ANALYSIS AND PRIORITY IDENTIFICATION OF EXISTING FISH PASSAGE DATA: COQUITLAM RIVER WATERSHED - COA-F18-F-2504

Prepared for:

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Cover photo – Crossing 51801 over Scott Creek. Photo credit Masse 2012

EXECUTIVE SUMMARY

Fish passage impediments created by road crossing structures in British Columbia are a significant challenge that can have a substantial cumulative impact on local fish populations by reducing access to critical habitat and fragmenting populations. Closed bottom road crossing structures (culverts) can present barriers to fish migration due to a number of factors including increased water velocity, turbulence, a vertical drop at the culvert outlet and/or maintenance issues. The rehabilitation of fish passage at road crossing structure barriers presents tangible opportunities to reconnect habitat values within currently fragmented ecosystems.

The Coquitlam River watershed was chosen for assessment planning due to a synergy between the objectives of the British Columbia Ministry of Environment and Climate Change Strategy- Ecosystem Branch and the Fish and Wildlife Compensation Program (FWCP) – Coast Region objectives. An organized approach to fish passage remediation in the watershed takes action towards implementation of some of the high level objectives of both organizations which are included in in the Coquitlam River Watershed Action Plan:

- the conservation and restoration of habitat capacity and diversity for fish and other aquatic organisms
- to sustain and increase the population viability of anadromous salmon and steelhead as well as resident salmonids.
- Maintain or improve opportunities to sustainably use ecosystem values for sustenance, social, ceremonial, recreational and commercial purposes.

Previously identified crossings that are barriers to fish passage in the Coquitlam watershed were prioritized based on past assessment information, available fisheries data as well as estimated upstream habitat quality and quantity. The results provide a planning tool to help guide further assessment and restoration of crossings.

A detailed review and prioritization ranking was conducted for 12 crossings structures identified as requiring further assessment according to the criteria identified in the methodology. Of these, 6 crossings were rated as high priority for follow up with habitat confirmation assessments and potentially fish inventories. Two crossings were rated as low priority for follow up with habitat confirmation assessments and potentially fish inventories and four crossing were rated as "no fix".

To date Phase 1 - Fish Passage Assessments have been conducted throughout most of the major potential fish bearing Coquitlam River watershed areas. Fifty-one crossings are modelled as still requiring assessment in the northern part of the watershed adjacent to the reservoir and behind gates controlled by the Greater Vancouver Regional District, on private land or are on deactivated roads that may require an all-terrain vehicle (Masse 2012). Access to these areas will need to be arranged as part of the field

planning for assessments on modelled crossings located on stream reaches identified as fish bearing or potentially fish bearing. Assessment of these crossings is recommended and should be conducted according to Fish Passage Technical Working Group (FPTWG) protocols. The FPTWG has prepared on-line training resources, field work guidance, field assessment protocols and data forms to help guide the collection of data and submission of assessment deliverables.

Habitat confirmation checks conducted according to protocols developed by the FPTWG are recommended for the crossings rated as high priority. Habitat confirmation checks gather detailed field and background data on habitat quality and quantity, fisheries values, land use issues and regional fisheries concerns. This information is then incorporated into a standardized reporting format to further refine priority rankings and focus design (Phase 3) and remediation (Phase 4) on fish passage restoration opportunities into areas of critical habitat for species of interest.

This project was funded in part by the Fish and Wildlife Compensation Program (FWCP) on behalf of its program partners BC Hydro, the Province of BC, Fisheries and Oceans Canada, First Nations and the public, who work together to conserve and enhance fish and wildlife impacted by the construction of BC Hydro dams. The project was also funded by the Ministry of Environment & Climate Change – Ecosystem Branch.

This project would not have been possible without the highly skilled GIS, data analysis, modelling and mapping support of Simon Norris from Hillcrest Geographics.

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1 INTRODUCTION

The health and viability of freshwater fish populations depends on access to suitable spawning, high water refuge, rearing and overwintering habitat. Watershed connectivity is important to accommodate population abundance fluctuations and the flow of genes that provides resilience to environmental stressors such as floods, landslides and extreme climate events.

Fish passage impediments created by road crossing structures in British Columbia are a significant challenge that can have a substantial cumulative impact on local fish populations by reducing access to critical habitat and fragmenting populations. Estimates based on fish passage data collected to date indicate that there are over 170,000 closed bottom culverts in the province that impede fish passage (FPTWG 2014). Closed bottom road crossing structures (culverts) can present barriers to fish migration due to increased water velocity, turbulence, a vertical drop at the culvert outlet and/or maintenance issues. Rehabilitation and replacement of crossing structure barriers can provide access to currently isolated high value habitats.

For this project, existing fish passage information in the Coquitlam River watershed, near Vancouver, British Columbia, was reviewed in order to prioritize and rank culverts for follow up in preparation for further assessment and restoration. A literature and Provincial Steam Crossing Inventory System (PSCIS) database review was conducted and rehabilitation opportunities were analyzed within the context of a GIS generated Fish Habitat Model of the known or potential fish habitat located upstream.

2 BACKGROUND

As a result of high-level direction from the provincial government, a Fish Passage Strategic Approach protocol has been developed for British Columbia to ensure that the greatest opportunities for restoration of fish passage are pursued. A Fish Passage Technical Working Group has been formed to coordinate the protocol and data is continuously amalgamated within PSCIS. Currently, British Columbia Timber Sales (BCTS) administers most of the fish passage assessment, design and remediation contracts with the majority of funding typically provided by the Land Based Investment Strategy (LBIS). The strategic approach protocol involves a four phase process as described in (FPTWG 2011):

- Phase 1: Fish Passage Assessment – Fish stream crossings within watersheds with high fish values are assessed to determine barrier status of structures and document a general assessment of adjacent habitat quality and quantity.
- Phase 2: Habitat Confirmation – Assessments of crossings prioritized for follow up in Phase 1 studies are conducted to confirm quality and quantity of habitat upstream and down as well as to scope for other potential nearby barriers that could affect the practicality of remediation.
- Phase 3: Design – Site plans and designs are drawn for priority crossings where high value fish habitat has been confirmed.
- Phase 4: Remediation – Implementation of reconnection of isolated habitats through replacement, rehabilitation or removal of prioritized crossing structure barriers.

The scope of this project includes portions of the planning for the first two phases of fish passage assessment in the Coquitlam River watershed. The Coquitlam River watershed was chosen for assessment planning because it is a watershed impacted by dam creation and operation, and there is a synergy between the objectives of the British Columbia Ministry of Environment and Climate Change Strategy – Ecosystem Branch and the Fish and Wildlife Compensation Program (FWCP) – Coast Region objectives. An organized approach to fish passage remediation in the watershed is a step towards addressing high level objectives of both organizations that are included in the Coquitlam River Watershed Action Plan (FWCP 2017):

- the conservation and restoration of habitat capacity and diversity for fish and other aquatic organisms
- to sustain and increase the population viability of anadromous salmon and steelhead as well as resident salmonids.
- Maintain or improve opportunities to sustainably use ecosystem values for sustenance, social, ceremonial, recreational and commercial purposes.

To date, within the Coquitlam River watershed, 129 fish passage assessments (Phase 1) conducted at crossing structures are documented in the PSCIS database. The assessments were completed using standardized protocols (MoE 2009, MoE 2011). The Fish and Wildlife Compensation Program and the Ecosystem Branch of the Ministry of Environment & Climate Change have funded the review of existing PSCIS information and other background literature to prioritize and rank crossing rehabilitation opportunities in select watersheds for follow up with habitat confirmation assessments.

3 OBJECTIVES

Objectives for the project include:

1. To review existing fish passage information in the Coquitlam River watershed in order to prioritize and rank crossing rehabilitation opportunities for follow up with habitat confirmation assessments.
2. Provide some of the background and field work tools necessary to facilitate an inventory of unassessed stream crossing structures on fish bearing and potentially fish bearing streams in the Coquitlam River watershed according to the FPTWG standards (MoE 2011).

Deliverables of this project are intended to encourage the collection of future fish passage data according to FPTWG standards including upload into the PSCIS database. This is so that the work will not be unnecessarily repeated and so that further phases of the Fish Passage Strategic Approach protocol can be prioritized on a watershed and province wide basis towards road structure barriers providing the best opportunities for rehabilitation.

4 STUDY AREA

The Coquitlam River watershed is located approximately 30 km east of Vancouver (Figure 1). The Coquitlam Lake Reservoir is located above the Coquitlam Dam within the Coast Mountains and covers an area of approximately 21 km^2. The study area overlaps the traditional territories of the Kwikwetlem First Nation, the Katzie First Nation, theMusqueam First Nation, the Seabird Island Band, the Shxw'ow'hamel First Nation, the Skawahlook First Nation, the Soowahlie First Nation, the Squamish Nation, and Tsleil-Waututh Nation. It is also within the asserted traditional territory of Sto:lo Nation. The upper Coquitlam watershed is within a gated area addressed by Metro Vancouver's Drinking Water Management Strategy. A portion of the watershed located to the south-east of the reservoir is located within Pine Cone Burke Provincial Park. A Kwikwetlem First Nation reserve is located in the lower part of the watershed (FWCP 2017).

The Coquitlam-Buntzen generating complex is comprised of two dams, a diversion tunnel, two outlet tunnels, and two power houses. The Coquitlam Dam is located at the south end of Coquitlam Lake Reservoir and functions to hold back water for storage and provide releases into the lower Coquitlam River. Water from Coquitlam Lake Reservoir water is diverted through a tunnel into Buntzen Lake, located within a watershed to the west of the Coquitlam River watershed. This water in turn flows to powerhouses located on the shore of Indian Arm also outside of the Coquitlam Watershed. A separate diversion tunnel is operated by Metro Vancouver to provide drinking water for the city.

The Coquitlam River is a 5^{th} order stream that drains an area 262 km^2 from its headwater at the Coquitlam Lake Reservoir Lake. Flows are driven primarily by rain events in the fall and snowmelt in the spring (Figure 2, FWCP 2017). The change in stream flows due to reservoir operations is evident in the hydrograph for the Coquitlam River near the mouth (Figure 3).

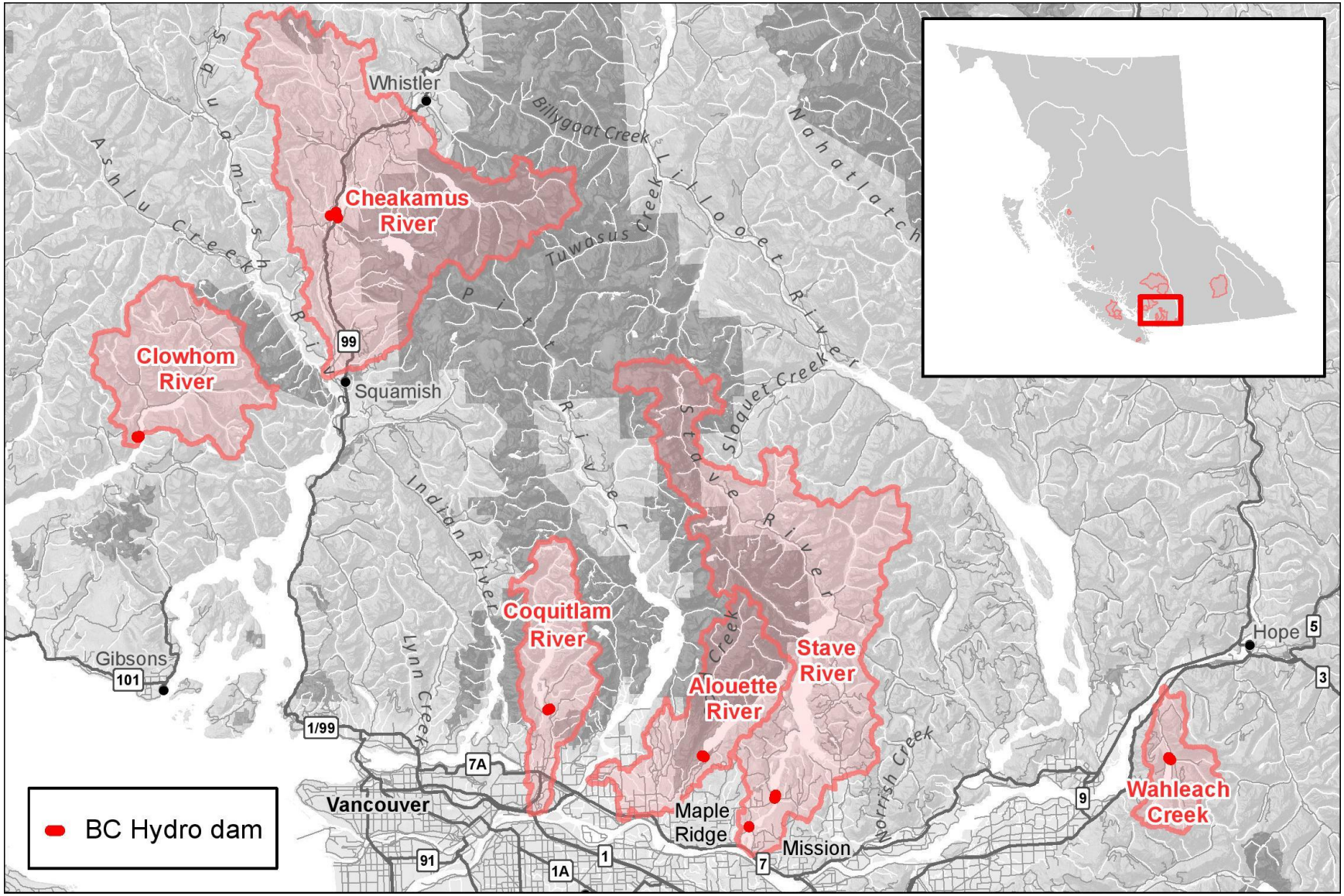

Figure 1. Map of study area.

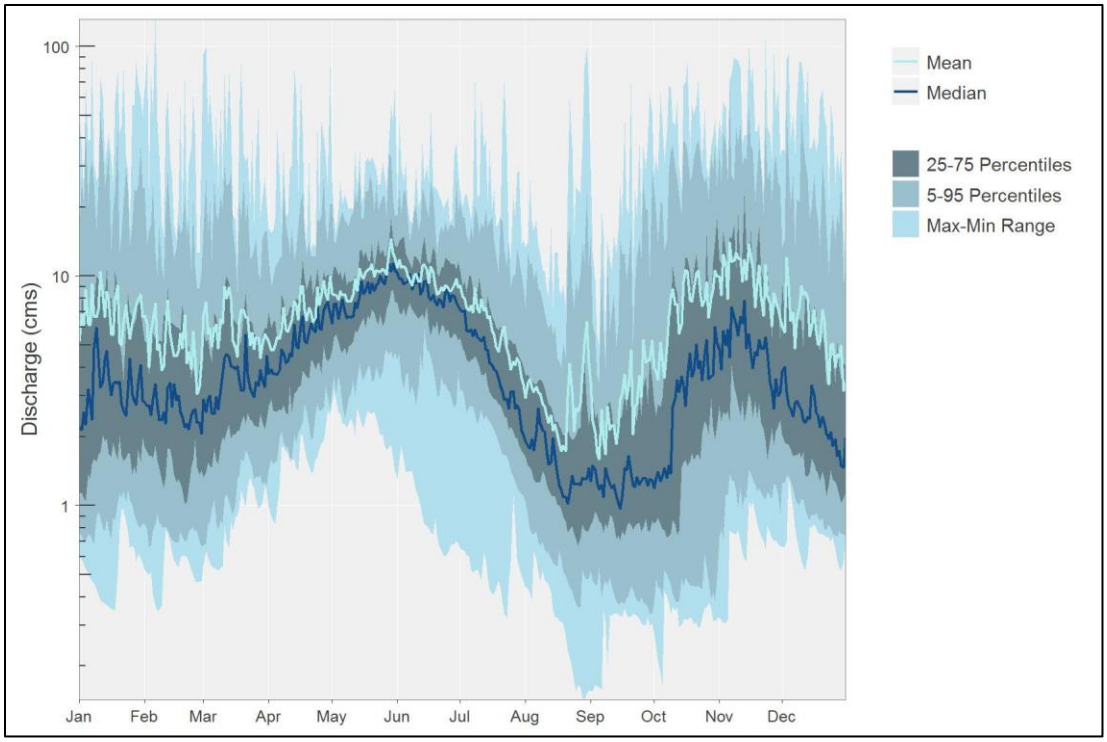

Figure 2. Coquitlam River above Coquitlam Lake (Station #08MH141 - Lat 49.487942 Lon -122.792511). Available daily discharge data from 1982 to 2016 plotted in R with fasstr (Goetz and Schwarz NA).

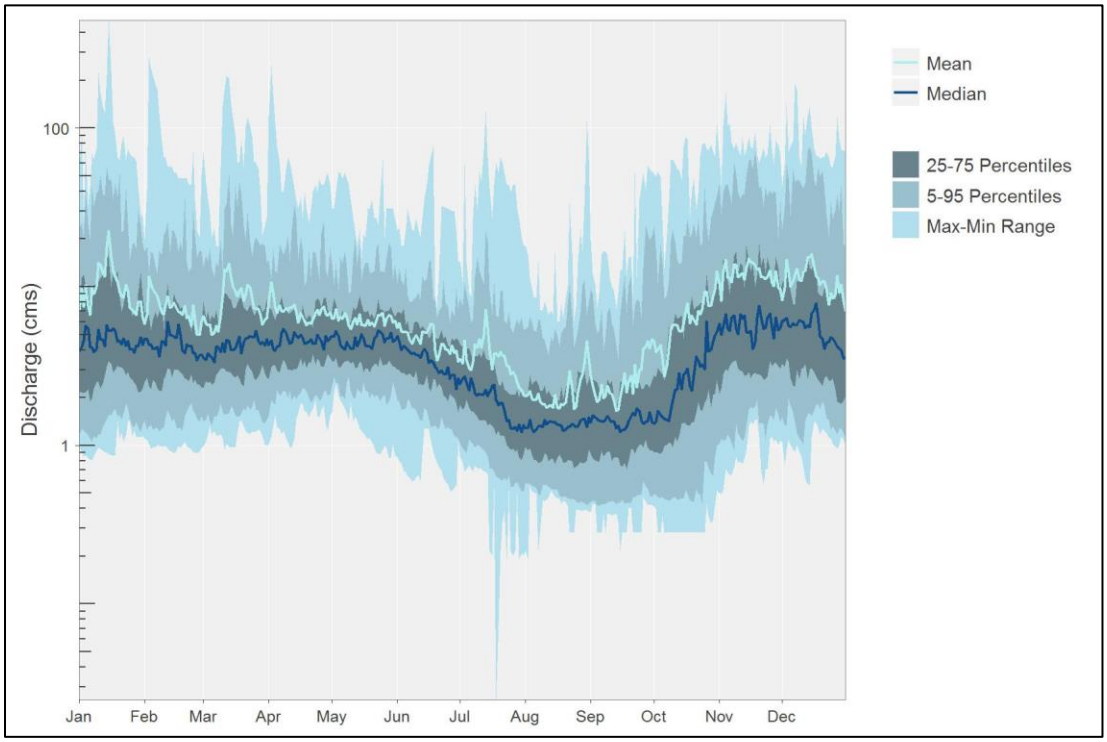

Figure 3. Coquitlam River at Port Coquitlam (Station #08MH002 - Lat 49.26524 Lon -122.781502). Available daily discharge data from 1915 to 2012 plotted in R with fasstr (Goetz and Schwarz NA).

4.1 Fisheries

Before the construction of the Coquitlam Dam in 1902, anadromous salmon and steelhead (*Oncorhynchus mykiss*) had access to the Coquitlam Lake and its tributaries. Sockeye salmon (*O. nerka*) and pink salmon (*O. gorbuscha*) were extirpated from the watershed following completion of the dam. Currently, below the dam steelhead, chinook, coho (*O. kisutch)* and chum salmon (*O. keta*) are present and pink salmon have been reestablished (Table 1). Resident fish species within the mainstem, reservoir and tributaries include rainbow trout (*O. mykiss*), cutthroat trout, bull trout (*Salvelinus confluentus*), dolly varden (*Salvelinus malma)*, redside shiner (*Richardsonius balteatus)*, prickly sculpin (*Cottus asper*) and threespine stickleback (*Gasterosteus aculeatus*). There is some uncertainty to whether the char in the watershed are bull trout, dolly varden, or a combination of both.

Kwikwetlem Sockeye Restoration Program is a collaborative effort of the Kwikwetlem First Nation, Fisheries and Oceans Canada, the Ministry of Environment & Climate Change Strategy, BC Hydro, local municipalities and their stewardship organization. They have been actively planning the restoration of sockeye salmon to the Coquitlam River Watershed (Plate *et al.* 2014).

The Coquitlam River Watershed Roundtable was founded in 2011 following a four year community engagement process. The roundtable coordinates and implements activities that promote the health and long-term sustainability of the watershed. They have developed a watershed action plan and numerous strategies for action to deal with pressures affecting the watershed such as stormwater, development, invasive species, water extraction, and mining among others (CRWR 2016b). . The core committee is the administrative body for the roundtable with members from a wide cross section of interest groups in the watershed including local government, First Nations, regional government, utilities, stewardship groups, educational institutions, arts societies and others (CRWR 2016a).

The North Fraser Salmon Assistance Project Society has completed a number of salmon habitat enhancement projects in the watershed since 2004 including wetland restoration (NFSAP 2004, 2008), off channel habitat restoration projects (NFSAP 2006, 2012) as well as fish passage improvement and spawning habitat enhancement (NFSAP 2014).

A great deal of fisheries information is available for the watershed within government report repositories (Ecocat, CLIR, etc.). The majority of fish species occurrence information is from fish salvages and impact assessments related to development and maintenance of municipal infrastructure.

Table 1. Fish species present in the Coquitlam River watershed (FISS 2018).

Scientific name	**Species name**	**Species code**
Ameiurus nebulosus	Brown Catfish (formerly Brown Bullhead)	BNH
Carassius auratus	Goldfish	GC
Catostomidae	Sucker (General)	SU
Catostomus macrocheilus	Largescale Sucker	CSU
Cottidae	Sculpin (General)	CC
Cottus aleuticus	Coastrange Sculpin (formerly Aleutian Sculpin)	CAL
Cottus asper	Prickly Sculpin	CAS
Cyprinidae	Dace (General)	DC
Cyprinus carpio	Carp	CP
Gasterosteidae	Stickleback (General)	SB
Gasterosteus aculeatus	Threespine Stickleback	TSB
Hybognathus hankinsoni	Brassy Minnow	BMC
Lampetra tridentata	Pacific Lamprey	PL
Lepomis gibbosus	Pumpkinseed	PMB
Micropterus dolomieui	Smallmouth Bass	SMB
Micropterus salmoides	Largemouth Bass	LMB
Mylocheilus caurinus	Peamouth Chub	PCC
Oncorhynchus clarki clarki	Coastal Cutthroat Trout	CCT
Oncorhynchus clarki spp.	Cutthroat Trout (Anadromous)	ACT
Oncorhynchus gorbuscha	Pink Salmon	PK
Oncorhynchus keta	Chum Salmon	CM
Oncorhynchus kisutch	Coho Salmon	CO
Oncorhynchus mykiss	Rainbow Trout	RB
Oncorhynchus mykiss	Steelhead	ST
Oncorhynchus mykiss	Steelhead (Summer-run)	SST
Oncorhynchus mykiss	Steelhead (Winter-run)	WST
Oncorhynchus nerka	Kokanee	KO
Oncorhynchus tshawytscha	Chinook Salmon	CH
Pacifastacus leniusculus	Signal Crayfish	CRA
Petromyzontidae	Lamprey (General)	L
Pomoxis nigromaculatus	Black Crappie	BCB
Ptychocheilus oregonensis	Northern Pikeminnow	NSC
Rhynichthys cataractae	Longnose Dace	LNC
Rhynichthys cataractae	Nooksack Dace	NDC
Richardsonius balteatus	Redside Shiner	RSC
Salmonidae	Cutthroat Trout	CT
Salvelinus malma	Dolly Varden	DV

5 METHODS

To identify priorities for crossing structure rehabilitation, a literature and PSCIS database review was conducted for the Coquitlam River watershed and data was analyzed within the Fish Habitat Model developed by Hillcrest Geographics and the BC Ministry of Environment (MoE 2016). The Fish Habitat Model identifies potential stream crossing locations and models known and potential fish habitat based on gradient. Gradient is calculated at intervals along a stream of at least 100 m to delineate segments based on a set of user provided gradient thresholds (MoE 2016). Following segment delineation, the average gradient of each segment is calculated and used to symbolize potential fish habitat as riffle/cascade, step-pool, step-pool very steep according to a set of average stream slope categories (0-5%, 6- 13% and 13 – 20%).

Past fish passage assessment reports for the Coquitlam River watershed were first reviewed to identify crossing structure barriers previously ranked as high or moderate priorities for rehabilitation. All previously prioritized crossings underwent a detailed review. To identify previously un-prioritized crossing structure barriers located on potentially high value streams, road crossing structures that met the following criteria in the Fish Habitat Model and/or PSCIS database also underwent a detailed review.

- Stream crossing barriers and potential barriers on streams with confirmed fish presence upstream of the structure.
- Stream crossing barriers and potential barriers on streams documented as ≥ 1.5m wide with linear lengths of modelled upstream habitat <20% gradient for ≥100 m.
- Stream crossing barriers and potential barriers located on streams classified as 3rd order or higher.
- Stream crossing barriers and potential barriers located on streams with >1 ha of modelled wetland and/or lake habitat upstream of the structure.
- Stream crossing barriers and potential barriers on streams with habitat value rated as "high" in past fish passage assessment data. Habitat value ratings are assigned during fish passage assessments and are defined in the *Field Assessment for Determining Fish Passage Status of Closed Bottom Structures* (MoE 2011, Table 2).

Table 2. Habitat Value Criteria.

Habitat Value	Fish Habitat Criteria
High	• The presence of high value spawning or rearing habitat (e.g., locations with abundance of suitably sized gravels, deep pools, undercut banks, or stable debris), which are critical to the fish population.
Medium	• Important migration corridor. • Presence of suitable spawning habitat. • Habitat with moderate rearing potential for the fish species present.
Low	• The absence of suitable spawning habitat, and habitat with low rearing potential (e.g., locations without deep pools, undercut banks, or stable debris, and with little or no suitably sized spawning gravels for the fish species present).

Adapted from: MoE 2011

Crossing structures that underwent the detailed review were ranked for further assessment as either high priority, medium priority, low priority, or "no fix", based on past assessment information, available fisheries data as well as upstream potential habitat quantity and quality. A combination of some or all of the following information was incorporated into this prioritization ranking:

- Contractor crossing prioritization in past fish passage assessment reports and data.
- Available fisheries data - Fish species present or suspected at the crossing location.
- Habitat quantity:
    - Stream width as documented in the PSCIS database as well as at nearby sample sites documented within the Fisheries Information Summary System (FISS).
    - Linear length of modelled upstream potential habitat (<20%). Consideration was given to the "net" amount of habitat available upstream which is defined as habitat upstream of the crossing uninterrupted by subsequent barrier road crossing structures.
    - Area of modelled wetland and/or lake habitat upstream of the structure connected to crossing location by contiguous modelled gradients <20%.
- Habitat quality:
    - Past crossing assessment and nearby FISS stream sample site comments regarding habitat quality, slope information in PSCIS/FISS databases and project reports as well as apparent habitat quality in site photos.
    - Modelled threshold gradient and average gradient outputs of upstream potential habitat generated by the Fish Habitat Model were also reviewed which is discussed in more detail below.

Gradient is a key factor in fish distribution and channel type. High value rearing, overwintering and spawning habitat is often located within channel types with lower gradients, while high gradient sections typically present upstream migration barriers and less available habitat. For this reason, waterbody segments in the Coquitlam River watershed were delineated and categorized into gradient categories using the Fish Habitat Model. The model outputs were used to identify potential gradient barriers as well as to help prioritize rehabilitation opportunities by estimating the slope and quantity of potential fish habitat upstream of a crossing.

The Fish Habitat Model utilized stream segments from the GIS stream layer (1:20,000) of the Freshwater Atlas for its gradient analysis (MoE 2016). For this project, the gradient categories detailed in Table 3 were utilized to delineate and classify habitat. The model starts at the mouth of a stream and iterates through each vertex of the stream flow line, calculating the gradient between the given vertex and the next vertex at least 100m upstream. It delineates additional stream segments at locations where the gradient exceeded the defined thresholds. Following delineation, the average gradient of each stream layer segment located within potential fish habitat was calculated with results classified according to the channel type categories. Finally, for potential habitat upstream of each crossing, stream lengths were

summed within the average gradient categories with total areas of wetland and lake habitat also calculated.

Table 3. Stream gradient threshold and average gradient categories generated from the Fish Habitat Model and associated channel type.

*Gradient Range	Channel Type
0 – 5%	Riffle and cascade pool
6 – 13%	Step pool
14 – 20%	Step pool - very steep
>20%	Non fish habitat

*Rounded to the nearest percent

Gradient threshold and average gradient categories were rounded to the nearest percent. Segments downstream of sections up to 13% grade were delineated and classified according to channel type groupings adapted from the British Columbia Channel Assessment Procedure Guidebook which include riffle and cascade pool and step-pool (FPC 1996, Table 3). Stream segments with sections containing gradients from 14 – 20% were classified as step pool - very steep. Stream segments upstream of 100 m sections with an average gradient >20% were considered non fish habitat. Although fish have been reported to utilize habitat with gradients up to 30% (Baxter 1999), a cutoff of 20% was used as the goal was to identify and prioritize crossing rehabilitation opportunities. Stream segments with gradients between 20-30% are extremely steep and do not typically provide high value spawning or rearing habitat.

6 RESULTS

In the Coquitlam River watershed, 65 crossing structure assessments are catalogued within the PSCIS database (Table 4). Of these, 39 crossings are located on modelled fish habitat. For these crossings, 10 are documented as barriers, 3 are assessed as potential barriers and 26 are considered passable. Maps are provided as Attachment 1.

Table 4. Summary of PSCIS crossings within the Coquitlam River watershed.

PSCIS Stream Crossings	Barrier	Potential	Passable	Total
Modelled as on potential fish habitat	10	3	26	**39**
Modelled as on non-fish habitat	9	0	3	**12**
No modelling data (not on mapped stream)	7	3	4	**14**
Total	**26**	**6**	**33**	**65**

A detailed review and prioritization ranking was conducted for 12 crossings structures identified as requiring further assessment according to the criteria identified in the methodology (Table 5). Of these, 6 crossings were rated as high priority for follow up with habitat confirmation assessments and potentially fish inventories (Tables 5 - 6). Two crossings were rated as low priority for follow up with habitat

confirmation assessments and potentially fish inventories (Table 5, Appendix 3) and four crossing were rated as "no fix" (Table 5, Appendix 4). Available links to photos stored in the PSCIS database are provided in the "Stream" column of priority tables.

The location of 51 potential crossing structures on modelled fish habitat that do not yet have associated PSCIS assessment information has been included in Appendix 4. Of note, a number of crossings that were not assessed during the assessments conducted by Masse Environmental Consultants in 2011 (Masse 2012) have detail related to why they were not assessed in the "comments" column of the Appendix 4 table. Many crossings were accessible by boat only in the upper watershed, were behind locked gates, on inaccessible private land, or were on deactivated roads impassable for 4-wheel drive.

A detailed digital summary of all PSCIS barrier and potential barrier crossings and modelled crossings on streams modelled as observed fish bearing or potentially fish bearing is provided as Attachment 2. A key to the data included in Attachment 2 is detailed in Appendix 5.

To date Phase 1 - Fish Passage Assessments have been conducted throughout most of the major potential fish bearing Coquitlam River watershed areas. Areas still requiring assessment of crossings are primarily in the northern part of the watershed adjacent to the reservoir and behind gates controlled by the Greater Vancouver Regional District (Masse 2012). Access to these areas should be arranged to facilitate fish passage assessments in the upper watershed.

Table 5. Summary of crossings that underwent a detailed review and associated prioritization ranking. Maps provided as Attachment 1.

Category	**Number of Crossings**	**Location**	**Comments**
High priority crossings	6	Table 6	Habitat confirmation and potential fish inventory recommended as high priority.
Moderate priority crossings	0		Fish habitat confirmation with potential fish inventory recommended as moderate priority.
Low priority crossings	2	Appendix 1	Fish habitat confirmation with potential fish inventory recommended as low priority.
No fix	4	Appendix 2	Likely non-fish bearing or passable. Follow up not recommended
Total	**12**		

Table 6. High priority crossings for habitat confirmation.

PSCIS ID	Map ID	Stream	Road	UTM (10U)	[1]Habitat Gain (km)	Lake/ Wetland (ha)	Stream Width (m)	Species upstream	[1]Road Tenure	Habitat Value	Comments
51791	092G109	Mantle Ck	Pipeline Rd	516406 5463989	0.1		2.5	CO,CRA	Local	Low	Assessment comments indicate good habitat for 75 m.
51794	092G109	Partridge Ck	Pipeline Rd	516435 5463399	1.1		4.2		Local	Medium	Large stream. Upstream channel appears to run adjacent to gravel pit type area. Assessment comments indicate fines clogging substrate.
51801	092G108	Scott Ck	Eagle Mountain Dr	513782 5462074	1.1		1.5	ACT,CAS,CC,CCT,CH,CM,CO,CT,DC,DV,L,LNC,RB,SB,SP,ST,SU,TR	Local	Medium	Prioritized (Masse 2012). Provides access to beaver pond rearing area. CH observation not far downstream.
51813	092G108	Scott Ck	Tangle-wood Lane	513674 5461070	1.2		4.8	ACT,CAS,CC,CCT,CH,CM,CO,CT,DC,DV,L,LNC,RB,SB,SP,ST,SU,TR	Local	High	Prioritized (Masse 2012). Baffled structure with outlet controls. Drop at outlet is barrier to small fish.
51857	092G108	Trib to Coquitlam	Lougheed Hwy	513807 5454371	0.1		4	BCB,BNH,CAS,CCT,CH,CO,CSU,LMB,NSC,PCC,PMB,RB,RSC,TSB	MoTI	High	Although passing chum spawners it should be passable to all life stages.
51959	092G109	Coquitlam R	Pipeline Rd	516587 5465006	109.3	1264.1	2.1	CAS,CC,CCT,CM,CO,CSU,CT,DV,KO,LNC,NSC,PCC,RB,RSC,SP,SST,ST,TR,TSB,WST	Local	High	Modelled as on Coquitlam River but actually on tributary with CO and RB observed upstream (FISS 2018). Assessment comments indicate excellent habitat.

[1]Habitat Gain – a modelled estimate of continuous linear distance of fish habitat (<20% gradient) located immediately upstream of the crossing. [2]DCK = District Manager Chilliwack (FLNRORD), Mission = The Corporation Of The District Of Mission, Norske = Norske Skog Canada Limited, PPR = Princeton Post And Rail Ltd., Transwood = Transwood Timber Ltd.

7 DISCUSSION AND CONCLUSION

Previously identified crossings that are barriers to fish passage in the Coquitlam watershed were prioritized based on past assessment information, available fisheries data as well as estimated upstream habitat quality and quantity. The results provide a planning tool to help guide further assessment and restoration of crossings. It should be noted that the methodology used for this analysis is one of many possible approaches that incorporates assumptions about the value of fish habitat based on limited data, inferred quantities as well as somewhat subjective interpretations of habitat quality.

A detailed review and prioritization ranking was conducted for 12 crossings structures identified as requiring further assessment according to the criteria identified in the methodology. Of these, 6 crossings were rated as high priority for follow up with habitat confirmation assessments and potentially fish inventories. Two crossings were rated as low priority for follow up with habitat confirmation assessments and potentially fish inventories and four crossing were rated as "no fix".

To date Phase 1 - Fish Passage Assessments have been conducted throughout most of the major potential fish bearing Coquitlam River watershed areas. Fifty-one crossings are modelled as still requiring assessment in the northern part of the watershed adjacent to the reservoir and behind gates controlled by the Greater Vancouver Regional District, on private land or are on deactivated roads that may require an all-terrain vehicle (Masse 2012). Access to these areas will need to be arranged as part of the field planning for assessments on modelled crossings located on stream reaches identified as fish bearing or potentially fish bearing. Assessment of these crossings is recommended and should be conducted according to FPTWG protocols. The FPTWG has prepared on-line training resources, field work guidance, field assessment protocols and data forms to help guide the collection of data and submission of assessment deliverables.

Phase 2: Habitat confirmation checks conducted according to protocols developed by the FPTWG (MoE 2011) are recommended for the crossings rated as high priority. Habitat confirmation checks gather detailed field and background data on habitat quality and quantity, fisheries values, land use issues and regional fisheries concerns. This information is then incorporated into a standardized reporting format to further refine priority rankings and focus design (Phase 3) and remediation (Phase 4) on fish passage restoration opportunities into areas of critical habitat for species of interest.

8 REFERENCES

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Appendix 1

Low Priority Crossings

PSCIS ID	Map ID	Stream	Road	UTM (9U)	[1]Habitat Gain (km)	Lake/ Wetland (ha)	Stream Width (m)	Species upstream	Road Tenure	Habitat Value	Comments
51800	092G109	Trib to Coquitlam	Pipeline Rd	516529 5462086	0.1		1.1		Local	Low	Small steep stream with small amount of available habitat modelled upstream.
52069	092G109	Marquart Ck	Pipeline Rd	516748 5462450	0.8		1.1		Local	Low	Assessment comments indicate "no habitat" upstream.

[1]Habitat Gain – a modelled estimate of continuous linear distance of fish habitat (<20% gradient) located immediately upstream of the crossing.

Appendix 2

Crossings with No Fix Recommended

PSCIS ID	Map ID	Stream	Road	UTM (9U)	[1]Habitat Gain (km)	Lake/ Wetland (ha)	Stream Width (m)	Species upstream	Road Tenure	Habitat Value	Comments
54104	092G108	Scott Ck	Lansdown Dr	513683 5459228	2.3		8	ACT,CAS,CC,CCT,CH,CM,CO,CT,DC,DV,L,LNC,RB,SB,SP,ST,SU,TR	Collector	High	Assessment comments and photos indicate passable.
54110	092G108	Scott Ck	Guildford Way	513680 5459016	2.5		11	ACT,CAS,CC,CCT,CH,CM,CO,CT,DC,DV,L,LNC,RB,SB,SP,ST,SU,TR	Arterial	High	Assessment comments and photos indicate passable.
54121	092G108	Scott Ck	Arlington Rd	513942 5458392	3.4		6.5	ACT,CAS,CC,CCT,CH,CM,CO,CT,DC,DV,L,LNC,RB,SB,SP,ST,SU,TR	Collector	High	Assessment comments and photos indicate passable.
54123	092G108	Hoy Ck	Barnet Hwy	514221 5458346	6.2		5	BNH,CC,CM,CO,CT,EB,GC,L,LW,RB,SP,ST	Arterial	High	Assessment comments and photos indicate passable.

[1]Habitat Gain – a modelled estimate of continuous linear distance of fish habitat (<20% gradient) located immediately upstream of the crossing.

Appendix 4

Unassessed Modelled Crossings

Crossing ID	Map ID	Stream Name	Road Name	UTM (10U)	[1]Habitat Gain (km)	Lake/ Wetland (ha)	Species Upstream	Road Tenure	[2]Comments
10300646	092G109		Rakanna Pl	516497 5461177	0.2			Local	
10300647	092G109		Turner Ave	516584 5461127	0.3			Local	
10300648	092G109		Hockaday St	516541 5461150	0.3			Collector	
10300650	092G109		Meadowvista Pl	514764 5460630	0.3			Local	No crossing. Stream follows green space to east.
10300651	092G109		Valleyview Crt	514729 5460545	0.4			Local	No crossing. Stream follows green space to east.
10300686	092G109		Lambert Way	516669 5461112	0.4			Local	
10301170	092G109		400	516099 5469081	0.1			Metro Vancouver	
10301171	092G109		405	516608 5469151	0			Metro Vancouver	
10301183	092G109		400	515914 5470497	0			Metro Vancouver	
10301186	092G114		400	517016 5473486	0			Metro Vancouver	
10301205	092G114		433	516908 5479026	0			Metro Vancouver	
10301220	092G109		451	515957 5466223	0.4			Metro Vancouver	
10301228	092G109		450	515925 5466410	0.6			Metro Vancouver	
10301239	092G109		David Ave	514725 5460460	0.5			Collector	
10301240	092G109		Pipeline Rd	516355 5461218	0.1			Arterial	No habitat upstream.
10301448	092G109		450	515331 5466327	7.8			Metro Vancouver	
10301449	092G109		450	514946 5466841	0			Metro Vancouver	
10301452	092G109		450	515174 5466581	0			Metro Vancouver	
10302057	092G109		Pipeline Rd	516451 5461643	0.1			Local	No crossing.
10302058	092G109	Marquart Ck	Pipeline Rd	516699 5462545	0.6			Local	No crossing.
10302061	092G109		Pipeline Rd	516429 5463693	0.1			Local	No crossing.
10302062	092G109		400	516571 5465087	0.4		CO,CT,RB	Metro Vancouver	
10302063	092G109		Pipeline Rd	516616 5464287	0.2			Local	
10302224	092G109		419	516443 5470401	2.3		CCT	Metro Vancouver	
10302226	092G109		419	517027 5470893	0			Metro Vancouver	
10302227	092G109		419	516914 5470842	0.7			Metro Vancouver	

Crossing ID	Map ID	Stream Name	Road Name	UTM (10U)	[1]Habitat Gain (km)	Lake/ Wetland (ha)	Species Upstream	Road Tenure	[2]Comments
10302286	092G109		401	520895 5469415	0			Metro Vancouver	
10302295	092G109		400	515727 5470809	0.1			Metro Vancouver	
10302307	092G114		400	514772 5482327	0.1			Metro Vancouver	
10302313	092G109	Coquitlam R	400	516359 5466892	95.5	1262.3	CAS,CC,CCT,CO,CSU,CT, DV,KO,NSC,PCC,RB,RSC, SP,SST,TSB,WST	Metro Vancouver	
10302317	092G109		400	516055 5468788	1			Metro Vancouver	
10302369	092G108		450	514379 5467301	0			Metro Vancouver	
10302373	092G108		450	514396 5467239	0.2			Metro Vancouver	
10302384	092G108		450	514376 5467360	0.1			Metro Vancouver	
10302705	092G109		422	516796 5470627	1.8		CCT	Metro Vancouver	
10302720	092G114			515387 5484583	0			Unclassified	
10303078	092G109		401	517603 5467427	0.7			Metro Vancouver	
10303079	092G109	Coquitlam R	401	516521 5465511	97.2	1262.3	CAS,CC,CCT,CO,CSU,CT, DV,KO,LNC,NSC,PCC,RB, RSC,SP,SST,ST,TR,TSB, WST	Metro Vancouver	
10303081	092G109			516380 5463707	0.1			Unclassified	No crossing.
10303100	092G109			515442 5465971	6.7			Unclassified	
10303101	092G109			515307 5465959	0.2			Unclassified	
10303107	092G109			515921 5466559	0.7			Unclassified	
10303291	092G114		434	516807 5478812	0.3			Metro Vancouver	
10303361	092G114	Coquitlam R		515654 5484632	4		RB	Unclassified	
10303488	092G109	Marquart Ck		516509 5462791	0.3			Unclassified	
10303492	092G109	Partridge Ck		515839 5463278	0.3			Unclassified	
10303493	092G109	Partridge Ck		515918 5463372	0.5			Unclassified	Does not exist.
10303494	092G109			516380 5461633	0			Unclassified	
10303878	092G109			516354 5461632	0			Unclassified	

Crossing ID	Map ID	Stream Name	Road Name	UTM (10U)	[1]Habitat Gain (km)	Lake/ Wetland (ha)	Species Upstream	Road Tenure	[2]Comments
10305124	092G108	Scott Ck		514248 5458130	10.3		ACT,BNH,CAS,CC,CCT,CH,CM,CO,CT,DC,DV,EB,GC,L,LNC,LW,RB,SB,SP,ST,SU,TR		
10305165	092G108			513838 5454325	0.2		BCB,BNH,CAS,CCT,CH,CO,CSU,LMB,NSC,PCC,PMB,RB,RSC,TSB		

[1]Habitat Gain – a modelled estimate of continuous linear distance of fish habitat (<20% gradient) located immediately upstream of the crossing.

[2]Comments from Masse 2012

Appendix 5

Key to Attachment 2 - Digital Summary of PSCIS and Modelled Crossings

Table heading	**Column Name (BC data distribution)**	**Details/attribute**	**Source/URL**
crossing_id / stream_crossing_id	stream_crossing_id	Unique crossing ID	Fish Habitat Model / pscis-assessments
map_tile	map_tile	1:50,000 mapsheet	nts-50k-grid-digital-baseline-mapping-at-1-50-000-nts
stream_name	gnis_name	The BCGNIS (BC Geographical Names Information System) name associated with the GNIS feature id	freshwater-atlas-stream-network
stream_order	stream_order	The calculated modified Strahler order.	freshwater-atlas-stream-network
road_name	road_name_full or rfi_highway_description or road_section_id	Dependent on logic incorporating distance of modelled crossing to associated road layers and presence absence of forest tenure information	digital-road-atlas-dra-master-partially-attributed-roads ministry-of-transportation-mot-road-features-inventory-rfi forest-tenure-road-segment-lines
fish_habitat_threshold_type_atcrossing		Stream threshold category of stream at crossing (ex. FISH HABITAT - INFERRED - 055-135PCT = no fish habitat downstream of crossing with gradient > 13.5% for more than 100m)	Fish Habitat Model freshwater-atlas-stream-network
habitat_gain_threshold_sub035		Total linear length (m) of inferred or observed fish habitat upstream of the crossing that does not exceed 3.5% gradient for more than 100 m.	Fish Habitat Model freshwater-atlas-stream-network
habitat_gain_threshold_sub05		Linear length (m) of inferred or observed fish habitat upstream of the crossing that does not exceed 5.5% gradient (cascade) for more than 100 m.	Fish Habitat Model freshwater-atlas-stream-network
habitat_gain_threshold_sub13		Linear length (m) of inferred or observed fish habitat upstream of the crossing that does not exceed 13.5% gradient (step-pool) for more than 100 m.	Fish Habitat Model freshwater-atlas-stream-network
habitat_gain_threshold_sub20		Linear length(m) of inferred or observed fish habitat upstream of the crossing that does not exceed 20.5% gradient (step pool – very steep) for more than 100 m.	Fish Habitat Model freshwater-atlas-stream-network
*slope		Derived slope of stream at crossing	Fish Habitat Model freshwater-atlas-stream-network
upstr_len_slope_0_035		Linear length (m) of inferred or observed fish habitat upstream of the crossing with average gradient ≤3.5% (riffle).	Fish Habitat Model freshwater-atlas-stream-network
upstr_len_slope_035_055		Linear length (m) of inferred or observed fish habitat upstream of the crossing with average gradient from 3.5 - 5.5% (cascade).	Fish Habitat Model freshwater-atlas-stream-network

Table heading	Column Name (BC data distribution)	Details/attribute	Source/URL
upstr_len_slope_055_135		Linear length (m) of inferred or observed fish habitat upstream of the crossing with average gradient 5.5 - 13.5% (step-pool).	Fish Habitat Model freshwater-atlas-stream-network
upstr_len_slope_135_205		Linear length(m) of inferred or observed fish habitat upstream of the crossing with average gradient 13.5 - 20.5% (step pool – very steep).	Fish Habitat Model freshwater-atlas-stream-network
upstr_len_slope_sub_205		Total linear length(m) of inferred or observed fish habitat upstream of the crossing with average gradient < 20.5%.	Fish Habitat Model freshwater-atlas-stream-network
lake_area_ha	area_ha	Total area of lake habitat upstream of crossing and stream segments modelled with habitat threshold <20.5%.	Fish Habitat Model freshwater-atlas-stream-network freshwater-atlas-lakes
wetland_area_ha	area_ha	Total area of wetland habitat upstream of crossing and stream segments modelled with habitat threshold <20.5%.	Fish Habitat Model freshwater-atlas-stream-network freshwater-atlas-wetlands
spp_upstream	species_code	Codes for fish species located on stream segments upstream of the subject crossing.	known-bc-fish-observations-and-bc-fish-distributions
road_tenure	road_class client_name	Dependent on logic incorporating distance of modelled crossing to associated road layers and presence absence of forest tenure information as well as presence of key words in attribute names (ex. FSR is output when "FSR" contained within DRA layer attribute "road_name_full" when DRA layer attributre "road_class" = "resource".	digital-road-atlas-dra-master-partially-attributed-roads ministry-of-transportation-mot-road-features-inventory-rfi forest-tenure-road-segment-lines
upstr_crossing_ids		Unique identifiers for all modelled or PSCIS crossings located upstream of the subject modelled crossing on stream segments modelled as <20.5% threshold.	Fish Habitat Model
dnstr_crossing_ids		Unique identifiers for all modelled or PSCIS crossings located downstream of the subject modelled crossing.	Fish Habitat Model
*habitat_value_code	habitat_value_code	Habitat value code assigned during PSCIS assessment.	pscis-assessments
*Prioritized		Reference to assessment report where crossing was prioritized.	
*assessment_comment	assessment_comment	Assessment comments recorded in database from PSCIS assessment.	pscis-assessments
*image_view_url	image_view_url	Link to photos taken during PSCIS assessment.	pscis-assessments

*PSCIS summary only