and sediment. There is an opportunity to do hand maintenance of the channel erosion points, plant shade tolerant shrubs or use an excavator and dig out the in-filled areas to connect the channel; the prescriptions depend on the landowner as well.

Reach 4 Restoration Prescription Summary

Reach 4 (Bungy Zone)	Issue	Location	Prescription	Priority
R4	Alterations	None		L
R4	Erosion	LB tributary below quarry	The 30-50m fish accessible tributary has eroding braids. Review with land owner; hand clean up and planting of channel or machine repair and remediate channel (gravel/cobble bottom, planted sides),	L
R4	Obstructions	None		NA
R4	Cover Habitat	Throughout	No LWD, no recommendations, hard to place. The deep bedrock and boulder pools in this reach offset LWD cover loss.	L
R4	Spawning Habitat	Lower reach	Good candidate for spawning gravel placement in the 250m x 60m glide via pit access road. Review placement strategy by machine or permit it to wash in from stockpiles- estimate 50 cm ³ (5 truck loads)	M-H
R4	Riparian Habitat	Open areas both sides	Site 1- left bank along pit edge, approx. 250m at top of bank is 13-15m wide Site 2 – infill planting right bank near residences (south side)	M M
R4	Sidechannel	None	No off channel other than short tributary noted	L
R4	Access/Encroachment	Trails	Left bank has narrow ridge trail. No erosion observed but the mossy flower garden rock outcrops are vulnerable to erosion. Signage recommended to stay on trail.	L
R4	Water Quality	Throughout	Water Quality Monitoring recommended- no drinking water intakes observed	M
R4	Garbage	None	No garbage in reach	L
R4	Education/ Partnerships	Throughout	Work with gravel pit operator to seed spawning gravel next to their pit. Land owner contact to protect the riparian area, stop the quads from destroying the narrow riparian area. Trail stewardship program. Purchase the riparian area or put in strict covenant	M M-H H

Reach 5 Restoration Prescriptions

This is a 2486m long canyon reach. There were many characteristics for instream and riparian habitat that scored Fair. The moderate rating for the reach is due to the resilient bedrock substrate. Where other reaches have eroded and lost their channel and riparian areas, this site has not. Fish habitat characteristics in this reach are likely the least changed from human impact of the reaches surveyed due to the bedrock structure. The habitat offered is not particularly good, the confined areas are subject to high flood velocity and debris exposure. Pool 1 below the Hydro Line had the widest (73m) channel in the reach. The width average was 50m and as narrow as 23m. Flood debris scour was 15m above the water levels in February. There are few places to hold in winter. Summer habitat is much better, the bedrock and boulders have pool crests that have not been beaten flat by flood debris. Pool depths of 2-4m exist in this reach in summer. There is likely poor primary food production in this reach. There was no allochthonous debris, trees are abundant but it gets washed out. Additionally the shaded deep bedrock limits algae production as an invertebrate food source.

This reach was historically logged to the top of bank. There are a few veterans but the second growth is quite tall and healthy. The riparian area is dominated by Douglas Fir. There was a small grove of Garry Oak at the lower end of the reach on the left bank (placemark 12). The gravel quarry and logging clearing resulted in thinning areas on the left (north) bank. Currently the left bank has no new development except Hydro line maintenance clearing. The quarry is over 100m away. The Garry Oak grove is worth protecting as an ecological feature. It is currently not under threat but could be easily disturbed by wheeled vehicles that could access this site.

The right (south) bank has a similar forestry history and a large gravel quarry set back over 100m. The new residential areas off River Bend Road are a concern. Many yards are cleared into the important south side riparian area, some to top of bank. A land owner contact program to educate and potentially replant these areas is recommended.

Reserve areas in Reach 5 include two small Regional District Park areas off River Bend Road that are in the south bank riparian zone. These parks offer a protected riparian area on the south bank. There are no park/reserve areas on the north bank, despite the high use and environmental values. The two park sites recommended are; at the BC Hydro Crossing where there is river access, hiking and rock climbing. The Garry Oak bluff downstream where there is a sensitive ecological area that should be noted with signage. Both sites are good candidates for Park status as protected area.

Riparian Restoration - The highest recommended actions in Reach 5 are protecting and planting altered riparian areas. There is a residential area along 770m of the south side where trees have been removed within 30m of the top of the bank.

On the north side of the reach off Nanaimo Lake Road is plant damage to sensitive rock bluff habitat along the 50m trail to the climbing wall from quads and people. This impact also includes garbage and erosion. Restoration with plantings, limiting access with placement of log barriers and awareness signs are suggested.

Reach 5 Restoration Prescription Summary

Reach 5 (Bore Hole lower)	Issue	Location	Prescription	Priority
R5	Alterations	BC Hydro Line; Trail to Bore Hole Viewpoint off Nanaimo Lakes Road	The powered vehicles are impacting the thin vegetation along the viewpoint. Install signage, add CWD and fencing to prevent further damage. This ecologically sensitive ribbon along the river site should be purchased as park area. It requires routine stewardship maintenance.	H
R5	Erosion	Na	None – Bedrock canyon, not eroding. Side walls are steep but vegetated. No slide tracks.	L
R5	Obstructions	Na	The Bore Hole is a natural impediment to Chum and Pink but is passable to Chinook , Steelhead and Coho. No improvements suggested.	L
R5	Cover Habitat	Na	Boulders are the functional cover feature in this reach. No other type of cover (LWD, Undercuts, Vegetation) exists in the bedrock canyon.	L
R5	Spawning Habitat	Na	There is not much available spawning habitat in the reach due to natural conditions of confinement and velocity. The substrates are bedrock, boulder and some cobble.	L
R5	Off Channel Habitat	None	The confined bedrock canyon , no off channel habitat is offered.	L
R5	Riparian Habitat	Garry Oak Bluff , on river left, (Placemark 12)	Protection: Garry Oak Bluff is a sensitive ecological area that should be identified for protection. Assess in summer, consider signage, passive protection. It is relatively isolated by foot trail. A special area that would be easily lost with human over-use.	H
R5	Riparian Habitat	River Bend Road Park and residential area on south bank (river right)	Replanting: South bank residential areas have removed trees on some properties – contact, partner, replant and protect. The RDN River Bend Park may offer a community riparian stewardship starting place to add signage and infill plant disturbed areas.	H
R5	Access/Encroachment	At river access BC Hydro Crossing off Nanaimo Lakes Road, on river left	As noted above needs Protection: High use recreation area for hikers, climbers, consider Park designation or volunteer stewardship group to maintain – repair steps to river, clean up garbage, protect sensitive areas, replant eroded areas install signage, fencing.	M
R5	Water Quality	Throughout	Water Quality Monitoring recommended- no drinking water intakes observed	M
R5	Garbage	BC Hydro parking lot	This is the only area we observed garbage in the reach	L

R5	Education/Partnerships	River Bend property owners	Education on the importance of south bank shade from native plants to property owners that have cleared the Right bank. Signage at the Hydro line access about garbage, foot traffic only, and plant protection.	M
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Reach 12 Restoration Prescriptions

Located above the bedrock canyon in a semi confined 1609m length. The overall condition of Reach 12 is lacking in habitat complexity. The historic logging and development of the corridors has had an effect. It is entirely in an industrial forestry setting, there are no residences or farms. This reach features the Hydro line and RDN Water line crossing. There are no deep pools with cover and spawning habitat rare. The reach is quite straight, with one meander, which further reduces its complexity. The channel has endured high flushing flows that removed the habitat features.

Instream Habitat - Recovery of instream habitat will be difficult in this reach. It has no gentle corners to anchor LWD material. The spawning gravel appears to have washed away as crests degraded. There was a head-cut of 0.5 to 1.0m exposure along the reach edges to support the loss of habitat foundation.

Riparian - The riparian area has a 26m average vegetation depth. The lower reach has a left bank floodplain area with as little as 5.0m width with trees failing and eroding. There are also thin riparian areas on the right (south side) near the hydro line clearing. Planting along this reach starting with the erodible and thin areas is recommended. The left bank planting is a good partnership opportunity with stewards and property owners as the work is accessible and not in an active industrial area.

Sidechannels - The left bank sidechannel is fed by an overflowing left bank to form a gravel scoured channel. From the water line in Reach 12, it is 700m long and empties into Reach 11. It is a seasonal channel 3-4m wide with long dry grassy gravel swales with isolated standing pools in winter. It currently offers flood refuge fish habitat in the lower 100m. This sidechannel is a rare feature as there are few unconfined refuge areas below First Nanaimo Lake. It has a road to the site making assessment and development costs cheaper. The sidechannel is in an area where there could be an opportunity to create protected rearing or spawning habitats. This may be an opportunity to provide Chinook spawning habitat which is significantly limited in the mainstem. A sidechannel could also offer spawning and rearing for other species (Coho, Steelhead, Cutthroat). Development of a sidechannel at this site has its risks to address. The river is actively flooding the left bank and damaging the thin riparian area along the bank. A sidechannel would require flood protection from this overland flow. Development would require further investigation such as preliminary topographic survey, test pits and water quality and quantity measures.

Reach 12 Restoration Prescription Summary

Reach 12 (Hydro/Water Line area)	Issue	Location	Prescription	Priority
R12	Alterations	Water Line and Hydro Line crossing	Both lack wide or high riparian. The water line riparian area should be planted as it is particularly exposed. The Hydro line will require maintenance of short trees except at the river bank where there is adequate clearance for conifers. Both banks approx. 30mx30m	M
R12	Erosion	Glide 4 LB Placemark 28	An old slide track 3-5m wide and 15m goes to water line from rail grade. Stabilize with planting /bioengineering.	M
R12	Obstructions	None		
R12	Cover Habitat	Lacking LWD throughout; Boulder Cover	No recommendations, LWD would be hard to place as there are no meanders with steep sidewalls lacking good anchoring opportunity Boulder groups in Glides to increase habitat. Has machine access in a few locations near the water line service road	L M
R12	Spawning Habitat	Jump Creek junction pool	There is a boulder dominated outlet crest of the pool that offers an anchor for gravel placement. Access to the site is over a bedrock bank from rail grade. This is the best of many poor sites in the reach.	M
R12	Riparian Habitat	Both sides	Increase riparian depth to at least 50m along this reach with planting where required, south bank takes priority.	H
R12	Access/Encroachment	Hydro/Water Crossings	Infill plant under power line and access road with shrubbery	M
R12	Off Channel Habitat	Below Water Line, River left bank	There is a 700m long seasonal channel flowing through the left bank floodplain. This may be a rearing or spawning site depending on water supply design and feasibility. Needs test pits and overview inspection of water supplies.	M
R12	Water Quality	Throughout	Water Quality Monitoring recommended- no drinking water intakes observed	M
R12	Garbage	Jump Pool	Some trash at Jump Creek pool beach, none in river or riparian areas	L
R12	Education/ Partnerships	Partnerships	Both BC Hydro and RDN water pass through this Mosaic Forest land, an opportunity for corporate sponsorship of habitat restoration of sidechannel and planting areas.	M-H

Reach 13 Restoration Prescriptions

Reach 13 goes from Jump Creek upstream 3564m under the Jump Mainline Bridge ending at Wolf Creek. It is only 2.0 km from First Nanaimo Lake, an area of Chinook adult holding. This reach is within reach of Chinook for spawning and rearing. The High ranked restoration items were;

- Wolf Creek culvert debris at the junction of R13 and 14
- Thin Riparian areas on south side
- Erosion – Bank failure from rail grade

Spawning Habitat - In this reach spawning habitat is limited; the confined and relatively steep (2%) gradient along with historic damage result in little spawning gravel. The confined setting limits the restoration opportunity to place gravel in this reach or install structures to collect it. Wolf Creek is a gravel supply to the river, but with a log jam in its culvert it is not permitting fish access up or gravel seeding down. Repairing/removing this culvert will add spawning gravel to the river and provide refuge habitat for fish.

Rearing/Cover Habitat - This habitat is limited. Pool 4 is the deepest pool (4m) in the reach that offers cover and refuge due to the bedrock sidewalls. Only five LWD were counted in the 3.2 km as there is no where for it to anchor in the confined channel with narrow floodplain. Large boulder placement (1-3 m+) to create habitat in the long featureless Glides and Riffles could be beneficial. Placement of boulders would be difficult as access is limited.

Alterations/Erosion – This is a concern in this reach in specific sites. There are other tributaries on the rail grade side that may offer refuge habitat if the culverts are maintained or removed. A culvert has washed out in this reach (Placemark 10) where it left a 30m wide sand bank washing into the river. This site requires remediation as it appeared unstable and increasing in degree of erosion. A culvert at Placemark 9 is plugged and needs to be cleaned out or removed before it fails. There may be others missed along this reach. The rail grade is an active recreational trail and the property owner may be interested in maintaining the route.

Riparian - Riparian areas along the south side of the river are thin and exposed. There are two sections of approximately 700m each that are thin, appearing to less than 30m width. They were recently logged and the property owner has likely replanted. Reviewing the riparian management plans with the property owner to identify sensitive riparian areas is recommended. These sites could be planted to higher density to encourage shade generation. The long term success of the riparian area in this reach is important to functions of shade, bank stability nutrients wildlife habitat and LWD input.

Reach 13 Restoration Prescription Summary

Reach 13	Alterations	Wolf Creek Rail Culvert (Placemark 9)	Wood Box culvert at river mouth is plugged with logs and blocks fish access. A bigger problem when it fails. Old rail line has plugged culverts and overflow. Need to be maintained or removed.	H
R13	Erosion	Rail Grade Slide Placemark 10	30m by 30m slope failure sending sediments into river from failed culvert. Needs stabilization and drainage cut off. Machinery if required may use the rail grade or above through the block setting.	H
R13	Obstructions	Culvert at Wolf Creek	Access to the tributary is blocked. Needs to be repaired	H
R13	Cover Habitat	throughout	Lacking cover and opportunities to place LWD Large Boulder placement in Glides/riffles but limited as no nearby road access, flying boulders could be considered..	L
R13	Spawning Habitat	throughout	Remove jam at Wolf Creek to permit movement of gravel. Placement of gravel is less feasible due to limited access and limited good sites.	M
R13	Riparian Habitat	South bank – two thin sections @ 650m length	Thin sections 15-20 m wide. Contact property owner about south aspect riparian management plans to ensure replanting to 30m minimum.	H
R13	Access/ Encroachment	Wolf Creek	As noted above, culvert blocks fish access. Needs to be repaired/removed.	H
R13	Water Quality	Entire Reach	Monitoring of water quality recommended	M
R13	Garbage	Rail Grade/Pool 1/Parking lot	Swimmer/hiker garbage is prevalent along the popular trails and pools. Rusted parts of old vehicles are scattered along the rail grade.	L
R13	Education/ Partnerships	Landowner	Work with land owner to identify sensitive riparian areas and management strategies	H

Reach 14 Restoration Prescriptions

This 2013m long reach is perhaps the most important reach in the Nanaimo River for summer Chinook Salmon. The fish hold in the lake and drop back to spawn in the reach in fall. In order to provide this function, the reach needs spawning habitat that is correctly sized, clean of sediments and stable from floods. Once the fry emerge they require a food supply and cover habitat composed of boulder and LWD cover. The adults salmon require no barriers to migration from flow or obstacles. They also require cool migration and holding temperatures. Being at the outlet of a Lake, there are no spawning gravel inputs except below the lake outlet. The water temperature in the lake and river can also be moderated by a healthy dense and tall canopy. The review of habitat in this reach found there were historic impairments to spawning and rearing habitat.

High ranked restoration activities include;

- Riparian planting
- Spawning Gravel addition
- Wolf Creek Culvert /Rail Grade culvert repairs to erosion/fish barriers
- Assess the North Nanaimo River sediment sources

Riparian - Riparian habitat depth in this reach averaged 41m, while better than most reach areas (and RDN bylaws) needs have an effective canopy closure of over 75% to achieve temperature moderation. Unfortunately we found an average of 51% canopy closure. Improving the height and depth of trees to achieve 75% canopy on the south side is recommended. The solution is working with the property owners to determine the areas and methods. LWD and bank stability are important to fish habitat as well. The trees immediately adjacent the reach have been reserved from logging for up to 100 years. These older second growth Douglas Fir and Red Cedar are resisting bank erosion and some are large enough to self anchor as LWD habitat. Both banks have areas where the width is less than 30m or is under stocked (esp Alder) where infill planting is recommended.

Erosion - Wolf Creek: The jam at the mouth is threatening the integrity of the wood box culvert and it appears to block fish access from the mainstem. The culvert should be inspected and the jam debris removed, and inspections/maintenance done on a routine basis unless the culvert is deactivated. Removal of the jam will offer increased flood refuge /rearing habitat for salmon that is significantly limited in this reach. Removal of the jam will permit a natural flow of substrates into the gravel starved main river. Inspection of Wolf Creek above the jam showed a deposition fan of fine sediment that should be addressed with removal or stabilization (planting).

Wolf Creek was not inspected upstream of the mainstem confluence. The BC iMap listed numerous log jams further upstream and only resident fish beyond the paved road. This reach should be inspected for habitat status and determine if there are any habitat opportunities in the 2.0 km long mainstem.

Erosion - Railway Grade Maintenance: The old rail grade has many stream crossings that are mostly metal culverts in various condition (operating to blown out) as with any non deactivated logging road, a routine of inspection and maintenance needs to be done to protect the environmentally sensitive area. We noted areas of concern at placemarks 16, 33,35 37.

Below is discussion on salmon habitat in the reach primarily regarding spawning and rearing sites. Spawning habitat in Reach 14 is the key salmon habitat function. The early run Nanaimo Chinook have adapted to hold in the lake through summer and drop back in fall to spawn.¹⁶

¹⁶ pers.comm. Brian Banks Nanaimo R. CEDP Manager.

Spawning Habitat: First Lake Outlet

The lake forms a narrow outlet 160m down to the North Nanaimo River that is approximately 40m wide. A snorkel survey of the lake outlet was done in January after a period of high water. The lake shore near the outlet (below the lowest summer cabin dock) consists of a blanket of organic material that was 0.1 to over 0.5m deep. The shoreline has a dense thicket of shrubbery (Red Osier/Willow) that is littered with deposition of flood debris logs. The lake was used for log storage for many years of logging operations, the sediment is likely residual organic material from bark and log litter.

As the lake narrows and current picks up, a cobble/gravel substrate forms. The substrates appeared thin and embedded with sediment and algae. The substrate loses its sediment coating as it joins the North Nanaimo confluence. Unfortunately the lake spawning habitat has been damaged by historic logging operations. The lake was a log storage area and escaped logs have contributed to the removal of the historic spawning habitat at the outlet (ref photo).

The lake outlet is now spawning gravel deficient. Addition of gravel is recommended. There is an area of approximately 6000m² of spawning habitat available. The gravel will need to be correctly sized and placed; starting at areas just above the North Nanaimo River and going upstream on the shallow glide. Further investigation will determine gravel delivery method; building a road, barge or helicopter.

Spawning Habitat: other areas Reach 14

The North Nanaimo (Deadwood Creek) is uniquely located just below the lake to provide a gravel supply that has offset some of the historic impact. It results two full spanning gravel bars below the confluence as well as large deposits at every pool tail out. Improvement to spawning habitat should consider the quantity and quality of gravel delivered from this tributary and how it is received in the mainstem. This small channel is easier to repair than the mainstem. Addressing the sediment and erosion aspects of the North Nanaimo will result in less sediment and cleaner gravels recruiting to the mainstem. This 10 km long tributary is described in the next segment.

Channel scouring in Reach 14 removed substrates that supported spawning gravel. Naturally formed crests made of boulders and sediments have been washed out or lowered; reducing their size and effectiveness. Degrading crests of spawning gravel result in reduced spawning area and washout of salmon eggs. Improvements to the crests would require detailed assessments and prescriptions¹⁷.

Rearing Habitat (Sidechannels)

North Nanaimo Channel: There is a 590m long seasonal sidechannel running from the North Nanaimo River along side the left bank inland 50-75m from the mainstem entering at Pool 3 (Placemark 14). It is 5-25m wide with the river side protected by a treed buffer and the steep rail grade on the left bank. The lower channel has larger deeper pools that are at river level and offer fish habitat for approximately 100m length. The channel has organic substrates covered with grass and pockets of water. It offers potential as a refuge and rearing habitat if excavated and protected from overflow from the mainstem and N. Nanaimo River.

A smaller off channel exists downstream left bank at placemark 24 (Pool 5) is 200m long and 3-8m wide. It is fed by a seasonal tributary and crosses the rail line. It offers refuge habitat. Fish access and habitat could be improved by excavation of old logging sediments and tree debris. Machine access may be possible overland from a nearby cut block.

¹⁷ Newbury R. & M. Gaboury 1993. *Stream Analysis and Fish Habitat Design. A Field Manual.*

Reach 14 Restoration Prescription Summary

Reach 14	Alterations/ Erosion	Rail Line along left bank (Placemark 16, 33,35,37)	Rail Culvert assessment – determine fish status, maintenance and repair. Some structures are eroding or have already failed.	M-H
R14	Erosion	P1,G2,G5,P4	Left bank is generally undercutting and eroding. Limited opportunity due to power of river and lack of soils. Willow staking where soils are present. Monitor.	L-M
R14	Obstructions	Wolf Creek	The jam at the mouth needs to be removed to permit fish passage and gravel input to mainstem. Culvert failure will result in a large sediment input and loss of access over the creek.	H
R14	Cover Habitat	Throughout R14	Lacking cover and opportunities to place LWD Large Boulder placement in Glides/riffles but limited access	L
R14	Spawning Habitat	R14 throughout	A good supply of gravel comes from N. Nanaimo but it is washed away Installation of boulders (crest) to trap gravel is a remedy but access is limited.	M
R14	Spawning Habitat	Lake Outlet	Lacks gravel recruitment. Has sediment concerns but a large area to choose (6000m2). Less chance of wash out in this location and high potential for use by Chinook. Access is difficult, may need helicopter or barge to deliver.	H
R14	Riparian Habitat	R14 Left Bank (P1, G2, P4)	Several clusters of veteran trees along the left bank. Many are exposed to high water. Bank erosion bioengineering and infill planting to hold soils to help protect the big trees and overall density.	M-H
R14	Off Channel Habitat	North Nanaimo River to P3	590 m long seasonally flooded along rail grade. Offers fish refuge in lower reaches but may trap fry as it dewater. Investigate water supply, enlargement of pools.	M
R14	Access/ Encroachment	Rail Line	The rail line recreational use is not causing any severe issues. Limited vehicle access due to wash outs. Good foot trail.	L
R14	Water Quality	Monitor	Monitor the temperature out of lake and major tributaries. Thermal cool zones from N. Nanaimo may attract spawners. Lake Limnology must be routinely monitored for lake turnover effect and thermal loads through the critical periods.	M-H
R14	Garbage	Rail Line	All public access is related to entrance areas at Wolf Creek and the lake campground. Currently the only real debris is a few abandoned vehicles on the rail grade.	L
R14	Education/ Partnerships	Wolf Creek	Habitat assessment; to determine sediment and erosion inputs to the main river, as well as salmon access, spawning and rearing status.	M
R14	Education/ Partnerships	North Nanaimo R.	Habitat assessment; to determine sediment and erosion inputs to the main river, as well as salmon access, spawning and rearing status.	H

Reach 16 Restoration Prescriptions

This 522m long reach is unique as the connector between First and Second lakes. Reach 16 was historically altered by blasting, dredging, rock armour placement as well as debris torrents. The purpose may have been for bridge installation, log transport or to reduce cabin flooding in Second Lake. The alterations to the channel appear to have lowered the elevation of second lake; reducing the spawning gravel, summer water volume and shoreline riparian areas. These alterations have reduced high value spawning habitat.

Spawning Gravel Restoration

Lake outlets are prime areas for Salmon spawning habitat; they have less sediment and flood surges buffered by lake volume. The unique habitat conditions result in First Lake outlet as an important spawning area for Chinook. Second Lake outlet offers the potential to be as important additional spawning site. The post-glacial gravel deposits lost to disturbance require replenishment.

The potential spawning improvement area is from the bridge upstream approximately 150m by 20m (3000m²) depending on depth and access. There is a nearby road and potential river access for a ramp on the south side just upstream of the bridge site. The ramp would permit the easiest material and machinery access to the site. Other more limited delivery options include spreading gravel from the bank with an excavator or gravel slinger if rock sizes can be accommodated. The spawning sites may require boulders for gravel anchoring and habitat complexity. The site needs to be measured for depth and width to accurately determine material needed.

Other Restoration Activities:

There are no other significant opportunities observed in the reach but small restoration activities that could be done with stewardship groups given the high public use in the area;

- water quality sampling,
- garbage clean up
- and planting disturbed areas at angling sites (Table 25).

Reach 16 Restoration Prescription Summary

Reach 16	Alterations	Bridge Abutment	A concern if logs jam against the center span but no evidence of buildup.	L
R16	Erosion	Road side	A small slip face from road along the north bank (10x3m), add shrubbery or wattles to enhance regeneration. A small project that could be useful for training/stewardship. The south bank road is narrow and runoff can enter river. Drainage and surfacing could reduce the concern.	L-M
R16	Obstructions	na	No concerns, no jams observed	L
R16	Cover Habitat	Na	No cover opportunity but has more desirable lake habitat nearby	L
R16	Spawning Habitat	Second Lake outlet	Approximately 150m by 20m area (3000m ²) for creation of spawning gravel habitat. This site will require access preparation of a ramp so it can be distributed from shore by excavator.	H
R16	Riparian Habitat	Along road, fishing trail edges	Maintenance planting in any gaps from disturbance.	L
R16	Access/ Encroachment	na	No concerns	L
R16	Water Quality	At Bridge	Good spot to routinely monitor water quality coming from second lake/upriver	M
R16	Garbage	Fishing trail to bedrock outcrop	Angling gear and other garbage is routine here. Good spot for a fish club to keep clean.	M
R16	Education/ Partnerships	All	This reach is well used by public/private, good site for educational signage	M

Reach 18 Restoration Prescriptions

This is a semi-confined 5595m long reach in the upper river. It is the first reach above 2nd lake and offers the most potential for spawning and rearing. Unfortunately habitat complexity is limited, there was one bedrock outcrop forming the only pool in our survey area. The river right bank is on a treed terrace just above flood plain levels. The river left bank rises more steeply up 5-20m elevation to the main logging road and hillslopes beyond. The right bank has areas where the floodplain entered the treed forest and left deposits of sand and wood debris. The floodplain areas were generally small, less than 10m wide. This reach lacks big opportunities for restoration. Infill planting to increase riparian depth and diversity is the highest ranked action.

Alterations - The reach has no alterations other than logging activities; there are active logging roads on both sides situated generally 100m or more from the river. There were no observed road erosion concerns other than Dash Creek crossing discussed below.

Erosion - Reach 18 has little erosion in the survey area. There is minor erosion mostly on the river right side which has lower banks and floodplain areas. There were no areas in the 1.5km survey area that warranted a high degree of sediment/erosion. In the area of the Dash Creek confluence, the mainstem Reach 18 has two large aggraded bars in the channel with un-vegetated widths 100-200m wide. To stabilize the river channel the bars could be treated with gravel bar staking and planting. Dash Creek drops over 300m elevation off the west hills along 8.5km into the mainstem. It is an alluvial channel that delivers a large amount of sediment as observed at the mainline bridge 750m upstream from the river. The past maintenance activities at the bridge resulted in piles of excavated sediment lining the river bank. Construction of a sediment sump at the bridge and removal, stabilization and planting of past deposits are recommended to manage sediment and protect fish habitat. Elimination of the sediment sources requires an assessment of the upstream channel.

Cover Habitat - Reach 18 has very little cover habitat. The edges of the river have small clusters of felled trees from flooding and undercutting and there are a few boulders. Trees could be anchored to protect banks as well as provide LWD cover habitat. Generally the lack of cover in this reach is due to flood scour that has removed the LWD. The straightened river has only 3 full meanders over its 5 km length lacking the inside bends with less scour that protect LWD placements. Rock structures such as Boulders, Bendway weirs and Groynes are all suitable structures to create meander/pool depth/cover but current channel access for placement is limited to a road at the top end. Overall given the difficult access and unprotected sites; addition of cover structures in this reach is considered to be a low priority. During the survey, upstream reaches had several large woody debris sources, none of this type of material was observed stockpiling in Reach 18. The lack of meander hinders LWD collection and it passed right through to Second Lake. In the lake there is a vast pile of LWD debris deposited in a 500m by 30m blanket of wood on the east shore of Second Lake.

Dash Creek at the confluence of Reach 18 may offer refuge habitat. Mapping indicates approximately 100m of pool habitat up from the mainstem. More inventory is required to determine if improvements can be made by adding cover and the potential for fish access and spawning habitat.

Spawning Habitat - Reach 18 is receiving a steady supply of sediments and gravel from tributaries (Dash Creek) as well as upstream mainstem. The river channel has pockets of gravel throughout the reach as well as at least two large aggraded gravel bars 50-150m wide near the Dash Creek confluence. Gravel bars offer poor spawning opportunity if unvegetated to meander and erode with

flood events. Fish eggs are either displaced or buried. Stabilization of the bars with plantings will improve the egg incubation survival. Chinook spawning utilization of this reach is less known but the fish may use it if conditions were improved.

Riparian Habitat - As noted, the riparian area is poor with only an average of 58% Crown Closure and 41m vegetation depth. Infill planting and additional reserve areas to at least 50m especially on the south bank is recommended.

Sidechannels - Offchannel habitat was found in the survey area of Reach 18 along the south bank. A low gradient drainage following an old roadway offers 775m of potential length in a 3-4m wide seasonal channel. This channel offers spawning gravel and flood protection but drops to a trickle flow between floods. It lies along a gravel deposit terrace that may have a high water table which test pits would show. The site is accessed adjacent the south bank logging roads.

Overall, Reach 18 has no significant fish habitat concerns, the highest effort should be addressed at limiting Dash Creek sediment , infill planting riparian areas and planting unvegetated gravel bars.

Reach 18 Restoration Prescription Summary

Reach 18 5595 m	Alterations	Entire length	Logging roads set back (100m+), a bridge crossing, and small boat launch, no other streamside developments	L
R18	Erosion	Mainstem	Minor erosion points along both banks, more commonly on lower right bank. Opportunity for localized protection devices (LWD, Rock Spurs, Bendway weirs) to address erosion and add depth and cover.	L
R18	Erosion	Dash Creek	Investigate erosion sources, maintenance of spoil piles and sump installation at the logging road bridge.	M
R18	Erosion	Mainstem aggraded Gravel Bars (near Dash Ck outlet)	Plant live stakes and seedlings for gravel bar stabilization in two sites.	M
R18	Obstructions	None		na
R18	Cover Habitat	throughout	Lacks cover (LWD, Boulders, Deep pools), boulder clusters would be the most cost effective but access is limited.	L
R18	Spawning Habitat	throughout	Lacks protected spawning beds. Planting the Dash Creek entrance gravel bars will stabilize the spawning habitat.	M
R18	Riparian Habitat	South Bank	Infill planting to 50m width in gap areas along the sunny south bank.	M
R18	Off Channel Habitat	South side tributary (placemark 4)	With vehicle access from Branch F, a 775m long seasonal 3-5m wide low gradient channel crosses the spur road. It offers high water refuge and spawning habitat. It may have potential as a constructed ground water fed channel. Requires test pits .	M
R18	Off Channel Habitat	Dash Creek	It offers refuge habitat in the lower 100m from the mainstem. It requires assessment of the channel and maintenance of sediment accumulations at the logging road.	L
R18	Access/Encroachment	Boat Launch TP Bridge	No river vehicle entry.	L
R18	Water Quality	TP Bridge	This is a good access point for water quality monitoring (Temp/Flow)	M
R18	Garbage	NA	No garbage observed at boat ramp or anywhere else.	L
R18	Education/Partnerships	Signage	A sign at the boat launch – Salmon Habitat – No vehicle entry	M

Reach 22 Restoration Prescriptions

Reach 22 is a 2347m long upper anadromous reach of the Nanaimo River. It offers a large amount of spawning substrate and some perennial pools for rearing. The limitations for spawning and rearing are related to the instability of banks from flood torrents. This reach historically would have offered a considerable amount of spawning and rearing habitat. It once had deep post glacial gravel deposits and large trees to anchor the gravel and hide fish. The instability of the top end of the river is shown in the poor habitat scores. The river gravel is following the fate of the trees and washing away. While being an upper reach of the Nanaimo River, it still generates plenty of power from flood water and debris to harm the current habitat. Restoration plans in this watershed need to be mindful of the power of the river. The easy restoration activities that work with the current state of the river would be to do the gravel bar staking and planting. Instream LWD may be risky. Enhancing one of the sidechannels in this river to provide spawning and rearing habitat is recommended to be investigated. This is all private land and the landowners need to be informed early in the planning stage.

Erosion – Willow Staking: Erosion repair is recommended for this reach. The alluvial fan at the top of the reach on left bank has 400m long gravel bar. Willow staking the bar will stabilize the material. This is a relatively low risk activity with a high benefit. The site can be repaired manually or with mechanized help with burial of plants depending on access and budget. This type of restoration offers stewardship involvement with the bar staking.

Erosion/Cover: The river right bank opposite the gravel bar is eroding and LWD placement would offer bank protection and fish cover. The bank has a grove of 2nd growth Fir that are falling over. Installing LWD structures that provide bank protection and fish cover would be very beneficial. The existing trees could contribute some of the LWD but the project would require machine and material access. LWD placement is higher risk and more inspections would be required to determine the strategy and work area.

Sidechannels: Sidechannels provide flood refuge, rearing or spawning habitat depending on their flow regimes. This reach is very dynamic, fish will use these floodplains as refuge during storms. Five floodplain channels were identified in this reach, channel 4 offers the most development potential.

- Sidechannel 1 (R22 Placemark 17)- located along the left bank, this channel is 283m long. It is braided 5-10m wide and dry in summer. It has a narrow floodplain (approx. 30m wide) adjacent the steep bank below the mainline road grade. It offers flood refuge and potential seasonal rearing and spawning. The narrow buffer with the mainstem leaves it vulnerable to floods and channel migration.
- Sidechannel 2 – (R22 Placemark 32) located on the right bank opposite SC#1. It is approximately 365m long and 3-4m wide. It is seasonal in flow regime. It is in a 100m wide flood plain, with the channel located further away from the mainstem (30-80m). Near the south side logging road it was fed by a sidehill tributary. The riparian area is a mixture of Maple and Alder. This sidechannel offers good flood refuge protection but the seasonal flow regime limits the rearing and spawning potential.
- Sidechannel 3 – (R22 Placemark 19) Located on the river left bank, below the mainline road at the foot of a steep bank. It is 129m long and 3m wide seasonal channel. The narrow floodplain is less than 30m wide with a small treed (Alder) line of protection from the main river. The sidechannel offers flood refuge habitat.
- Sidechannel 4 (Placemark 27) – the largest and most active channel. It is 387m long and 15m wide in the mid point. It is located on the river right bank in a 50-90m wide floodplain. The floodplain is treed with Alder and Cedar 30-50 years old growing on a gravel terrace

that is less than 3m height. The low aspect of the right bank may permit extending the length of the channel. The sidechannel is fed by the mainstem over a gravel bar. It flows around the right side of the island in a shallow pool-riffle complex. The substrates are 40% gravel. There are rooted trees along the edge of the channel. It has been in existence for at least 30-40 years. This channel offers seasonal flood refuge, spawning and rearing habitat. It offers the best fish habitat and most improvement potential.

- Sidechannel 5 (Placemark 37) – Located at the top of Reach 22 on river left bank. It flows on the north side of a large alluvial fan. The fan is low and treeless resulting in frequent inundation. It is fed over an open gravel bar from the mainstem. It was dry in February and offers only limited fish protection in its current state.

Reach 22 Restoration Prescription Summary

Reach 22	Alterations	Reach 22	No recent alterations to the reach it was historically logged to the river bank	NA
R22	Erosion/Cover	Placemark 32-35, (upper reach)	Left bank has a 400m long alluvial fan requires live staking and planting to stabilize exposed materials. This work can be done by hand or with machinery (excavate trenches, place willow bundles, backfill) depending on the budget. Right bank along 400m , is 1-2m high, eroded to undercut tree roots. Anchor fallen trees LWD along the bank for protection and fish habitat.	H M-H
R22	Obstructions	None		
R22	Cover Habitat (LWD)	Placemark 32-35	Noted above: anchor LWD using fallen trees	M
R22	Spawning Habitat	NA	Benefits to spawning habitat in controlling erosion	na
R22	Riparian Habitat	Placemark 32-35	Left bank alluvial fan – live stake and plant to stabilize. Right bank riparian area – infill planting of conifers due to flood damage	H M
R22	Riparian Habitat	South Bank	Infill planting to 50m width in gap areas along the sunny south bank.	M
R22	Access/Encroachment	NA	No vehicle or trail access observed.	na
R22	Water Quality	Sediment Monitoring	Green Creek enters just upstream, investigate the sediment sources into this reach.	M
R22	Garbage	na	No garbage observed	na
R22	Education/Partnerships	Planting	Planting/staking the alluvial fan could be a stewardship initiative. Having community groups get involved with permission from property owner. Similar projects completed recently on Cowichan.	H
R22	Access/Encroachment	na	No trails or roads near the reach	na

Reach 23 Restoration Prescriptions

Reach 23 is the furthest upstream reach surveyed. Above this reach is steep confined reaches to the barrier at Reach 25. This reach is 3038m long and ends at the confluence of Sadie Creek out of Fourth Lake. Restoration opportunities are found in the riparian area, more ha

Riparian Vegetation Planting –This reach has an average of 43m vegetation depth in the survey area, Infill planting to 50m width in gap areas along the reach is recommended.

Monitoring Tributaries - Reach 23 is an upper anadromous reach of the Nanaimo River. This reach receives flow from three major tributaries. The tributaries are a source of water, sediment and LWD. Habitat surveys of their channels is recommended. They play an important role in determining the health of the mainstem river.

- Green Creek enters at the bottom of Reach 23 and has a gravel bed channel for approximately 600m to the first logging road bridge and above is steeper and bedrock controlled. Green Creek appears to have been responsible for erosion/deposition in Reach 22 area immediately below. The Creek cut a new channel further downstream on the right bank due to debris jam buildup several years ago. The new route appears to have settled and stabilized.
- Sadie Creek runs 250m out of the dam at Fourth Lake and enters the top of Reach 23. Above the logging road bridge crossing it is a bedrock canyon with waterfalls and cascades. Below the bridge it is alluvial lower gradient and has recently cut a new channel through treed riparian areas where it enters reach 23. There is wood debris hung up on trees in a flooded confluence area. This area has active erosion until it settles.
- Rocky Run Creek is a 10m wide tributary on the left bank that enters mid reach. Inspection of the reach at the logging road bridge 200m upstream found the channel to be stable with rooted trees lining a boulder cobble substrate. It is steep but the confluence area may offer spawning habitat.

Sidechannels: A braid in the mainstem exists on the right bank below Sadie Creek. This channel is approximately 156m long and 15-20m wide. It is separated from the mainstem by a low treed floodplain that is 5 to 30m wide. It appears to have recently cut through the floodplain. It is not a good candidate for development as it is unprotected from the river..

Reach 23 Restoration Prescription Summary

Reach 23	Alterations	Reach 23	No recent alterations to the reach it was historically logged to the river bank	na
R23	Erosion	Tributaries	Monitor tributary erosion, maintenance at road crossings as required, re-plant disturbed areas.	M
R23	Obstructions	None	None, there are accumulations of LWD in the floodplains	L
R23	Cover Habitat	Lacking Throughout	Poor habitat but little opportunity for placement,	L
R23	Spawning Habitat	No opportunities	Gravel is supplanted from tributary inputs	L
R23	Riparian Habitat	South Bank	Infill planting to 50m width in gap areas along the sunny south bank.	M-H
R23	Access/Encroachment	None	None	L
R23	Water Quality	Tributaries	sediment source monitoring	M
R23	Garbage	None	None seen, no recreational use	L
R23	Education/Partnerships	None	No current opportunities, remote location	L
R23	Access/Encroachment	None	None seen	

Restoration Prescriptions Summary

The Reach 2-23 restoration assessments are quite extensive. A summary table of only the high ranked prescriptions was done. Table 27 below is a summary of the 43 higher priority items ranked High or Medium-High taken from the overall summary in Appendix 1.

Table 27.) Higher Priority Restoration Activities by Reach Nanaimo River 2021.

Reach	Habitat Issue	Location	Prescription	Priority
Reach 2	Erosion/Planting	Morden Trail and upstream River Left Bank to Placemark 12.	Plant (500m) eroding bank, 1-3m high. Prescribe shrub cuttings (Willow, Red Osier) on sides and trees (Cedar, Doug Fir, Spruce, on top)	H
R2	Erosion/Planting	Right Bank – along pasture at Placemark 23	Restore (430m) actively eroding low bank along farm pasture. With property owner permission; bank planting (cuttings, trees), this could start immediately in fall.	H
R2	Riparian Planting	Throughout R2	Underplanting opportunities in many areas. Infill poorly stocked/damaged riparian. Primarily planting seedling conifers – Douglas Fir, Red Cedar etc. Participating property owners will determine locations. Highest priority is south and west sides of river .	M-H
R2	Riparian Invasives/Planting	River Left Bank (Placemarks 16,18,20)	At least three polygons (25-30m long) of heavy broom infestation adjacent river bank that should be removed and replanted (conifers or shrubs) with property owner permission.	M-H
R2	Water Quality	R2	Water quality monitoring of the reach and sidechannel habitats is recommended to gain information on habitat quality and trends. The Thatcher/Morden sidechannel may be anoxic in summer.	H
R2	Education/Partnerships	Morden Trail	Potential river stewardship & education activity site at end of trail – improve access, fence, signage, planting.	M-H
Reach 3	Erosion	Three large locations Right Bank Lower	1.) Lower RB has 350m length – undercutting and collapsing. High velocity /Floodplain area. Review leaning trees with arborist, to mitigate tree loss on bank . Use existing trees as LWD/CWD.	H
		Left Bank along trail	2.) Along trail/power pole LB Dyke (200m). Contact land owner about repair of rock voids where eroding into river.	H
		Right Bank below pumphouse	3.) Upper RB (470m) undercutting and collapsing. High velocity /Floodplain area. Review leaning trees with arborist, use trees as LWD/CWD .	H
R3	Riparian Habitat	R3 - LB	Planting along hydro lines approx. 200m. This will shade the west exposure. The area is a public park trail way with good access but poor soils.	H
R3	Water Quality	R3	Water quality monitoring program - this may be already in place with the RDN Water Smart program.	H
		R3	Review Highways Road runoff treatment – eliminate direct drains to the river with bioswales. Need to talk to highways manager about modernizing the storm water system for the bridges.	H
R3	Education/Partnerships	R3	Nanaimo River Hatchery, Nature Trust Nanaimo River property. Nanaimo Forest Products all have interest in this reach. Restoration plans must include property owners at initial set up. More land purchase protection of remaining riparian area.	H

Reach 4	Issue	Location	Prescription	Priority
R4	Spawning Habitat	Lower reach	Candidate for spawning gravel placement in the 250m x 60m glide via pit access road. Review placement strategy by machine or permit it to wash in from stockpiles- estimate 50 cm ³ (5 truck loads)	M-H
R4	Education/Partnerships	Throughout	Land owner contact to protect the riparian area, stop the quads from destroying the narrow riparian area. Trail stewardship program. Purchase the riparian area or put in strict covenant	M-H H
Reach 5	Alterations	BC Hydro Line; Trail to Bore Hole Viewpoint off Nanaimo Lakes Road	The powered vehicles are impacting the thin vegetation along the viewpoint. Install signage, add CWD and fencing to prevent further damage. This ecologically sensitive ribbon along the river site should be purchased as park area. It requires routine stewardship maintenance.	H
R5	Riparian Habitat	Garry Oak Bluff, on river left, (Placemark 12)	Protection: Garry Oak Bluff is a sensitive ecological area that should be identified for protection. Assess in summer, consider signage, passive protection. It is relatively isolated by foot trail. A special area that would be easily lost with human over-use.	H
R5	Riparian Habitat	River Bend Road Park and residential area on south bank (river right)	Replanting: South bank residential areas have removed trees on some properties – contact, partner, replant and protect. The RDN River Bend Park may offer a community riparian stewardship starting place to add signage and infill plant disturbed areas.	H
R5	Access/Encroachment	At river access BC Hydro Crossing off Nanaimo Lakes Road, on river left	As noted above, needs Protection: High use recreation area for hikers, climbers, consider Park designation or volunteer stewardship group to maintain – repair steps to river, clean up garbage, protect sensitive areas, replant eroded areas install signage, fencing.	H
Reach 12	Riparian Habitat	Both sides	Increase riparian depth to at least 50m along this reach with planting where required, south bank takes priority.	H
R12	Education/Partnerships	Partnerships	Both BC Hydro and RDN water pass through this Mosaic Forest land, an opportunity for corporate sponsorship of habitat restoration of sidechannel and planting areas.	M-H
Reach 13	Alterations	Wolf Creek & Rail Culvert (Stn 9)	Wood Box culvert at river mouth is plugged with logs and blocks fish access. A bigger problem when it fails. Old rail line has plugged culverts and overflow. Need to be maintained or removed.	H H
R13	Erosion	Rail Grade Slide Placemark 10	30m by 30m slope failure sending sediments into river from failed culvert. Needs stabilization and drainage cut off. Machinery if required may use the rail grade or above through the block setting.	H
R13	Obstructions	Culvert at Wolf Creek	Access to the tributary is blocked. Needs to be repaired as above	H
R13	Riparian Habitat	South bank – two thin sections @ 650m length	Thin sections 15-20 m wide. Contact property owner about south aspect riparian management plans to ensure replanting to 30m minimum.	H

R13	Access/Encroachment	Wolf Creek	As noted above, culvert blocks fish access. Needs to be repaired/removed.	H
R13	Education/Partnerships	Landowner	Work with land owner to identify sensitive riparian areas and management strategies	H
Reach 14 To 1st Lake	Alterations/Erosion	Rail Line along left bank (Sites 16, 33,35,37)	Rail Culvert assessment – determine fish status, maintenance and repair. Some structures are eroding or have already failed.	M-H
R14	Obstructions	Wolf Creek	The jam at the mouth needs to be removed to permit fish passage and gravel input to mainstem. Culvert failure will result in a large sediment input and loss of access over the creek.	H
R14	Spawning Habitat	Lake Outlet	Lacks gravel recruitment. Has sediment concerns but a large area to choose (6000m ²). Less chance of wash out in this location and high potential for use by Chinook. Access is difficult, may need helicopter or barge to deliver.	H
R14	Riparian Habitat	R14 Left Bank (P1, G2, P4)	Several clusters of veteran trees along the left bank. Many are exposed to high water. Bank erosion bioengineering and infill planting may hold soils to protect the big trees. The sites are	M-H
R14	Water Quality	Monitor	Monitor the temperature out of lake and major tributaries. Thermal cool zones from N. Nanaimo may attract spawners. Lake Limnology must be routinely monitored for lake turnover effect and thermal loads through the critical periods.	M-H
R14	Education/Partnerships	North Nanaimo R.	Habitat assessment; to determine sediment and erosion inputs to the main river, as well as salmon access, spawning and rearing status.	H
Reach 15	Water Quality	First Lake	Routine Lake limnology monthly	M-H
Reach 16	Spawning Habitat	Second Lake outlet	Approximately 150m by 20m area (3000m ²) for creation of spawning gravel habitat. This site will require access preparation of a ramp so it can be distributed from shore by excavator.	H
Reach 18	Erosion	Dash Creek Road Crossing	Investigate erosion sources, maintenance of spoil piles and sump installation.	H
Reach 22	Erosion/Cover	Placemark 32-35, (upper reach)	Left bank has a 400m long alluvial fan requires live staking and planting to stabilize exposed materials. This work can be done by hand or with machinery (excavate trenches, place willow bundles, backfill) depending on the budget. Right bank along 400m, has 1-2m bank eroded, undercut trees. Anchor fallen trees as LWD along the bank for protection and fish habitat	H M-H
R22	Riparian Habitat	Placemark 32-35	Left bank alluvial fan – live stake and plant to stabilize.	H
R22	Riparian Habitat	South Bank	Infill planting to 50m width in gap areas along the sunny south bank.	M-H
R22	Education/Partnerships	Planting	Planting/staking the alluvial fan could be a stewardship initiative. Having community groups get involved with permission from property owner.	H
Reach 23	Riparian Habitat	South Bank	Infill planting to minimum 50m width in gap areas along the sunny south bank.	M-H

Watershed Restoration Plans

Additional Assessments

This report covers a habitat assessment of selected Chinook habitats of the Nanaimo River. A complete watershed assessment involves the geomorphology, silviculture, hydrology and cultural uses. It should involve Mosaic Forest Management the Snuneymuxw First Nation and any other Riparian property owners. These assessments would identify areas not covered in this habitat survey such as:

- Terrain stability, landslides – upland areas are unknown but there were localized slides along reach 14 and 13 on the old rail grade. This assessment requires terrain assessment experts (P.Geo P.Eng.)
- Hydrology study of the river – collect data on the health of the river channel and identify sediment sources from the tributaries. Requires a channel assessment by a river engineer, hydrologist (P.Geo, P.Eng.).
- Logging Road surveys for maintenance or deactivation in partnership with the landowners. The mainstem river has few concerns as the mainline is generally well built and does not encroach. Side roads and tributaries such as Dash Creek (R18) and culverts along Reach 23 may be opportunities to improve road networks and fish habitat. This work may be done by various professionals (P.Eng, RPF, or experienced contractors.)
- Fish crossing assessment/restoration – our survey was limited to areas directly beside the Nanaimo mainstem, we identified fish obstructions at Wolf Creek (R13) and the rail grade culverts. An assessment of all fish passage structures along the fish bearing tributaries is warranted.
- Agricultural practices – the historic clearings to the river bank in Reach 2 and 3 and activities on the property result in implementing Environmental Farm Plan¹⁸ Assessments on these properties. This plan is voluntary to property owners.

These surveys should follow documented methodology such as what was developed for the Watershed Restoration Program, Forest Practices Code and Develop With Care Practices by BC Environment.

Habitat Surveys

There is missing data on the complete status of fish habitat in the watershed. The 2021 survey objectives were to inspect eleven out of twenty three reaches in the Nanaimo Mainstem with respect to Chinook spawning and rearing habitat. Un-surveyed are 12 mainstem reaches and fish bearing tributaries (Jump Creek, N. Nanaimo R. etc). The full story of fish habitat is not known until these reaches are assessed.

Reach 1 on the Snuneymuxw Reserve is of high priority as it is used by all species of salmon. It has residential areas in floodplains that are inundated twice in the last three years. The expected remediation plan for floods should be done with full knowledge of fish habitat values. This will lead to better outcomes for both concerns.

Reaches 5 and 6 are in bedrock canyons that have cascades known as the Bore Hole and White Rapids; they are known impediments to salmon migration. The fish way at White Rapids is a critical

¹⁸ <https://www2.gov.bc.ca/gov/content/industry/agriculture-seafood/programs/environmental-farm-plan>

passageway for early run Chinook to escape the lower reach warm waters and seek the sanctuary of cooler waters of the lakes and headwaters. The passages need assessment to determine if adjustments to the structures can be made to adapt to climate change scenarios of very low and very high flow.

Reaches 7-11 are relatively confined in a deep gorge but they all have residential development on the river left bank and forestry operations on the right bank. This close presence to humans unfortunately warrants assessment to ensure the habitat values are protected.

Salmon bearing tributaries of the Nanaimo River require habitat assessments. The North Nanaimo River and Jump Creek are the largest and longest (10 km and 5 km respectively) salmon accessible waterways other than Haslam Creek (USHP 2010). Other tributaries that require assessment include Wolf, Dash, Rush, Rocky Run and Green Creeks. These tributaries affect the health of the mainstem including delivery of cool water and spawning gravel.

Lake Assessments:

The four Nanaimo lakes are important components of the watershed that were not surveyed. There is bathymetry data from 1979 but no online records of water quality on the iMap BC site (<https://maps.gov.bc.ca/ess/hm/imap4m/>). Collecting water quality on a regular basis will be key. The temperature and oxygen profile of these lakes needs to be monitored over an entire yearly period to determine any limiting factors. First Lake has a high amount of organic sediment lining the shoreline observed during the snorkel survey to Reach 14. This was not surprising since the lake was used as log storage for years and would have resulted in organic deposits (bark, wood fibre) settling on the bottom. Organic material decomposition may be stressing the fish in the lake through reduced oxygen and hydrogen sulphide production. Second Lake appears to have been historically lowered in elevation at the Reach 16 connection to First Lake losing shoreline and spawning habitat. Third Lake appears to be an unaltered shallow open water wetland offering year round fish rearing habitat depending on its temperature and oxygen profile. Fourth Lake is above the anadromous barrier but has a large reservoir behind a dam (built in 1934) that augments flow to the river as well as serving the Pulp Mill intake in Reach 3.

Jump Lake is isolated by a dam (built in 1931) that stops salmon at approximately 5km. A second dam was built upstream with larger storage (1976). It is used as a water supply lake for the City of Nanaimo under several water licenses. It stores and discharges maintenance water flow (maintaining a minimum flow of approximately 1cms according to WSC 2021 low flow reading) and is monitored by a real time hydrometric station (https://wateroffice.ec.gc.ca/report/real_time_e.html?stn=08HB092) near the confluence with the mainstem. Jump Lake and Fourth Lake are both impoundments that are used for regulating flows in the Nanaimo River. They are used to augment low flow and/or increase migration flow for spawners. There may be opportunities for more storage, more release or cooler water at these sites.

Sidechannel Assessments;

There are at least a dozen sidechannel areas identified in floodplains along the surveyed areas. They are described in more detail in the reach sections. These channels offer fish production through flood refuge, rearing and/or spawning. Our report identifies the location, length, flow regime and fish access. Further investigation for development may include more accurate mapping, digging test pits and measuring water level/quality.

Sidechannels that are already offering fish utilization are higher priority. Reach 2 and 3 have constructed channels; the right bank Napoleon Sidechannel next to the hatchery and to a lesser degree the Polkinghorne Sidechannel along the Morden Colliery Trail. These have maintenance requirements and need assessment of flood protection, sediment removal, spawning gravel addition and riparian planting. These channels are already producing fish and offer the best cost benefit for sidechannel efforts.

There are undeveloped sidechannels to assess for restoration potential: for example upstream in Reach 12 over the Nanaimo City water line is an undeveloped 800m long flood channel in a reach where both Chinook and Coho frequent. The channel is in unprotected floodplain with seasonal flow. All sidechannel assessments should consider flood protection, water supply, property ownership. The assessments will help determine the fish species that will benefit for refuge, rearing, and or spawning.

Riparian Assessment:

The reaches throughout the watershed riparian area were identified from orthophotos by Wright et al (2020) by species and age class to 100m width. Assessment at a site level of the health, type and density of the riparian vegetation is the next step. Riparian assessment and restoration procedures are based on improving the forest health and biodiversity towards a target of old growth characteristics, described in the publication "*Riparian Restoration in British Columbia: What's Happening Now, What's Needed for the Future* by Vince Poulin, Cathy Harris and Bart Simmons (March 2000) for the Watershed Restoration Program". There are examples of impaired riparian areas; upper reaches (R 13,14, 22 & 23) areas of floodplain are dense Red Alder groves with little conifer density. There are unvegetated gravel deposition areas or slide tracks where bioengineering techniques are recommended. These sites require a more detailed measurement of area and plant community. The areas with erosion sources directly into fish habitat should be prioritized (i.e.staking gravel fans in R22).

Restoration Prescriptions

The list of habitat concern is meant to generate interest in action and undertake restoration. Tables 27 and Appendix 1 provide that list. Stream habitat restoration require designs to follow standards that are approved, reliable and applicable to the needs of the habitat and skills of the people undertaking the activity. Restoration of habitat has to be reviewed by agencies, landowner and often several funding agencies.

The restoration designs for the sites are based on standard practices developed and published for stream restoration projects. The B.C. Watershed Restoration Program provides a standard reference for stream restoration techniques in "*Fish Habitat Rehabilitation Procedures; Watershed Restoration Technical Circular No.9*"¹⁹. This manual remains the most complete reference of restoration strategies in BC streams.

In 1995 the Pacific Streamkeepers Federation introduced The Streamkeepers Handbook. It has 14 modules on stream restoration and stewardship (below). This manual is available online (<http://www.pskf.ca/>) with updates and instructional videos. It is a very practical guide for activities scaled for stewardship. The habitat assessment identified many activities where the scope of the restoration work fits with the capabilities of Stewardship. These modules, accompanied by Streamkeeper Certificate training would permit contributions by local stewardship groups.

- Module 1 – Introductory Stream Habitat Survey
- Module 2 – Advanced Stream Habitat Survey
- Module 3 – Water Quality Survey
- Module 4 – Stream Invertebrate Survey
- Module 5 – Storm Drain Marking
- Module 6 – Stream Clean up
- Module 7 – Streamside Planting
- Module 8 – Streamside fencing
- Module 9 – Observe, Record, Report.
- Module 10 – Community Awareness
- Module 11 – Juvenile Fish Trapping and Identification
- Module 12 – Salmonid Spawner Survey
- Module 13 – Creel Survey
- Module 14- Stream Channel Improvement

In the authors experience, there is no job too big or small to involve stewardship groups. Haslam Creek has had a variety of restoration treatments (LWD placement, channel restoration & Riparian Planting) conducted by NFGPA working with property owners (NAC/Harmac), Stzuminus First Nation, permit and funding agencies, professionals and contractors. They were integral to organization of the project: assisting with contractor selection, property owner permission, fish removal, construction monitoring, seeding, planting, reporting and budget.

¹⁹ Slaney, P.A. and D. Zaldokas, 1997. Fish Habitat Rehabilitation Procedures, Watershed Restoration Program, MOELP, UBC , Vancouver BC.

Restoration Prescription Category

Each restoration category and its overall effect for each reach is discussed below. The restoration prescriptions were categorized by the following topics for each reach;

- Alterations
- Erosion
- Obstructions
- Cover Habitat
- Spawning Habitat
- Off Channel Habitat
- Riparian Habitat
- Access/Encroachment
- Water Quality
- Garbage
- Education/Partnerships

The Restoration prescriptions are described with examples below;

1.) Alterations – Reach 3,5,16.

Alterations in the Nanaimo River consisted of a wide variety of anthropogenic features; there were Foot trails, Vehicle trails, Rock Armoured banks, Water lines, Hydro lines, Culverts, Rail line and Bridges. Of these Reach 3, 5 and 16 have potential restoration rankings of High. Reach 3 has a vast blanket of rock armour and to protect the concrete pumphouse (planting beds are needed). Reach 5 at the Hydro Line has quad trails gaining access off Nanaimo Lakes Road to sensitive rock bluffs tearing up the sensitive soils- this needs to be blocked and remediated. At Reach 16, the centre span of the logging bridge is in the stream channel. Its preparation and rock armour appears to have resulted in loss of the spawning gravel upstream of the bridge in a high potential area, it is a potential candidate for spawning gravel placement.

2.) Erosion – Reach 2,3,22

Reaches 2, 3 and 22 had restoration action ranked High in locations after Poor scores for erosion. These reaches have hundreds of metres of actively eroding bank. Based on similar work in Haslam Creek, the prescriptions are likely to incorporate LWD, Rock spurs, bioengineering and riparian planting after a more detailed hydrology/biology assessment.

3.) Obstructions – Reach 14

There were no fish migration obstructions in the main reaches. The scores were low (1). Tributaries entering Reach 14, such as Wolf Creek and unnamed channels under the old rail grade had plugged culverts with obstructions to fish passage.

4.) Cover/Rearing Habitat – Reach 3,22.

All reaches Cover scored a Poor rating (5) in this category except Reach 5 and 16 scoring a Fair (3) rating due to some boulder cover. LWD and Boulders regarded separately as cover components scored a Poor (5) in all reaches. While both were Poor, there was most boulder habitat in the mid reach canyon area (Reach 4 & 5) and most LWD in Reach 2 and 3. The restoration recommendations for addition of Cover items in the mainstem is ranked as Low or Not Applicable. The evidence from the survey showed the river to be very powerful and installation of LWD structures that project into the river are likely to get blown out. Rock structures offer more flood and

debris resistance but they fail if water gets around them or they are hit by large floating debris. The best cover offered in the river presently is in the off channel habitat.

5.) Spawning Habitat – Reach 14, 18.

Spawning habitat was based on lack of Fines and presence of Gravel. Overall, Fines were surprisingly low (<20% of substrate) and scored Good (1) in all reaches except Reach 14 and 23 Fair (3) where sediment pulses from tributaries were observed. The percent spawning gravel was not rated but amounts over 20% were found in Reach 2, 14, 18 and 22. The results were spotty but the summer Chinook that spawn at the tail out of First Lake into Reach 14 use a diminishing pile of gravel covered with organic sediments from log storage and granular sediments washing in from the North Nanaimo River. Spawning gravel addition is recommended at Reach 14 and 16 as the highest benefit to areas frequented by Chinook spawners.

6.) Off Channel Habitat – Reach 2, 3, 12.

Off channel habitat that is functional exists in the lower Reaches 2 and 3. The Polkinghorne Sidechannel on the Morden Colliery Trail offers three seasons of fish use. The Napoleon Creek sidechannel system alongside the Nanaimo River Hatchery is year round habitat for rearing and spawning used by Chum and Coho. These channels are sedimented and require maintenance. Highly recommend repairing /maintaining structures already built/working before moving to new sites. New sites are offered at Reaches 2, 3, 12, 14, 18 and 22 which have low benches with flood channels. With respect to Chinook spawning habitat, Reach 12 has a 800m long left bank flood channel under the Hydro line and over the water line that may offer the most promise.

7.) Riparian Planting - All

The Riparian Habitat scores was assessed for Land Use, Slope, Stability, Crown Cover, Access (Trails) and Vegetation Depth. The Poorest overall scores in this category were Reach 2, 5, and 12. Reach 12, 16 and 18 scored Poorest (5) in vegetation depth. We recommend Riparian planting as High in every reach. There is also a High need for bioengineering; to stabilize sediment and slopes.

8.) Access/Encroachment – Reach 5

There were Fair (3) scores in all the lower reaches (2-14) due to ongoing human access trails and structures. Reach 5 has a trail/quad access damage to sensitive buffs. The restoration solutions are considered to be good partnership activities. The upper reaches in private forest land had low or no occurrences.

9.) Water Quality

This was not assessed in the survey but field instrument testing raised concerns in the Thatcher/Morden Sidechannel (low oxygen/high temperatures). These measures are needed in First and second Lake where Chinook hold in summer.

10.) Garbage – Reach 3 and 5

Public access sites at trail heads and parking areas had garbage. Fortunately very little was observed in the river itself. The most garbage was at the Reach 3 swimming area next to the pump house. Another area where dumping was observed is along the Nanaimo Lakes Road at pull outs/trail heads in Reach 5, 13, and 14.

11.) Education/Partnerships - throughout
























In Reach 2, the Morden trail offers an educational site which could feature a bank restoration project. In Reach 3 restoration work will require partnerships with Nature Trust, The Nanaimo Forest Products. In Reach 4/5 we recommend Land Owner contact on the south side to educate home owners of the concern for vegetation removal along the river bank. In Reach 5, recommend

partnering with land owners (BC Hydro) on restricting Quad access to the bluffs. In Reach 12 exists the infrastructure for Nanaimo City Water and BC Hydro transmission in areas needing riparian restoration as well as the potential of building a sidechannel on Mosaic Forest lands. Reach 13 and 14 have localized erosion issues, garbage and plugged culverts that all require consultation with the property owner-Mosaic Forest. Posting Salmon Habitat signs at boat launches and stream crossings in forestry areas (Reach 16, 18,22 & 23) is also a good stewardship opportunity for a group to pick up and work with the property owner.

Project Restoration Timing

Table 28 shows a standard timeline for projects considered in this report. This table also shows the pre and post enhancement monitoring timing of a typical restoration activity.

Table 28.) Stream Restoration Schedule

Activity	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Planning & approvals												
Pework Site mtgs, prep mtl's & Eq												
Instream work												
Construction report												
Project assessment Year 2 Monitoring report												

Planning Schedule

Year One

- Assess summer water levels in all reaches
- Map reaches and tributaries that are not currently mapped correctly
- Choose project sites in the areas where the most benefit can be realized
- Assess fish densities in project sites
- Conduct restoration projects- expand year 1 project details where funding and landowner permission is available
- Conduct initial post project assessment
- Inventory any possible off channel sites
- Contact new land owners about future projects

Year Two

- Plan and conduct any new projects made available by landowner contact or inventories in year one.
- Assess year one activities
- Make any necessary changes to year one project sites

Year Three through Five

- Plan and conduct any new projects made available by landowner contact or inventories in past year.
- Assess past years activities
- Conduct maintenance on past project sites

Conclusion

Habitat Survey

The Nanaimo River was surveyed in 11 of 25 mainstem reaches. The reaches surveyed were considered to be the primary Chinook Salmon spring, summer and fall run habitat areas of the watershed. Reaches 2-5 were considered for fall chinook. Reaches 12-14 were measured for summer chinook and reaches 16-23 were measured for utilization by spring chinook. The surveyed reaches all offer potential spawning and rearing habitat for these fish. The un-surveyed reaches were in areas of higher gradient, canyon and bedrock reaches (except Reach 1) with little or no known Chinook Salmon usage other than as migration corridor.

The Urban Salmon Habitat Survey of the Nanaimo River watershed serves as a reference for both monitoring and restoring the watershed. This habitat survey method collects information on the functioning condition, measurements of the habitat units (Pools, Riffles, Glides) as well as specific locations. The survey methodology provides reference locations for the Pools, Riffles and Glides using the GPS reference locations. This offers repeatable surveys critical to understanding the current and future conditions. The 11 reaches in the river represented 30 km. The survey efficiency was over 50% with 17 km surveyed (Table 23).

The habitat condition of the Nanaimo River is summarized in Table 26 in the habitat section above. Instream Habitat supporting spawning and rearing is poor in the Nanaimo River. The river could be considered 'washed out'. There was very little LWD and boulder cover. The pools were infrequent and shallow due to having their crests degraded or residual depth filled in. Spawning habitat was similarly affected with sites having the gravel washed away. Erosion was high in the unconfined reaches (2,3 & 18) where the river has cut through poorly protected benches. The floodplains were logged and present vegetation lacks the size and root strength to hold on. Riparian depth was insufficient in many areas.

Restoration Opportunities

Restoration should be considered a tool for bringing recovery of habitat to assist natural processes that are impaired. The Nanaimo River has many areas where restoration is recommended after analysis of the habitat condition. These activities are wide in scale and type which is a good for opportunities by various groups and budgets.

Riparian Areas: Overall the most important long term objective is to establish a healthy riparian area. A functioning riparian area has root strength to resist erosion, it offers tall trees for shade and it donates large woody debris to the river that is large enough to offer functional cover habitat. The habitat and restoration sections of this report identify areas in every reach that require riparian restoration. The scale and design vary. The largest riparian planting length (over 1.0km) is in Reach 2. There are many smaller sites that are important as well such as at trails (Reach 2,3, 4) slides (Reach 13 & 14) and gravel bars (Reach 3,18 and 22). The repair of these sites offers a diversity of scope and skill sets. There are many opportunities for stewardship group involvement riparian restoration.

Spawning Area: The spawning sites on the Nanaimo River are limited. Restoration sites are difficult to identify as they require wide stable crests. The sites with the best opportunity are in Reach 3, 4,14 and 16 offering opportunities in all three Chinook areas.

Cover Habitat restoration with LWD addition was only recommended in limited reaches. It is recommended in areas of Reach 3 and 22 where the trees are peeling off the undercut banks and efforts may slow the process. Boulder cover addition was identified in more reaches (3, 12,13 & 14)

than LWD as it offers a more reliable structure but being harder to place it was generally ranked low in priority.

Off Channel Habitat restoration opportunities were identified in Reach 2,3, 12, 14, 18 and 22. Off channel habitat. These areas will require further testing and surveys as the investments warrants. Maintenance of existing manmade channels in Reach 3 is recommended first, with removal of sediments, addition of gravel and cover.

First Steps

Stream restoration can be a public activity for stewardship groups in the community to be involved. Activities can be an educational, training or awareness for all ages and abilities. All of the softer engineering activities including some LWD placement, gravel placement, tree planting, fish sampling, water quality and habitat measurements can be completed by just about anyone with some training and equipment.

Members of the Nanaimo Fish and Game Club, the Ladysmith Sportsmen Club, the Chemainus Rod and Gun Club, the Nanaimo Area Land Trust and Snuneymuxw First Nation- Fisheries Department are all community stewards that have the training and experience in the restoration techniques described above. The Nanaimo River Roundtable Committee is the key watershed based organization in the area. It is essential to partner with all the private land owners along the river for successful recovery of the watershed. Past work by the Nanaimo Fish and Game Club (2007 -2015) and their partners (Nanaimo Forest Products, Nanaimo Airport Commission) on Haslam Creek offers examples of restoration. Their work has been successful but not without setbacks and adjustments.

The focus of restoration on the Nanaimo River should not start with this list; it should start with forming partnerships with the land owners. The priority of activities in the restoration plan is not necessarily the order in which they should be done. Restoration with land owners and partners as active participants is vital to long term success.

Restoration should start small with monitoring to avoid big failures, which early in the process would defeat the effort. Small failures are learning opportunities and permit adjustments. In 2022 the first steps might be the following;

- 1.) Prioritize opportunities and review with property owners
- 2.) Complete additional analysis for designs and data gaps
- 3.) Do smaller or lower risk projects first – i.e riparian restoration
- 4.) Monitor, assess and document all projects

Restoration of the Nanaimo River is a long term project. The health of the Nanaimo River is ultimately in the trees along the river and that may take over 200 years.

Submitted by

David R. Clough, RPBio & Brad Remillard, RPBio

Appendix 1 Table 27 – Nanaimo River 2021 Reach Restoration Prescription Summary.

Reach	Habitat Issue	Location	Prescription	Priority
Reach 1	Not Surveyed			
Reach 2 (Morden Trail)	Habitat Issue	Location	Prescription	Priority
R2	Alterations/Erosion	RDN Trail Morden Trail Access (Placemark 7)	The public use this site for river access around the fence and down the bank. There is erosion and loss of riparian. The site could be better fenced and planted. Another option is to build a ramp to the water that incorporates fish values.	M
R2	Erosion/Planting	Morden Trail and upstream on River Left Bank to Placemark 12.	Plant (500m) eroding bank, 1-3m high. Prescribe shrub cuttings (Willow, Red Osier) on sides and trees (Cedar, Doug Fir, Spruce, on top)	H
R2	Erosion/Planting	Right Bank – along pasture at Placemark 23	Restore (430m) actively eroding low bank along farm pasture. With property owner permission; bank planting (cuttings, trees), this could start immediately in fall.	H
			More planning for bank protection/fish habitat rock spurs, bendway weirs and LWD cover (w P.Eng.).	M
R2	Obstructions	None	No barriers, no large log jams.	L
R2	Cover Habitat – Rock Spurs	Throughout	Addition of fish cover habitat in this reach is limited due to high velocity and scour impacts; simple LWD placements will not hold up.	L
			Consider installation of rock spurs/bendway weirs to push the thalweg away from the bank (ie Tsolum River, Englishman River examples).	M
R2	Spawning Habitat	Mainstem.	The spawning gravel is clean but it is vulnerable to floods and debris . The river profile is dropping as pool crests are washed out. Spawning habitat improvement is limited in the mainstem.	L
		Offchannel Areas	Off channel/sidechannel sites offer more potential spawning habitat improvement. The Frey Road sidechannel (Placemark 21) currently offers semi-protected spawning habitat in a long gravel glide. There is potential for additional spawning production of this channel if flood protection, and water supply can be improved.	M
				L

			Thatcher Creek sidechannel-fed by thatcher creek and floodplain, there are spawning gravel locations below the Morden Trail with less flood protection than Frey Road.	
R2	Riparian Planting	Throughout R2	Underplanting opportunities in many areas. Infill poorly stocked/damaged riparian. Primarily planting seedling conifers – Douglas Fir, Red Cedar etc. Participating property owners will determine locations. Highest priority is south and west sides of river .	M-H
R2	Riparian Invasives/Planting	River Left Bank (Placemarks 16,18,20)	At least three polygons (25-30m long) of heavy broom infestation adjacent river bank that should be removed and replanted (conifers or shrubs) with property owner permission.	M-H
R2	Off Channel Habitat	Thatcher Creek Morden Road Frey Road Akenhead Road	There are at least four sidechannels along the reach. They all may offer potential improvements. They require further study; water quality through the summer and inspection of their water supplies. The Frey Road channel may offer protected spawning habitat while the others offer rearing/flood protection.	
R2	Water Quality	R2	Water quality monitoring of the reach and sidechannel habitats is recommended to gain information on habitat quality and trends. The Thatcher sidechannel may be anoxic in summer.	H
R2	Garbage	Throughout	There was no high accumulations of garbage along this reach	L
R2	Education/Partnerships	Morden Trail	Potential river education site at end of trail – improve access, fence, signage, planting.	M-H
R2	Access/Encroachment	Morden Trail	Trail ends at eroding slope to river, fence and repair site (plantings)	M
Reach 3 (Hatchery Run)	Habitat Issue	Location	Prescription	Priority
R3	Alterations	Pumphouse Area RipRap/Intake area	Lack of vegetation along the right bank on the armoured rock. Create plant polygons on the back side of riprap (note floods over the rock here)	L
R3	Erosion	Three large locations 1.) Right Bank Lower 2.) Left Bank along trail 3.) Right Bank below pumphouse	1.) Lower RB has 350m length – undercutting and collapsing. High velocity /Floodplain area. Review leaning trees with arborist, to mitigate tree loss on bank . 2.) Along trail/power pole Dyke (200m). Contact land owner about repair of rock voids where eroding into river. 3.) Upper RB (470m) undercutting and collapsing. High velocity /Floodplain area. Review leaning trees with arborist, to mitigate tree loss on bank .	H M H
			Installation of Rock Spurs, Bendway Weirs and Groynes should be considered after stabilization of the riparian trees.	L-M

R3	Obstructions	None	No LWD jams in channel	L
R3	Cover Habitat	Throughout	Boulder Placement – consider placement in location of existing LB rock dyke where several already provide cover. LWD Placement – avoid placement in high velocity mainstem, active floodplain; consider placement in protected Oxbow pools.	M M
R3	Spawning Habitat	Throughout	Lack of stable protected spawning beds. The pumphouse pool riprap maintains a create, gravel placement here could be considered. (Would require routine replenishment)	L
R3	Riparian Habitat	R3 - LB	Planting along hydro lines approx. 200m. This will shade the west exposure. The area is a public park trail way with good access but poor soils.	H
R3	Off Channel Habitat	Several locations 1.) Old River channel (LB)	1.) The old river channel offers a ready made off channel that requires a protected water supply and more cover habitat. 2.) Hatchery Sidechannel – a good coho producer, it should be assessed for wild production – fry /smolt fence. 3.) River floodplain –Right Bank – there are many overland floodchannels, they do not offer reliable fish habitat and are harming the riparian forest and bringing sediment into the hatchery channel. The recent mainstem redirect degraded the profile, reducing the flood pressure into the riparian. Repairing these semi active flood routes is worth consideration – replanting , plugging with CWD and /or filling and planting the entrances.	M M M
R3	Water Quality	R3	Water quality monitoring program - this may be already in place with the RDN Water Smart program.	H
		R3	Review Highways Road runoff treatment – eliminate direct drains to the river with bioswales. Need to talk to highways manager about modernizing the storm water system for the bridges.	M
R3	Garbage	Pumphouse Recreational area	Recreational users at beach are littering every year, install more signage.	M
R3	Education/Partnerships	R3	Nanaimo River Hatchery, Nature Trust Nanaimo River property. Nanaimo Forest Products all have interest in this reach. Restoration plans must include property owners at initial set up. More land purchase protection of remaining riparian area.	H
R3	Access/Encroachment	Trails	Both sides have trails set back from edge that are not creating erosion or harming riparian	

Reach 4 (Bungy Zone)	Issue	Location	Prescription	Priority
R4	Alterations	No concerns		NA
R4	Erosion	LB tributary below quarry	The 30-50m fish accessible tributary has eroding braids. Review with land owner; hand clean up and planting of channel or machine repair and remediate channel (gravel/cobble bottom, planted sides),	L
R4	Obstructions	No concerns		NA
R4	Cover Habitat	Throughout	No LWD, no recommendations, hard to place. The deep bedrock and boulder pools in this reach offset LWD cover loss.	NA
R4	Spawning Habitat	Lower reach	Candidate for spawning gravel placement in the 250m x 60m glide via pit access road. Review placement strategy by machine or permit it to wash in from stockpiles- estimate 50 cm ³ (5 truck loads)	M-H
R4	Riparian Habitat	Open areas both sides	Site 1- left bank along pit edge, approx. 250m at top of bank is 13- 15m wide Site 2 – infill planting right bank near residences (south side)	M M
R4	Sidechannel	None	No off channel other than short tributary noted	NA
R4	Access/Encroachment	Trails	Left bank has narrow ridge trail. No erosion observed but the mossy flower garden rock outcrops are vulnerable to erosion. Signage recommended to stay on trail.	L
R4	Water Quality	Throughout	Water Quality Monitoring recommended- no drinking water intakes observed	M
R4	Garbage	None	No garbage, scrap in reach	NA
R4	Education/Partnerships	Throughout	Land owner contact to protect the riparian area, stop the quads from destroying the narrow riparian area. Trail stewardship program. Purchase the riparian area or put in strict covenant	M-H H
Reach 5 (Bore Hole lower)	Issue	Location	Prescription	Priority
R5	Alterations	BC Hydro Line; Trail to Bore Hole Viewpoint off Nanaimo Lakes Road	The powered vehicles are impacting the thin vegetation along the viewpoint. Install signage, fencing and or barriers to prevent further damage. As noted below, this site could be a park area or a stewardship maintenance/restoration site.	M
R5	Erosion	Na	None – Bedrock canyon, not eroding. Side walls are steep but vegetated. No slide tracks.	L

R5	Obstructions	Na	The Bore Hole is a natural impediment to Chum and Pink but is passable to Chinook , Steelhead and Coho. No improvements suggested.	L
R5	Cover Habitat	Na	Boulders are the functional cover feature in this reach. No other type of cover (LWD, Undercuts, Vegetation) exists in the bedrock canyon.	L
R5	Spawning Habitat	Na	There is not much available spawning habitat in the reach due to natural conditions of confinement and velocity. The substrates are bedrock, boulder and some cobble.	L
R5	Off Channel Habitat	None	The confined bedrock canyon , no off channel habitat is offered.	L
R5	Riparian Habitat	Garry Oak Bluff , on river left, (Placemark 12)	Protection: Garry Oak Bluff is a sensitive ecological area that should be identified for protection. Assess in summer, consider signage, passive protection. It is relatively isolated by foot trail. A special area that would be easily lost with human over-use.	M
R5	Riparian Habitat	River Bend Road Park and residential area on south bank (river right)	Replanting: South bank residential areas have removed trees on some properties – contact, partner, replant and protect. The RDN River Bend Park may offer a community riparian stewardship starting place to add signage and infill plant disturbed areas.	M
R5	Access/Encroachment	At river access BC Hydro Crossing off Nanaimo Lakes Road, on river left	Protection: High use recreation area for hikers, climbers, consider Park designation or volunteer stewardship group to maintain – repair steps to river, clean up garbage, protect sensitive areas, replant eroded areas install signage, fencing.	M
R5	Water Quality	Throughout	Water Quality Monitoring recommended- no drinking water intakes observed	M
R5	Garbage	BC Hydro parking lot	This is the only area we observed garbage in the reach	L
R5	Education/Partnerships	River Bend property owners	Education on the importance of south bank shade from native plants to property owners that have cleared the Right bank. Signage at the Hydro line access about garbage, foot traffic only, and plant protection.	M
Reach 12 (Hydro/Water Line X)	Issue	Location	Prescription	Priority
R12	Alterations	Water Line and Hydro Line crossing	Both lack wide or high riparian. The water line riparian area should be planted as it is particularly exposed. The Hydro line will require maintenance of short trees except at the river bank where there is adequate clearance for conifers. Both banks approx. 30mx30m	M
R12	Erosion	Glide 4 LB Placemark 28	An old slide track 3-5m wide and 15m goes to water line from rail grade. Stabilize with planting /bioengineering.	M

R12	Obstructions	None		
R12	Cover Habitat	Lacking LWD throughout;	No recommendations, LWD would be hard to place as there are no meanders with steep sidewalls lacking good anchoring opportunity.	L
R12	Spawning Habitat	Jump Creek junction pool	There is a boulder dominated outlet crest of the pool that offers an anchor for gravel placement. Access to the site is over a bedrock bank from rail grade. This is the best of many poor sites in the reach.	M
R12	Riparian Habitat	Both sides	Increase riparian depth with planting, south bank takes priority to increase to at least 30m width.	M
R12	Access/Encroachment	Hydro/Water Crossings	Infill plant under power line and access road with shrubbery	M
R12	Off Channel Habitat	Below Water Line, River left bank	There is a 700m long seasonal channel flowing through the left bank floodplain. This may be a rearing or spawning site depending on water supply design and feasibility. Needs test pits and overview inspection of water supplies.	H
R12	Water Quality	Throughout	Water Quality Monitoring recommended- no drinking water intakes observed	M
R12	Garbage	Jump Pool	Some trash at Jump Creek pool beach, none in river or riparian areas	L
R12	Education/Partnerships	Partnerships	Both BC Hydro and RDN water pass through this Mosaic Forest land, an opportunity for corporate sponsorship of habitat restoration of sidechannel and planting areas.	M-H
Reach 13 Wolf Creek	Alterations	Wolf Creek Rail Culvert (Placemark 9)	Wood Box culvert at river mouth is plugged with logs and blocks fish access. A bigger problem when it fails. Old rail line has plugged culverts and overflow. Need to be maintained or removed.	H
R13	Erosion	Rail Grade Slide Placemark 10	30m by 30m slope failure sending sediments into river from failed culvert. Needs stabilization and drainage cut off. Machinery if required may use the rail grade or above through the block setting.	H
R13	Obstructions	Culvert at Wolf Creek	Access to the tributary is blocked. Needs to be repaired	H
R13	Cover Habitat	throughout	Lacking cover and opportunities to place LWD Large Boulder placement in Glides/riffles but limited access	L
R13	Spawning Habitat	throughout	Remove jam at Wolf Creek to permit movement of gravel. Placement of gravel is less feasible due to limited access and limited good sites.	M
R13	Riparian Habitat	South bank – two thin sections @ 650m length	Thin sections 15-20 m wide. Contact property owner about south aspect riparian management plans to ensure replanting to 30m minimum.	H

R13	Access/Encroachment	Wolf Creek	As noted above, culvert blocks fish access. Needs to be repaired/removed.	H
R13	Water Quality	Entire Reach	Monitoring of water quality recommended	M
R13	Garbage	Rail Grade/Pool 1/Parking lot	Swimmer/hiker garbage is prevalent along the popular trails and pools. Rusted parts of old vehicles are scattered along the rail grade.	L
R13	Education/Partnerships	Landowner	Work with land owner to identify sensitive riparian areas and management strategies	H
Reach 14 To 1st Lake	Alterations/Erosion	Rail Line along left bank (Placemark 16, 33,35,37)	Rail Culvert assessment – determine fish status, maintenance and repair. Some structures are eroding or have already failed.	M-H
R14	Erosion	P1,G2,G5,P4	Left bank is generally undercutting and eroding. Limited opportunity due to power of river and lack of soils. Willow staking where soils are present. Monitor.	L-M
R14	Obstructions	Wolf Creek	The jam at the mouth needs to be removed to permit fish passage and gravel input to mainstem. Culvert failure will result in a large sediment input and loss of access over the creek.	H
R14	Cover Habitat	Throughout R14	Lacking cover and opportunities to place LWD Large Boulder placement in Glides/riffles but limited access	L
R14	Spawning Habitat	R14 throughout	A good supply of gravel comes from N. Nanaimo but it is washed away Installation of boulders (crest) to trap gravel is a remedy but access is limited.	M
R14	Spawning Habitat	Lake Outlet	Lacks gravel recruitment. Has sediment concerns but a large area to choose (6000m ²). Less chance of wash out in this location and high potential for use by Chinook. Access is difficult, may need helicopter or barge to deliver.	H
R14	Riparian Habitat	R14 Left Bank (P1, G2, P4)	Several clusters of veteran trees along the left bank. Many are exposed to high water . Bank erosion bioengineering and infill planting may hold soils to protect the big trees. The sites are	M-H
R14	Off Channel Habitat	North Nanaimo River to P3	590 m long seasonally flooded along rail grade. Offers fish refuge in lower reaches but may trap fry as it dewater. Investigate water supply, enlargement of pools.	M
R14	Access/Encroachment	Rail Line	The rail line recreational use is not causing any severe issues. Limited vehicle access due to wash outs. Good foot trail.	L
R14	Water Quality	Monitor	Monitor the temperature out of lake and major tributaries. Thermal cool zones from N. Nanaimo may attract spawners. Lake Limnology must be routinely monitored for lake turnover effect and thermal loads through the critical periods.	M-H
R14	Garbage	Rail Line	All public access is related to entrance areas at Wolf Creek and the lake campground. Currently the only real debris is a few abandoned vehicles on the rail grade.	L

R14	Education/Partnerships	Wolf Creek	Habitat assessment; to determine sediment and erosion inputs to the main river, as well as salmon access, spawning and rearing status.	M
R14	Education/Partnerships	North Nanaimo R.	Habitat assessment; to determine sediment and erosion inputs to the main river, as well as salmon access, spawning and rearing status.	H
Reach 15				
First Lake	Water Quality	First Lake	Routine Lake limnology monthly	M-H
Reach 16 Between 1st/2nd lakes	Alterations	Bridge Abutment	A concern if logs jam against the center span but no evidence of buildup.	L
R16	Erosion	Road side	A small slip face from road along the north bank (10x3m), add shrubbery or wattles to enhance regeneration. A small project that could be useful for training/stewardship. The south bank road is narrow and runoff can enter river. Drainage and surfacing could reduce the concern.	L-M
R16	Obstructions	na	No concerns, no jams observed	L
R16	Cover Habitat	Na	no cover opportunity but has more desirable lake habitat nearby	L
R16	Spawning Habitat	Second Lake outlet	Approximately 150m by 20m area (3000m ²) for creation of spawning gravel habitat. This site will require access preparation of a ramp so it can be distributed from shore by excavator.	H
R16	Riparian Habitat	Along road, fishing trail edges	Maintenance planting in any gaps from disturbance.	L
R16	Access/Encroachment	na	No concerns	L
R16	Water Quality	At Bridge	Good spot to routinely monitor water quality coming from second lake/upriver	M
R16	Garbage	Fishing trail to bedrock outcrop	Angling gear and other garbage is routine here. Good spot for a fish club to keep clean.	M
R16	Education/Partnerships	All	This reach is well used by public/private, good site for educational signage	M
Reach 17 2nd lake	Water Quality	Second lake	Monthly sampling to determine lake oxygen, temperature profile. Nutrient sampling to determine productivity.	M
Reach 18 Above 2nd Lake				
R18	Alterations	Entire length	Logging roads set back (100m+), a bridge crossing, no other developments	na
R18	Erosion	Mainstem	Minor erosion points along both banks, more commonly on lower right bank. Opportunity for localized protection devices (LWD, Rock Spurs, Bendway weirs) to address erosion and add depth and cover.	L

R18	Erosion	Dash Creek	Investigate erosion sources, maintenance of spoil piles and sump installation at the logging road bridge.	M
R18	Erosion	Mainstem aggraded Gravel Bars (near Dash Ck outlet)	Plant live stakes and seedlings for gravel bar stabilization in two sites.	M
R18	Obstructions	None		na
R18	Cover Habitat	throughout	Lacks cover (LWD, Boulders, Deep pools), boulder clusters would be the most cost effective but access is limited.	L
R18	Spawning Habitat	throughout	Lacks protected spawning beds. Planting the Dash Creek entrance gravel bars will stabilize the spawning habitat.	M
R18	Riparian Habitat	South Bank	Infill planting to 50m width in gap areas along the sunny south bank.	M
R18	Off Channel Habitat	South side tributary (placemark 4)	With vehicle access from Branch F, a 775m long seasonal 3-5m wide low gradient channel crosses the spur road. It offers high water refuge and spawning habitat. It may have potential as a constructed ground water fed channel. Requires test pits .	M
R18	Off Channel Habitat	Dash Creek	It offers refuge habitat in the lower 100m from the mainstem. It requires assessment of the channel and maintenance of sediment accumulations at the logging road.	L
R18	Access/Encroachment	Boat Launch TP Bridge	No river vehicle entry.	L
R18	Water Quality	TP Bridge	This is a good access point for water quality monitoring (Temp/Flow)	M
R18	Garbage	NA	No garbage observed at boat ramp or anywhere else.	L
R18	Education/Partnerships	Signage	A sign at the boat launch – Salmon Habitat – No vehicle entry	M
Reach 22 To Green Ck	Alterations	Reach 22	No recent alterations to the reach it was historically logged to the river bank	NA
R22	Erosion	Placemark 32-35, (upper reach)	Left bank has a 400m long alluvial fan requires live staking and planting to stabilize exposed materials. This work can be done by hand or with machinery (excavate trenches, place willow bundles, backfill) depending on the budget. Recent bar stabilization in Cowichan has been done both ways and is a reliable method. Right bank along 400m , is 1-2m high, eroded to undercut tree roots. Anchor LWD spurs along the bank for protection and fish habitat	H M
R22	Obstructions	None		
R22	Cover Habitat (LWD)	Placemark 32-35	Noted above: add LWD	M
R22	Spawning Habitat	NA	Benefits to spawning habitat in controlling erosion	na
R22	Riparian Habitat	Placemark 32-35	Left bank alluvial fan – live stake and plant to stabilize.	H

			Right bank riparian area – infill planting of conifers due to flood damage	M
R22	Riparian Habitat	South Bank	Infill planting to 50m width in gap areas along the sunny south bank.	M
R22	Access/Encroachment	NA	No vehicle or trail access observed.	na
R22	Water Quality	Sediment Monitoring	Green Creek enters just upstream, investigate the sediment sources into this reach.	M
R22	Garbage	na	No garbage observed	na
R22	Education/Partnerships	Planting	Planting/staking the alluvial fan could be a stewardship initiative. Having community groups get involved with permission from property owner. Similar projects completed recently on Cowichan.	H
R22	Access/Encroachment	na	No trails or roads near the reach	na
Reach 23 To Sadie Ck	Alterations	Reach 23	No recent alterations to the reach it was historically logged to the river bank	na
R23	Erosion	Tributaries	Monitor tributary erosion, maintenance at road crossings as required, re-plant disturbed areas.	M
R23	Obstructions	None	None, there are accumulations of LWD in the floodplains	L
R23	Cover Habitat	Lacking Throughout	Poor habitat but little opportunity for placement	L
R23	Spawning Habitat	No opportunities	Gravel is supplanted from tributary inputs	L
R23	Riparian Habitat	South Bank	Infill planting to 50m width in gap areas along the sunny south bank.	M
R23	Access/Encroachment	None	None	L
R23	Water Quality	Tributaries	sediment source monitoring	M
R23	Garbage	None	None seen, no recreational use	L
R23	Education/Partnerships	None	No current opportunities, remote location	L
R23	Access/Encroachment	None	None seen	

Appendix 4 – Reach 4 Habitat Data

Stream Name		Nanaimo R	Watershed Code	920-38440	Date	#####	Reach Name	Nan R4	Discharge Depth #1	Velocity T1	Site Length																												
Quality Information		Dissolved Oxygen	pH	Total Dissolved Solids	Temp C	at Beginning of Reach	Discharge Depth #2	Velocity T2	Discharge Depth #3	Velocity T3																													
(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				Percent Crown	LWD	LWD/bank-full channel width	Erosion Sites (length)	Altered Stream Sites (length)	Obstructions (number)	Off-Channel Habitat (length)	Off-Channel Habitat at (bank side)	Land Use Right	Vegetation Type Right	Riparian Slope Right	Stability Right	Vegetation Depth Right	Livestock Access Right	Photos	Comments				
Pool	0.00	236.00	236.00	42.00	#####			3.00	0.50	52.00	30	30	10	10	0	5	0	0	0	0	60.00	0	0	0	0	0	Nat	Con	Con	65	55	High	High	60	50	0	0	going d/s	
Riffle	236.00	375.00		42.00	0.00			1.00	5.00	52.00	30	30	10	10	0	5	0	0	0	0	60.00	0	0	0	0	0	Nat	Con	Con	65	55	High	High	60	50			offers	
Glide	375.00	451.00		38.00				1.50	2.00	60.00	20	80	0	0	0	5	0	0	0	0	60.00	0	0	0	0	0	Nat	Con	Con	80	80	High	High	50	40			left bank	
Pool	451	831	380	38.00	14440			3.00	0.50	46.00	30	30	10	10	0	5	0	0	0	60.00	1					Nat	Con	Con	80	80	High	High	50	40			cable		
Riffle	831	906		33.00	0			1.00	2.00	55.00	30	30	10	10	0	5	0	0	0	60.00	0	0	0	0	0	Nat	Con	Con	90	80	High	High	100	100			anglers		
Glide	906	1011		33.00				1.00	1.00	55.00	5	40	30	20	10	5				60.00	0					Nat	Con	Con	90	80	High	High	75	100			warehouse		
Riffle	1011	1178		23.00	0			0.50	3.00	60.00	0	20	40	40	0	5	0	0	0	60.00	0					Nat	Con	Con	80	50	High	High	50	100			habitat here		
Pool	1178	1515	337	34.00	11458			3.00	0.00	48.00	50	35	5	5	5	5	0	0	0	80.00	0	0	30	0		Nat	Con	Con	80	50	High	High	40	60			left bank braid,		
Reach Totals and Averages			1515.0	953	35.4	35810	53593	67	1.75	1.75	53.50	66	24	37	14	13	2	5	0	0	62.50	1	0.04	0	2	0	0	0	0	0	0	0	0	0	0	0	0		

Appendix 5 – Reach 5 Habitat Data

Stream Name		Nanaimo R	Watershed Code	920-38440	Date	Feb.19/2	Reach Name	Nan R5	Discharge Depth #1	Velocity T1	Site Length																												
Quality Information		Dissolved Oxygen	pH	Total Dissolved Solids	Temp C	Chainage at Beginning of Reach	Discharge Depth #2	Velocity T2	Discharge Depth #3	Velocity T3																													
(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				Percent Crown	LWD	LWD/bank-full channel width	Erosion Sites (length)	Altered Stream Sites (length)	Obstructions (number)	Off-Channel Habitat (length)	Off-Channel Habitat at (bank side)	Land Use Right	Vegetation Type Right	Riparian Slope Right	Stability Right	Vegetation Depth Right	Livestock Access Right	Photos	Comments				
Pool	0	136	136.0	59.0	8024			3.0	0.5	73.0		60	20	10	10	0	10	0	0	0	30.00	0	0	0	0	0	EX	Con	Con	65	80	High	High	30	70	10	10	Top R5 below	
Riffle	136	483		54.0				1.0	5.0	68.0		30	30	20	20	0	5	0	0	0	50.00	0	0	0	0	0	R	Con	Con	65	60	High	High	30	70	0	0	blasted out	
Pool	483	517	34.0	42.0	1428			2.0	1.0	64.0		70	30	0	0	0	5	0	0	0	75.00	0	0	0	0	0	R	Con	Con	90	90	High	High	10	70	10	0	s bank	
Riffle	517	600		30.0				1.0	8.0	68.0		90	10	0	0	0	5	0	5	0	75.00	0	0	0	0	0	R	Con	Con	90	90	High	High	50	70	0	0	on S bank	
Pool	600	652	52.0	30.0	1560			2.0	2.0	35.0		90	10	0	0	0	5	0	0	0	70.00	0	0	0	0	0	R	Con	Con	90	90	High	High	10	70	10	0	s bank	
Glide	652	749		23.0				3.0	2.0	23.0		100	0	0	0	0	5	0	0	0	60.00	0	0	0	0	0	R	Con	Con	90	90	High	High	10	70	0	0	s bank	
Pool	749	872	34.0	33.0	1428			3.0	0.5	40.0		90	10	0	0	0	5	0	0	0	40.00	0	0	10	0	0	R	Con	Con	90	90	High	High	10	70	10	0		
Riffle	872	965		33.0				1.0	2.0	40.0		50	50	0	0	0	5	0	0	0	50.00	0	0	0	0	0	R	Con	Con	65	60	High	High	30	70	0	0	blasted out	
Pool	965	1047	82.0	34.0	2788			3.0	0.5	40.0		50	50	0	0	0	5	0	0	0	50.00	0	0	0	0	0	R	Con	Con	90	90	High	High	10	70	0	0	s bank	
Reach Totals and Averages			1047	338.0	37.6	15228	39321	38.7	2.4	50.1	75	70	23	3	3	0	6	0	1	0	56	0	0.00	0	9	0	0	0	0	0	0	0	0	0	0	0	0		

Appendix 6 – Reach 12 Habitat Data

Stream Name	Nanaimo	Watershed Code	920-3844	Date	21-02-04	Reach Name	R12	Discharge Depth #1	Velocity T1	Site Length																																						
Quality Information																																																
Dissolved Oxygen		pH	Total Dissolved Solids	Temp C			at Beginning of Reach	0.00	Discharge Depth #2	T2																																						
Velocity (m/s)		Average Depth (at flow site)	Wetted Width (at flow site)	Discharge (m ³ /s)		Chainage at End of Reach	1609.00	Discharge Depth #3	T3																																							
(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					Percent Crown Cover	LWD	LWD/bankfull 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 Right	Photos	Comments					
												Bed	Bld	Cob	Grv	Fine	Bold	LWD	Cutbk	Veg	Other										Right	Left	Right	Left	Right	Left	Right	Left	Right	Left								
Glide 1	0	182	182	46	0	8372		0.50	1.00	51.00		0	75	10	10	5	0					40	0		0	0	0						Nat	Nat	n	Con	30	10	n	Med	20	30	0	0		is glide		
Riffle 1	182	359	177	35	0	6195		0.50	2.00	48.00		0	70	20	5	5	10					40	0		10	0	0						Nat	Nat	n	Con	5	10	n	Med	10	30	0	0		R1		
Glide 2	359	663	304	40	0	12160		0.75	1.50	60.00		0	80	10	10	0	5					45	0		0	0	0						Nat	Nat	n	Con	20	5	n	Med	30	25	0	0		g2		
Riffle 2	663	922	259	46	0	11914		0.75	2.00	48.00		0	60	30	10	0	5					40	0		20								Nat	Nat	n	Con	20	50	n	High	20	30				waterline		
Glide 3	922	1020	98	60	0	5880		0.75	1.00	62.00		0	80	20	0	0	0					40	0		40								C	C	Sh	Sh	15	70	n	High	5	5				10		G3
Riffle 3	1020	1277	257	58	0	14906		0.75	2.00	60.00		0	80	15	5	0	0					50	0										Nat	Nat	n	Con	30	70	n	High	40	10				R3		
Glide 4	1277	1350	73	52	0	3796		0.50	1.00	66.00		0	75	15	5	0	0					55			50								Nat	Nat	n	Con	10	70	n	Med	15	40				50		G4
Riffle 4	1350	1497	147	40	0	5880		1.00	3.00	52.00		20	55	15	5	5	10					50			15			100	10				Nat	Nat	n	Con	5	70	Low	Med	20	40				40		R4
Pool 1	1497	1609	112	43	4816	4816		2.00	1.00	58.00		20	60	20	0	0	5					45	1		20								Nat	Nat	n	Con	40	50	Med	High	50	40				20		P1
Reach Totals and Averages		1609	1609	46.7	4816	73919	6.5	0.83	1.61	56.1	83	4	71	17	6	2	4					45	1	0.03	5	5	0	6					11	11			9	29	19	19	23	28	0	7				

Appendix 7 – Reach 13 Habitat Data

Stream Name		Nanaimo Code	Watershed Code	Date	21-02-04	Reach Name	R13 DRC BRR	Discharge Depth #1	Velocity T1	Site Length																																	
Water Quality Information		Disolved Oxygen	pH	Total Dissolved Solids	Temp C	Discharge Depth #2	Velocity T2	Discharge Depth #3	Velocity T3	Site Length																																	
Velocity (m/s)		Average Depth (at flow site)	Wetted Width (at flow site)	Discharge (m3/s)	Chainage at End of Reach	Discharge Depth #3	Velocity T3																																				
(All Pool and Cross Section Data)																																											
Habitat Type	Start (chainage at start)	Finish (chainage at end)	Pool Unit Length	Wetted Width	Pool Area	Wetted Reach Area	%Po ol Area	Habitat unit Depth (m)	Percent Gradient	Bankfull Width(m)	Average Percent Wetted Area	Substrate Percent					Percent Instream Cover					Percent Crown Cover	LW D	LWD/ bankfull channel width	Erosion Sites (length)	Altered Stream Sites (length)	Obstructions (number)	Off-Channel Habitat (length)	Off-Channel Habitat (width)	Channel Habitat (width)	Land Use Right	Land Use Left	Vegetation Type		Riparian Slope		Stability		Vegetation Depth		Livestock Access	Photos	Comments
Riffle 1	0	390		33	0			0.50	2.00	45.00		0	40	30	30	0	5	0	0	0	55	2	0	0	0	0	0	0	Nat	Nat	Con	Con	30	30	High	Med	15	70	30		R1 wolf Ck		
Glide 1	390	540		33	0			1.00	1.00	42.00		0	40	30	20	10	5	0	0	55	0	0	0	0	0	0	0	Nat	Nat	Con	Con	30	15	High	High	15	70			G1			
Riffle 2	540	630		36	0			0.50	3.00	42.00		0	50	30	20	0	15	0	0	55	0	0	0	0	0	0	0	Nat	Nat	Con	Con	30	15	High	High	15	70			R2			
Glide 2	630	1128		33	0			0.75	1.00	38.00		0	50	30	10	10	5	0	0	40	0	0	0	0	0	0	0	Nat	Nat	Con	Con	30	30	Med	Med	15	70			G2			
Riffle 3	1128	1606		50	0			0.75	3.00	58.00		0	50	30	10	10	5	0	0	45	0	0	0	0	0	0	0	Nat	Nat	Con	Con	40	75	Low	Low	15	70			R3			
Pool 1	1606	1736	130	34	4420			3.00	0.00	47.00			50	20	20	10	0	10	0	55	2	50						Nat	Nat	Con	Con	35	35	Low	Med	30	30	20		p1			
Riffle 4	1736	1883		37	0			0.50	2.00	46.00		0	70	30	0	0	5	0	0	55	0	0	0	0	0	0	0	Nat	Nat	Con	Con	35	30	Low	Med	40	40	50		R4			
Pool 2	1883	1998	115	28	3220			2.00	1.00	48.00		0	40	30	20	0	0	0	0	55	0	0	0	0	0	0	0	Nat	Nat	Con	Con	45	15	High	High	20	40			P2			
Riffle 5	1998	2062		30	0			0.50	2.00	37.00		0	40	30	20	0	0	0	0	55	0	0	0	0	0	0	0	Nat	Nat	Con	Con	50	80	High	High	25	40			R5			
Glide 3	2062	2243		35	0			1.00	2.00	39.00		0	40	30	20	0	5	0	0	55	0	0	0	0	0	0	0	Nat	Nat	Con	Con	35	70	High	High	40	50			G3			
Riffle 6	2243	2560		35	0																		0	0	0	0	0	0	0	0	0	0	0	0	0	0			R6				
Pool 3	2560	2698	138	35	4830																	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			P3				
Riffle 7	2698	2981		32	0																	0	0	0	0	0	0	0	0	0	0	0	0	0	0			R7					
Pool 4	2981	3123	142	24	3408			4.00	0.00	42.00		50	40	10	0	0	0	0	0	55		0	0	0	0	0	0	Nat	Nat	Con	Con	50	10	High	High	25	40	0	0	P4			
Riffle 8	3123	3207		24	0			0.50	4.00	28.00		30	70	0	0	0	5	0	0	60	0	0	0	0	0	0	0	Nat	Nat	Con	Con	50	10	High	High	20	40	30		R8			
Glide 5	3207	3564		22	0			2.00	1.00	28.00		40	15	15	10	0	0	0	5	60	1	0	0	0	0	0	0	Nat	Nat	Con	Con	30	30	High	High	15	40	30		Ck			
Reach Totals and Averages		3564	525	33	15878	116053	14	1.3	1.7	41.5	78	10	46	24	14	3	4	1	0	53	5	0.06	1	0	0	0	0	13	13			21	25	27	27	23	50	0	4				

Appendix 8– Reach 14 Habitat Data

Stream Name		Watershed Code		Date		Reach Name		Glide 1 is lake outlet		Discharge Depth #1		Velocity T1		Site Length																																
Nanaimo		920-38		Feb 4/21		R14		BRR DRC		0.00		T2		2013																																
Quality Information		pH Average Depth (at flow site)		Total Dissolved Solids Wetted Width (at flow site)		Temp Discharge (m3/s)		at Beginning of Reach Chainage at End of Reach		Discharge Depth #2		Discharge Depth #3		T3																																
(All Pool and Cross Section Data)																																														
Habitat Type	Start (chainage at start)	Finish (chainage at end)	Pool 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				Percent Crown Cover	LWD	LWD/bankfull channel width	Erosion Sites (length)	Altered Stream Sites (length)	Obstructions (number)	Off-Channel Habitat (length)	Off-Channel Habitat (width)	On-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				
Riffle 1	0.00	81.00		37.00	0.00			0.50	2.00	38.0		0	10	60	30	0	0	0		50	0	20						Nat	Nat	Mix	Mix	30	10	Med	Med	10	100				R1					
Pool 1	81.00	175.00	94.00	36.00	3384.00			1.00	1.00	39.0		0	10	10	40	10	0	0		50	0	0						Nat	Nat	Con	Mix	25	15	Med	Med	30	100			15	p1					
Glide 2	175.00	210.00		21.00	0.00			1.00	3.00	60.0		0	0	20	60	20	5	0		40	0	20						Nat	Nat	Con	Con	15	5	Med	Med	20	100				R					
Riffle 2	210.00	344.00		45.00	0.00			0.50	1.00	51.0		0	10	40	40	10	5	0		40	1	20						Nat	Nat	Con	Con	15	10	Med	Low	20	30			20	G2					
Riffle 3	344.00	364.00		47.00	0.00			1.00	2.00	65.0		0	10	40	60	0	0	5		60	1	20						Nat	Nat	Con	Con	25	10	Low	Low	7	100				R3					
Glide 3	364.00	433.00		40.00	0.00			0.50	2.00	44.0		0	10	50	40	0	0	5		60	1	0						Nat	Nat	Con	Con	5	10	Med	Med	20	30				G					
Pool 2	433.00	459.00	26	22	572			1.00	1.00	44.0		0	0	30	60	10	0	5		60	9	30						Nat	Nat	Con	Con	25	5	Low	Med	5	100				P2					
Glide 4	459.00	630.00		30	0			0.75	2.00	37.0		0	30	30	30	10	0	5		50	1	0	0	0	0			Nat	Nat	Con	Con	15	15	Med	Med	25	20				G4					
Riffle 4	630.00	694.00		37	0			0.50	2.00	44.0		0	0	20	60	20	0	5		50	1	0	0	0	0			Nat	Nat	Con	Con	15	15	Med	Med	20	25				R4					
Pool 3	694.00	791.00	97	38	3686			2.00	0.00	67.0		0	0	20	50	30	0	10		40	4	0	0	0				Nat	Nat	Con	Con	10	10	Med	Med	10	10			10	P3					
Glide 5	791.00	1047.00		30	0			0.50	3.00	51.0										0		0						Nat	Nat	Con	Con	0	0	Med	Med	0	0				G5					
Pool 4	1047.00	1323.00	276	41	11316			3.00	1.00	57.0		60	30	30	30	10	0	5		40	1	50						Nat	Nat	Con	Con	5	15	Med	Low	40	40				P4					
Riffle 5	1323.00	1374.00		30	0			0.50	0.00	44.0		0	60	20	20	0	10	0		50	0	0						Nat	Nat	Con	Con	10	10	Med	Med	15	75				R5					
Pool 5	1374.00	1588.00	214	40	8560			2.00	1.00	45.0		0	20	30	30	20	0	0		50	0	0						Nat	Nat	Con	Con	10	15	Med	Med	10	75			10	p5					
Riffle 6	1588.00	1732.00		45	0			0.50	3.00	52.0		0	70	15	15	0	10	0		50	1	0						Nat	Nat	Con	Con	10	30	Med	Med	10	45				R6					
Pool 6	1732.00	1811.00	79	43	3397			2.00	0.00	47.0		0	10	10	10	70	0	0		50	0	0						Nat	Nat	Con	Con	20	30	Med	Med	25	70			30	P6					
Glide 6	1811.00	1903.00		32	0			0.50	1.00	43.0		0	70	10	10	10	0	0		60	0	0						Nat	Nat	Con	Con	35	10	Med	Med	30	70	0	0		G					
Riffle 7	1903.00	1943.00		60	0			0.50	8.00	90.0		40	40	20	0	15	0			60	0	0						Nat	Nat	Con	Con	10	50	Med	Med	25	85				R7					
Pool 7	1943.00	2013.00	70	52	3640			3.00	0.00	90.0		0	60	20	20	0	5	0		60	0	0						Nat	Nat	Con	Con	0	0	Med	Med	0	0				P7					
Reach Totals and Averages																																														
		2013.00	856	38.2	34555	76918	44.9	1.1	1.74	53.1	72.02	6	24	26	34	12	3	2		51	20	0.53	8	0	0	0																				
		122																				160																								

Appendix 9 – Reach 16 Habitat Data

Stream Name		Watershed Code	Date	Feb. 21 Field Crew	Reach Name	R16 BRR DRC	Discharge Depth #1	Velocity T1	Site Length																																				
Quality Information		Dissolved Oxygen	pH	Total Dissolved Solids	Temp C	Chainage at Beginning of Reach	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	Discharge Depth #3	T3																																						
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			Crown Cover %	LWD	LW D/bank-full channel width	Erosion Sites (length)	Altered Stream Sites (length)	Obstructions (number)	Off-Channel Habitat (length)	Off-Channel Habitat (bank side)	Off-Channel Habitat (width)	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				
Glide 1	0	244	244	24		5856		1.5	2.0	30.00	66	30	40	20	10	5			40	0		10	150					C	C	Con	n	25	40	High	n	12	8				G1				
Rifle 1	244	416	172	20		3440		1.5	4.0	38.00		10	70	10	10	5			40	0		5					C	C	Con	n	45	50	High	n	7	5				ripap					
Glide 2	416	522	106	24		2544		1.5	1.0	35.00		10	70	10	10	10			40	0							C	C	Con	n	45	50	High	n	15	15				G2					
Reach Totals and Averages				522	522	22.7	0.0	11840	0.0	1.50	2.3	34.3	66	17	60	13	10	0	7	40	0	0.00	2	30	0	0		C	C	Con	n	7	7			7	7	3	3	11	9	0	0		

Appendix 10 – Reach 18 Habitat Data

Stream Name		Watershed Code	Date	Feb. 21 Field Crew	Reach Name	R18 DRC BRR	Discharge Depth #1	Velocity T1	Site Length																																					
Quality Information		Dissolved Oxygen	pH	Total Dissolved Solids	Temp C	Chainage at Beginning of Reach	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	Discharge Depth #3	T3																																							
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			Crown Cover %	LWD	LW D/bank-full channel width	Erosion Sites (length)	Altered Stream Sites (length)	Obstructions (number)	Off-Channel Habitat (length)	Off-Channel Habitat (bank side)	Off-Channel Habitat (width)	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					
Glide 1	0	130	130	33	0	4290		1.00	2.00	39.0	89	0	25	25	25	25	5		60.0	0		0	0					Nat	Nat	n	Con	35	10	Med	Med	35	30		0		G1					
Rifle 1	130	238	108	41	4428	4428		0.50	3.00	45.0		0	60	20	20	0	5		60.0	0		0	0	0				Nat	Nat	n	Con	15	10	Med	Med	20	30				R1					
Glide 2	238	437	199	37	7363	7363		0.50	1.00	40.0		0	40	40	10	10	0		50.0	0		0	0	0				Nat	Nat	n	Con	10	5	High	Med	22	30				G2					
Rifle 2	437	572	135	40	5400	5400		0.30	3.00	44.0		0	60	20	20	0	0		55.0	0		0	0	0				Nat	Nat	Mix	Mix	5	5	High	High	35	30				R2					
Pool 1	572	664	92	30	2760	2760		3.00	0.00	35.0		10	30	20	20	10	0		55.0	0		0	0	0				Nat	Nat	Mix	Con	10	10	Low	Med	30	30				p1					
Glide 3	664	982	318	30	9540	9540		0.50	1.00	38.0		0	30	30	30	10	0		60.0	0		0	0	0				Nat	Nat	Mix	Mix	5	5	Med	Med	30	10				G3					
Rifle 3	982	1346	364	41	14924	14924		0.30	1.00	45.0		0	40	30	30	5	5		60.0	0		0	0	0				Nat	Nat	Mix	Mix	10	5	Med	Med	30	20				R3					
Glide 4	1346	1512	166	41	8606	8606		1.00	2.00	45.0		0	40	30	30	5			50.0	0		50	0					Nat	Nat	n	Con	20	10	Low	Low	30	30				G4 at BR					
Reach Totals and Averages				1512	1382	37	51221	55377	92.50	0.89	1.6	41.4	89	1	41	27	23	9	3	56	0	0.00	0	3	0	0			Nat	Nat	n	Con	8	8			8	8	24	24	29	26	0	0		

Appendix 11 – Reach 22 Habitat Data

Stream Name Nanaimo		Watershed Code 920-3844		Date Feb. 2/21		Reach Name R22		BRR DRC		Discharge Depth #1		Velocity T1		Site Length																		
Quality Information		pH		Total Dissolved Solids		Temp C		Chainage at Beginning of Reach		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		Discharge Depth #3		T3																				
(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	Percent Crown Cover	Percent Wetted Area	LW D/bank-full channel width	Erosion Sites (length)	Altered Stream Sites (length)	Obstructions (number)	Off-Channel Habitat (length)	Off-Channel Habitat at (bank side)	Off-Channel Habitat at (width)	Land Use Right Left	Vegetation Type Right Left	Riparian Slope Right Left	Stability Right Left	Vegetation Depth Right Left	Livestock Access Right Left	Photos	Comments		
Riffle 1	0	180		41	0	7380		0.30	2.00	100.0		0 40 40 20 0	5										Nat	Nat	Mix	Mix	5 5	Med	40 40		R1	
Glide 1	180	334		40	0	6160		0.50	1.00	47.0		30 30 30 10 0				55.00	0	50	0	0	100	4	L	Nat	Nat	Con	Con	5 15	Low	60 25		G1
Riffle 2	334	393		28	0	1652		1.00	2.00	36.0		15 65 10 5 5 10				55.00	0	30	0				Nat	Nat	Con	Con	10 50	Med	60 15		R2	
Glide 2	393	484		26	0	2366		1.00	1.00	39.0		0 30 30 20 10 5				50.00	0	30	0				Nat	Nat	Con	Con	10 45	Med	60 15		G3	
Riffle 3	484	702		27	0	5886		1.00	1.00	45.0		0 20 20 50 10 5				50.00	0	30	0				Nat	C	Con	Mix	5 45	Med	60 10		G	
Pool 1	702	823	121	33	3993	3993		1.50	1.00	100.0		0 10 30 50 10 0				50.00	2	50	0				Nat	Nat	Con	Sh	10 5	Low	60 25		staking	
Glide 3	823	947		26	0	3224		1.00	2.00	120.0		0 10 30 50 10 0				40.00	0	0	0				Nat	Nat	Con	Sh	10 10	Low	60 25		G4	
																							0 0 0 0			0 0						
Reach Totals and Averages			947	121	31.6	3993	30661.0	13.0	0.90	1.4	69.6	45	3 29 27 32 8 4	51	2	0.15	20	0	0	11			7 9			7 13	33 25	57.1 22.1	0 0			

Appendix 12 – Reach 23 Habitat Data

Stream Name Nanaimo		Watershed Code 920-38		Date Feb. 2/21		Reach Name R23		BRR DRC		Discharge Depth #1		Velocity T1		Site Length																	
Quality Information		pH		Total Dissolved Solids		Temp C		Chainage at Beginning of Reach		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		Discharge Depth #3		T3																			
(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	Percent Crown Cover	Percent Wetted Area	LW D/bank-full channel width	Erosion Sites (length)	Altered Stream Sites (length)	Obstructions (number)	Off-Channel Habitat (length)	Off-Channel Habitat at (bank side)	Off-Channel Habitat at (width)	Land Use Right Left	Vegetation Type Right Left	Riparian Slope Right Left	Stability Right Left	Vegetation Depth Right Left	Livestock Access Right Left	Photos	Comments	
Glide 1	0	109		30	0	3270		0.50	1.00	32.00		0 50 20 10 10	5										Nat	Nat	Con	Con	10 15	Med	35 30		G
Pool 1	109	167	58	37	2146			0.50	0.00	41.00		20 10 10 40 20	0			65.00	1	0	0				Nat	Nat	Con	Con	10 5	High	30 30		P
Riffle 1	167	264		27	0	2619		0.30	6.00	41.00		90 10 0 0 0				60.00	0	0	0				Nat	Nat	Con	Con	15 10	High	60 35		R1
Glide 2	264	369		28	0	2940		0.50	1.00	34.00		5 55 20 10 10 5				55.00	0	0	0				Nat	Nat	Mix	Mix	10 10	High	60 25		G - rd parallel
Riffle 2	369	406		26	0	962		0.30	2.00	28.00		0 50 30 10 10	0			60.00	0	0	0				Nat	Nat	Mix	Mix	10 10	High	75 40		R
Glide 3	406	642		28	0	6608		0.30	1.00	34.00		0 50 30 10 10	0			70.00							Nat	Nat	Con	Mix	10 10	High	60 30		G
																							0 0 0 0			0 0					
Reach Totals and Averages			642	58	29.3	2146	18545	11.6	0.40	1.83	35.0 83.8	19 38 18 13 10	2	60.83	1	0.05	0	0	0	0			6 6			6 6	8 16	53.3 31.7	0 0		

Appendix 12 – Nanaimo River USHP Habitat Assessment Scores - Reach 2,3,4 & 5.

USHP Sum & Ratings Table
 Nanaimo **Reach 2,3,4 & 5** Watershed code 920-384400

Habitat Parameter	Reach 2	Ratings	Nan R3	Ratings	Nan R4	Ratings	Nan R5	Ratings	Avg Rating
% Pool Area	40	5	22	5	67	1	39	5	4.0
Large Woody Debris/Bankfull Channel Width	0	5	1	5	0	5	0	5	5.0
% Cover in Pools	1	5	5	5	5	5	6	3	4.5
Average% Boulder Cover	0	5	2	5	5	5	6	5	5.0
Average % Fines	2	1	4	1	2	1	0	1	1.0
Average % Gravel	56	not rat	16	not rat	13	not rated	3	not rated	
% of Reach Eroded	55	5	33	5	0	1	0	1	3.0
Obstructions	0	0	0	0	0	0	0	0	0.0
% of Reach Altered	0	1	13	5	2	1	9	3	2.5
% Wetted Area	59	5	61	5	66	5	75	3	4.5
Average		3.6		4.0		2.7		2.9	3.3

Off-Channel Habitat as % of Reach	19.7	3.0	53.7	1.0	0.0	5.0	0.0	5.0	3.5
Reach Lengths	1679.0	not rat	2245	not rat	1515	not rated	1047	not rated	0.0

Fish Data

Reach	Reach 2	Ratins gs	Nan R3	Ratin gs	Nan R4	Ratings	Nan R5	Rating s	Total
Fry Capacity	124246	--	162432	--	80390	--	58981	--	0.0
Actual Pop.	0.0		0.0		0.0		0.0		0.0

Riparian Ratings

Reach	Reach 2	Ave. Ratin gs	Nan R3	Ave. Ratin gs	Nan R4	Ave. Ratings	Nan R5	Ave. Rating s	Total
Land Use	34	2	40	1	24	2	46	3	1.8
Riparian Slope	32	2	34	1	72	5	86	5	3.0
Bank Stability	70	4	142	4	16	1	18	1	2.5
% Crown Cover	39	5	43	3	63	3	56	3	3.5
% of Reach Accessed by Livestock	9	3	16	3	0	0	12	3	2.3
Average Vegetation Depth	203	1	112	1	64	1	46	3	1.5
Average		3		2.2		2		2.9	2.4

Appendix 13 – Nanaimo River USHP Habitat Assessment Scores - Reach 12,13 & 14.

Stream Name	Nanaimo		Reach 12, 13 & 14		Watershed Code		920-384400
Habitat Parameter	R12	Ratings	R13	Ratings	R14	Ratings	Avg Rating
% Pool Area	7	5	14	5	45	3	4.3
Large Woody Debris/Bankfull Channel Width	0.0	5	0.1	5	0.5	5	5.0
% Cover in Pools	4	5	5	5	5	5	5.0
Average% Boulder Cover	4	5	4	5	3	5	5.0
Average % Fines	2	1	3	1	12	3	1.7
Average % Gravel	6	not rated	14	not rated	34	not rated	
% of Reach Eroded	5	1	1	1	8	3	1.7
Obstructions	0	0	0	0	0	0	0.0
% of Reach Altered	5	1	0	1	0	1	1.0
% Wetted Area	83	3	78	3	72	3	3.0
Average		2.9		2.9		3.1	3.0
Off-Channel Habitat as % of Reach	6	5	0	5	0	5	5.0
Reach Lengths	1609	not rated	3564	not rated	2013	not rated	
Fish Data							
Reach	R12	Ratings	R13	Ratings	R14	Ratings	
Fry Capacity	112630	--	174079	--	115377	--	
Actual Pop.	0.00		0.00		0.00		
Riparian Ratings							
Reach	R12	Ave. Ratings	R13	Ave. Ratings	R14	Ave. Ratings	Total
Land Use	22	1	26	1	34	1	1.1
Riparian Slope	38	2	46	2	36	1	1.6
Bank Stability	38	2	54	2	106	3	2.4
% Crown Cover	45	3	53	3	51	3	3.0
% of Reach Accessed by Livestock	19	3	11	3	11	3	3.0
Average Vegetation Depth	26	5	36	3	41	3	3.7
Average		3		2		2	2.5

Appendix 14 – Nanaimo River USHP Habitat Assessment Scores - Reach 16,18,22,& 23.

Stream Name Nanaimo **Reach 16,18,22 &23** **Watershed Code** 920-384400

Habitat Parameter	R16	Ratings	R18	Ratings	R22	Ratings	R23	Ratings	Avg Score
% Pool Area	0	5	92	1	13	5	12	5	4.0
Large Woody Debris/Bankfull Channel Width	0	5	0	5	0	5	0	5	5.0
% Cover in Pools	7	3	3	5	4	5	2	5	4.5
Average% Boulder Cover	7	5	3	5	4	5	2	5	5.0
Average % Fines	0	1	9	1	8	1	10	3	1.5
Average % Gravel	10	not rate	23	not rate	32	not rate	13	not rate	
% of Reach Eroded	2	1	0	1	20	5	0	1	2.0
Obstructions	0	0	0	0	0	0	0	0	0.0
% of Reach Altered	30	5	3	1	0	1	0	1	2.0
% Wetted Area	66	5	89	3	45	5	84	3	4.0
Totals		3.3		2.4		3.6		3.1	3.1

Off-Channel Habitat as % of Reach	0	5	0	5	11	5	0	5	4.0
Reach Lengths	522	not rated	1512	not rated	947	not rated	642	not rated	0

Riparian Ratings

Reach	R16	Ave. Ratings	R18	Ave. Ratings	R22	Ave. Ratings	R23	Ave. Ratings	Total
Land Use	14	2	16	1	16	1	12	1	1.4
Riparian Slope	14	2	16	1	20	1	12	1	1.4
Bank Stability	6	1	48	3	58	4	24	2	2.5
% Crown Cover	40	3	56	3	51	3	61	3	3.0
% of Reach Accessed by Livestock	0	0	0	0	0	0	0	0	0.0
Average Vegetation Depth	10	5	28	5	40	3	43	3	4.0
Totals		2		2		2		2	2.1