FISH PASSAGE PLANNING: ASH RIVER WATERSHED
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Prepared for:

Ministry of Environment & Climate Change Strategy Ecosystem Branch
PO Box 9338 Stn Prov Govt
Victoria BC, V8W 9M1

Fish and Wildlife Compensation Program
6911 Southpoint Drive, 11th floor
Burnaby, BC V3N 4X8

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Prepared by:
Allan Irvine, R.P.Bio
Masse Environmental Consultants Ltd
812 Vernon Street
Nelson, BC, V1L 4G4

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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.

For this project, fish passage planning maps and data tables/files have been prepared for the Ash River watershed, near Port Alberni, on Vancouver Island. This work is intended to provide a product that will serve as a catalyst for the implementation of fish passage remediation projects in the watershed with the goal of restoration of fish passage into critical habitat areas for priority species.

The Ash 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 the Ash River Watershed Action Plan:

- Conserving and restoring habitat capacity and diversity for fish and other aquatic organisms.
- Sustaining and increasing the population viability of anadromous salmon and steelhead, as well as resident rainbow trout and cutthroat trout.
- Maintain or improve opportunities to sustainably use ecosystem values for sustenance, social, ceremonial, recreational and commercial purposes.

A strategic approach to the planning and data collection at road crossing structures and the sharing of information provided by the Fish Passage Technical Working Group (FPTWG) provides a platform for an efficient allocation of effort towards the restoration of fish passage opportunities in the Ash River watershed with the highest ecosystem benefits. The FPTWG tools such as the data collection protocol documents and the Provincial Stream Crossing Inventory System database tools should be used so that data collection is consistent and can be shared.

In the Ash River watershed, 603 crossings were identified using the fish habitat model. Of these, 192 crossings are predicted to occur on modelled fish habitat, while the remaining 411 are predicted to be located on modelled non-fish habitat (above sections of stream >100m long with gradient >20%).

Assessment of modelled crossing locations on modelled fish habitat in the watershed 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.

The maps and spreadsheets developed through this project are a step towards implementation of an inventory of closed bottom structures in the Ash River watershed (Phase 1). Following the assessment of fish passage at crossing structures, subsequent phases of the FPTWG's Fish Passage Strategic Approach can follow (Phase 2 – Habitat Confirmation, Phase 3 – Design, Phase 4 – Remediation), hopefully resulting in the restoration of fish passage into areas of critical habitat in the watershed 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 Strategy-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.

This report was prepared by:

Allan Irvine, B.Sc., R.P.Bio.
Masse Environmental Consultants Ltd

Reviewed by:

Ico de Zwart, Ph.D., R.P.Bio.
Masse Environmental Consultants Ltd
812 Vernon St, Nelson, BC, V1L 4G4

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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, fish passage planning maps and data files have been prepared for the Ash River watershed, near Port Alberni, on Vancouver Island, British Columbia. This work is intended to provide a product that will serve as a catalyst to the future implementation of fish passage remediation projects in the watershed with the goal of restoration of fish passage into critical habitat areas for priority species.

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 (FPTWG) has been formed to coordinate the protocol, and the data is continuously amalgamated within the Provincial Stream Crossing Inventory Database (PSCIS). The strategic approach protocol involves a four phase process as described in FPTWG (2014):

- 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 phase of fish passage assessment in the Ash River watershed. The Ash 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.

To date, within the Ash River watershed, no fish passage assessments (Phase 1) are documented within the PSCIS database. PSCIS data is accessed through Imap BC or with information downloaded directly from the British Columbia Data Catalogue. Data uploaded includes assessment data and links to project reports and photos.

3 OBJECTIVES

An objective of this project is to provide some of the background and field work tools necessary to facilitate an inventory of stream crossing structures on fish bearing and potentially fish bearing streams in the Ash River watershed according to the FPTWG standards (MoE 2011).

This work is intended to provide a product that will serve as a catalyst to the future implementation of fish passage remediation projects in the watershed with the goal of restoration of fish passage into critical habitat areas for priority species.

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 Ash River watershed is located approximately 40 km north-west of Port Alberni within central Vancouver Island (Figure 1). The watershed is within the traditional territories of the Hupacasath, K'ómoks, Tseshaht, We Wai Kai and Wei Wai Kum First Nations. Hydro-electric generation, forestry and mineral exploration are the main industrial activities in the watershed. Recreational users include hunters, fishers, campers and off-road motorized recreationists. The western end of the watershed is located within Strathcona Provincial Park and much of the northern portion is forest land managed by Island Timberlands LP. The watershed is within the South Island Natural Resource District (FWCP 2017).

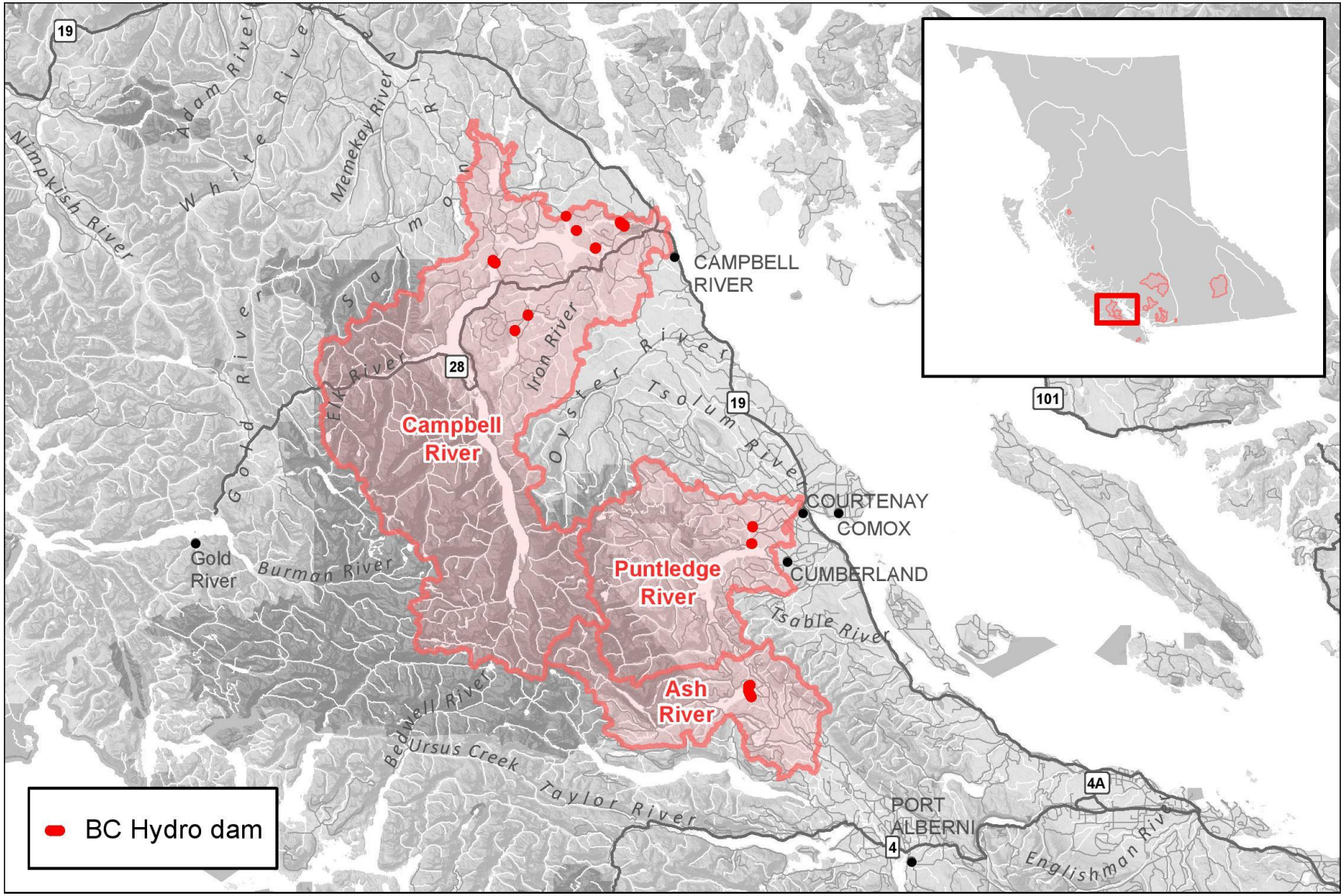

Figure 1. Map of study area.

The Ash River is a 5th order stream that drains an area of 381 km^2 in a generally south-eastern direction into the Stamp River approximately 5 km to the north-east of the mouth of Great Central Lake. From there the Stamp River flows in a south-eastern direction into the Somass River which enters the Pacific Ocean at the Alberni Inlet near Port Alberni, BC approximately 20 km downstream from the confluence with the Ash River. Stream discharges are typical of British Columbia coastal basins, with high inflows from snowmelt in May through July, low flows in August through early October and high precipitation from late October to March with mixtures of snow and heavy rain (Figure 2, FWCP 2017).

Construction of the Elsie Dam and four saddle dams were completed at the outlet of Elsie Lake in 1958. Water is diverted from the Elsie Lake Reservoir through a 7.8 km long tunnel and penstock to a powerhouse located at Great Central Lake.

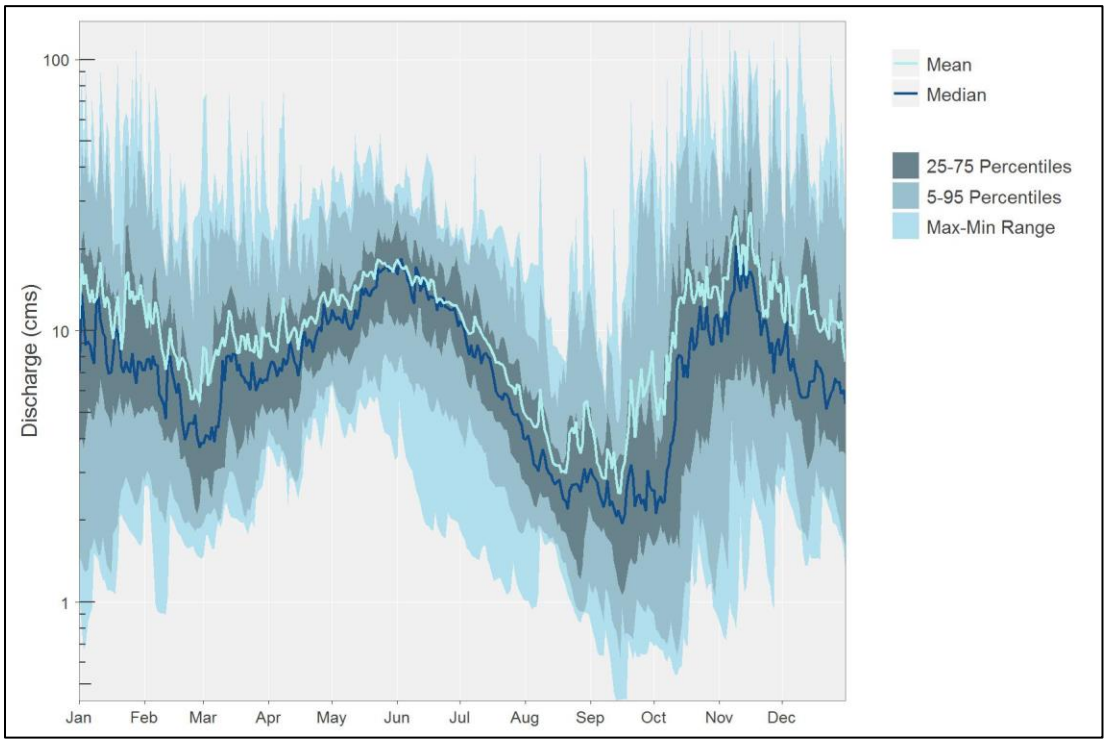

Figure 2. Ash River below Moran Creek (Station #08HB023 - Lat 49.369919 Lon -124.984108). Available daily discharge data from 1959 to 2016 plotted in R with fasstr (Goetz and Schwarz NA).

4.1 Fisheries

Downsteam of Elsie Lake Dam, anadromous species present within the Ash River watershed include steelhead (*O. mykiss*), pacific lamprey (*Entosphenus tridentatus*), chinook salmon (O. *tshawytscha*), coho salmon (*O. kisutch*) and sockeye salmon (*O. nerka*) (Table 1). Resident populations of rainbow trout (*O. mykiss*) and cutthroat trout, (*O.clarkii spp.)* among others are present upstream of the Elliot

Dam. A small population of kokanee may be present in the watershed although it is unconfirmed (FWCP 2017).

Dickson falls is approximately 9 m high and is locate approximately 11 km upstream from the mouth of the Ash River and approximately 1.4 km downstream of Dickson Lake (Lewis and Ganshorn 2006). Traditional ecological knowledge from the Hupacasath First Nation, past survey work and stable isotope analysis of lake sediments support a hypothesis that anadromous salmon were historically not blocked by Dickson falls and were historically present upstream of the Elsie dam (Lewis and Ganshorn 2005, Hatfield 2007).

To support fish, flows are released down the Ash River from Elsie Dam according to specifications detailed in in the Ash River Project Water Use Plan (BC Hydro 2004). Requirements for minimum flows are 3.5 m^3/s from May 1 to October 31; 5 m^3/s from November 1 to April 30; and three separate pulse flows for adult steelhead migration, of ~9 m3/s for 48 hours between August 1 and September 30 (Figure 2).

Information for fish inventories completed within the Ash River watershed is sparse within government report repositories, with only one lake inventory report located (Rigets 2005). Fish distribution information is available within inventory surveys and barriers are often identified in these reports. Local forestry companies would likely have access to fish distribution information in the watershed through inventory and stream classification reports.

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

Scientific name	**Species name**	**Species code**
Ameiurus nebulosus	Brown Catfish (formerly Brown Bullhead)	BNH
Cottidae	Sculpin (General)	CC
Entosphenus tridentatus	Pacific lamprey	PL
Gasterosteidae	Stickleback (General)	SB
Gasterosteus aculeatus	Threespine Stickleback	TSB
Lepomis gibbosus	Pumpkinseed	PMB
Micropterus dolomieui	Smallmouth Bass	SMB
Oncorhynchus clarkii spp.	Cutthroat Trout	CT
Oncorhynchus kisutch	Coho Salmon	CO
Oncorhynchus mykiss	Rainbow Trout	RB
Oncorhynchus mykiss	Steelhead	ST
Oncorhynchus nerka	Sockeye Salmon	SK
Oncorhynchus tshawytscha	Chinook Salmon	CH
Richardsonius balteatus	Redside Shiner	RSC
Salvelinus malma	Dolly Varden	DV

5 METHODS

To amalgamate maps and datasheets for crossing structure inventory, potential stream crossing locations were derived and analyzed within the Fish Habitat Model (MoE 2016). The Fish Habitat Model identifies potential stream crossing locations and models known and potential fish habitat based on gradient.

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/or lower quality e habitat. Gradient categories are used in the Fish Passage Model to identify potential gradient barriers as well as to help characterize habitat associated with 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 2 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 2. 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 2). 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 Ash River watershed, 603 crossings were modelled using the fish habitat model (Table 3). Of these, 192 crossings are predicted to occur on modelled fish habitat, while the remaining 411 are predicted to be located on modelled non-fish habitat (above sections of stream >100m long with gradient >20%). Maps of the watershed are provided as Attachment 1 and a summary of modelled crossing characteristics (stream name, road name, modelled habitat characteristics upstream, area of wetlands/lakes/reservoir upstream, etc.) are provided as Appendix 1 with a more detailed digital summary provided as Attachment 2. A key to the data included in Attachment 2 is detailed in Appendix 2.

Table 3. Summary of modelled crossings within the Ash River watershed.

Crossings	Number
On observed or modelled potential fish habitat	192
On modelled non-fish habitat	411
Total	**603**

7 NEXT STEPS

7.1 Phase 1 - Fish Passage Assessment

7.1.1 Preparing for the Field

Maps and datasheets provided as deliverables for this project can be used to prioritize stream crossing structure inventories based on sub-watersheds of interest, species of interest as well as quantities and types of habitat upstream and downstream of modelled crossings. To compliment these materials, field work guidance has been provided by the FPTWG. Fisheries literature for the watershed should be reviewed to gather information on fish bearing stream reaches as well as non-fish bearing reaches in preparation for field assessment. Stream reconnaissance reports showing non-fish bearing status can provide the information necessary to greatly reduce the number of crossings requiring inventory. FISS sample sites and obstacles to fish passage have been included on maps to aid in background review of watershed information. Details related to each of these points can be accessed through Imap BC or with information downloaded directly form the British Columbia Data Catalogue. Additionally local knowledge from government, First Nations and industry fisheries/habitat staff should be used to augment the modeled fish habitat data and background fisheries information when possible.

7.1.2 Data Collection

The FPTWG has prepared on-line training resources as well as the procedural document titled "Field Assessment for Determining Fish Passage Status of Closed Bottom Structures" and details assessment deliverables to help guide data collection and submission. A brief summary of data collection, data submission protocols and reporting is included below.

Each watershed should be systematically approached to assess crossings identified as fish bearing or potentially fish bearing. Additional closed bottom crossings encountered incidentally in the field can also be assessed if they occur on unmapped streams and appear to have potential for fish presence. Drainage culverts should not be assessed unless mapped and identified as potentially or known fish bearing.

For all crossings assessed, including open bottom structures and fords, photos should be taken that include images of the crossing inlet, crossing outlet, crossing barrel, channel downstream and channel upstream and any relevant features (ex. natural barriers, road signs adjacent to crossing to aid in location, significant habitat features, etc.). Additionally, the following information should be recorded for all surveyed crossings on standardized filed forms found in MoE 2011: date of inspection, crossing reference, crew member initials, Universal Transverse Mercator (UTM) coordinates, stream name, road name and kilometer, road tenure information, crossing type, crossing subtype, culvert diameter or span for OBS, culvert length or width for OBS. A more detailed "full assessment" was completed for all closed bottom structures.

In addition to the above information full assessments should include the following parameters: presence/absence of continuous culvert embedment (yes/no), average depth of embedment, whether or not the culvert bed resembled the native stream bed, presence of and percentage backwatering, fill depth, outlet drop, outlet pool depth, inlet drop, culvert slope, average downstream channel width, stream slope, presence/absence of beaver activity, presence/absence of fish at time of survey, type of valley fill, and a habitat value rating. Some of this information is utilized to determine the barrier status of the crossing based on data obtained from various studies (Clarkin et al. 2003; Robison and Walsh 2003) and scored according to the values provided in the MoE protocol (MoE 2011, Tables 4 – 5).

Table 4. Fish barrier scoring.

Risk	Embedded	Value	Outlet Drop	Value	Slope	Value	SWR	Value	Length	Value
LOW	>30cm or >20% of diameter and continuous	0	<15	0	<1	0	<1.0	0	<15	0
MOD	<30cm or 20% of diameter but continuous	5	15-30	5	1-3	5	1.0-1.3	3	15-30	3
HIGH	No embedment or discontinuous	10	>30	10	>3	10	>1.3	6	>30	6

Table 5. Fish barrier result.

Cumulative Score	Result
0-14	Passable
15-19	Potential Barrier
≥20	Barrier

Habitat value ratings should be given for each stream where a crossing is assessed and should be based on channel morphology, flow characteristics (perennial, intermittent, ephemeral), fish migration patterns, the presence/absence of deep pools, un-embedded boulders, substrate, woody debris, undercut banks, aquatic vegetation and overhanging riparian vegetation (Table 6, MoE 2011). For crossings determined to be potential barriers or barriers based on the data, a culvert fix should be recommended based on options provided in MoE 2011 which include:

1. Removal
2. Open Bottom Structure
3. Streambed Simulation
4. Additional Substrate Material
5. Backwater

Table 6. 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).

All field data collected including photos must be uploaded to the Provincial Stream Crossing Inventory System (PSCIS) by using the excel PSCIS Assessment Form via the Electronic Submission Framework (ESF). A users guide for the PSCIS system is provided on the Fish Passage Activity website.

Reporting for fish passage assessments should include the following as summarized in the FPTWG assessment deliverables:

- Executive Summary.
- Study Area – description and map.
- Scope of works completed.
- Methods.

- Results including a data summary table with structures number and fish passage score and description of fish presence determination.
- Analysis of data collected including Habitat Gained Index (amount of suitable habitat potentially available upstream of the crossing).
- Recommendations - Priorities for fish passage restoration and any limitations and linkages. (ex. structure is a priority but road that crosses downstream was not assessed and other crossings on the same system should be fixed in conjunction to realize highest habitat gains).
- Map showing priority restoration sites.
- Conclusions.

7.2 Phase 2 – Fish Habitat Confirmation

Following the assessment of closed bottom structures in an area of interest, highest priority crossings can progress to the second phase of the FPTWG strategic protocol (Fish Habitat Confirmation). Preparation before going out to the field as well as field sampling and data collection should follow the steps outlined in FPTWG 2011 – "A Checklist for Fish Habitat Confirmation Prior to the Rehabilitation of a Stream Crossing". The main objectives of these fish habitat assessments are to confirm the presence of high value fish habitat, a large amount of habitat gain through remediation and the absence of fish migration barriers immediately downstream of crossings.

7.2.1 Step 1: Preparation Before Going Out to the Field

Step 1 of the habitat confirmation protocol involves a background review of all relevant access and fisheries information. All provincial fish habitat modeling should be reviewed and government information databases should be searched for relevant background information. Local regulatory biologists should be consulted regarding local fisheries information and insights into fish species utilizing study area watersheds.

Maps and/or web mapping services should be reviewed to determine distance to any potential barriers downstream and upstream of the crossings. PSCIS information on any downstream or upstream crossings located within the watershed should also be reviewed to determine if they have been assessed for fish passage. Fish sampling permits should be obtained for electrofishing to facilitate assessment of fish bearing status and fish species present in subject streams.

7.2.2 Step 2: Field Sampling and Data Collection

Step 2 consists of surveying all the culvert crossings identified as high priority as well as the fish habitat upstream and downstream of the crossing. Each culvert should be flagged and labeled in the field including the crossing ID, date and crew initials. The crossings should be assessed again for fish passage following the procedures outlined in "Field Assessment for Determining Fish Passage Status of Closed Bottomed Structures" (MoE 2011) to confirm the accuracy of the original assessment and determination that the crossing was a barrier to fish passage.

The stream should be surveyed upstream and downstream of the crossing to assess habitat quality. Any upstream crossings should be assessed for fish passage and habitat at access points on the stream should be assessed to determine quality of habitat at The crew should survey the stream downstream of the crossing to the point where fish passage has been previously confirmed. When necessary, electrofishing should be conducted to aid in the determination of fish bearing status and species identification. Any potential barriers to fish passage should be inventoried with photos, physical descriptions and locations recorded. Surveyed routes should be recorded using GPS units. Each habitat type within the surveyed area should be described, photographed and rated.

7.2.3 Step 3: Submit Survey Summary and Conclusions

A brief document should be drafted for each habitat confirmation conducted and should include maps and photos and use the headings below as detailed in FPTWG (2011):

- Site Location
- Findings from Background Information Search
- Stream Characteristics at Crossing
- Stream Characteristics Downstream
- Stream Characteristics Upstream
- Conclusions

8 CONCLUSION

In the Ash River watershed, 603 crossings were identified using the fish habitat model. Of these, 192 crossings are predicted to occur on modelled fish habitat, while the remaining 411 are predicted to be located on modelled non-fish habitat (above sections of stream >100m long with gradient >20%).

Assessment of modelled crossing locations in the watershed 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.

The rehabilitation of fish passage at road crossing structure barriers presents tangible opportunities to reconnect habitat values within currently fragmented ecosystems. A strategic approach to the planning and data collection at road crossing structures and the sharing of information provided by the FPTWG tools such as the data collection protocol documents and the PSCIS database provides a platform for an efficient allocation of effort towards the restoration of fish passage at sites with the highest ecosystem benefits. Following implementation of an inventory of closed bottom structures in the Ash River watershed (Phase 1) subsequent phases of the FPTWG's Fish Passage Strategic Approach can follow (Phase 2 – Habitat Confirmation, Phase 3 – Design, Phase 4 – Remediation) hopefully resulting in the restoration of fish passage into areas of critical habitat for species of interest in the watershed.

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Appendix 1

Modelled Crossings on Known and Potential Fish Habitat

Crossing ID	Map ID	Stream Name	Road Name	UTM (10U)	Habitat Gain (km)	Lake/ Wetland (ha)	Species Upstream	*Road Tenure
200392	092F113			343508 5478624	2.8		CT,RB	Resource
200397	092F113			352764 5479226	3.9			Resource
200398	092F113			345344 5480418	0.3			Resource
200399	092F113			348742 5478958	0.4			Resource
200407	092F113			348510 5483263	1.1			Resource
200618	092F113			347865 5478715	0.5			Resource
200619	092F113			347767 5478788	0.4			Resource
200638	092F113			348636 5484135	0			Resource
200721	092F112			333191 5475873	0.6			Resource
200722	092F112			333089 5475920	0.6			Resource
201204	092F113			344156 5478203	1			Resource
201205	092F113			344067 5478213	0.5			Resource
201206	092F113			352433 5479197	4.2			Resource
201236	092F112			333873 5479350	4		CT,RB,ST	Resource
201240	092F113			348652 5478720	2.3	6.1		Resource
201241	092F113			345519 5480688	1.4			Resource
201243	092F113			341015 5479718	1.2			Resource
201249	092F113	Wolf Ck		355434 5474692	0.6		CO,RB	Resource
201271	092F113			353456 5478111	1.1	2.3		Resource
201272	092F113			342540 5479542	0.7			Resource
201275	092F113			343274 5479835	0.9			Resource
201276	092F113			343386 5479931	3.9			Resource
201279	092F113			348931 5480541	7.4	4.4		Resource
201281	092F113			350087 5479715	1	2		Resource
201286	092F113			341362 5479382	1.1			Resource
201287	092F113			341176 5479561	0.7			Resource
201288	092F113			341422 5479307	0.4			Resource
201290	092F113			348388 5483859	0.4			Resource
201294	092F113	Katlum Ck		347354 5484523	1.7			Resource
201301	092F113			349009 5481367	8.2	0.8		Unclassified
201302	092F113			348680 5481198	0.1			Unclassified
201303	092F113			350903 5478513	0.2			Resource
201305	092F113			348491 5476551	1.2	18.3	CT	Resource
201307	092F113			348421 5478330	0.6			Resource
201310	092F113			348172 5478672	1.4			Resource
201311	092F113			348334 5478775	1.2			Resource
201312	092F113			348450 5479245	0.5	1.5		Resource
201314	092F113			348468 5480381	1.7	4.9		Resource
201315	092F113			350046 5476011	0.3			Resource
201316	092F113			350106 5476090	0.7			Resource
201318	092F113			348969 5479948	0			Resource
201319	092F113			348616 5480959	1.2	0.4		Resource
201321	092F113			345201 5480547	0.1			Unclassified
201324	092F113			349401 5478283	8	6.7		Resource

Crossing ID	Map ID	Stream Name	Road Name	UTM (10U)	Habitat Gain (km)	Lake/ Wetland (ha)	Species Upstream	*Road Tenure
201325	092F113			346607 5482135	1.2			Resource
201326	092F113			346116 5481293	0.2			Resource
201327	092F113			351170 5477289	1.6			Resource
201329	092F113			347123 5476532	1.7		BNH,CT,DV,RB,SMB	Resource
201337	092F113			350019 5474961	0.4			Resource
201338	092F113			343987 5477690	0.4			Resource
201340	092F113			351334 5476578	2.4			Resource
201341	092F113			351909 5478419	5.4			Resource
201342	092F113			350893 5480420	0.3			Resource
201344	092F113			352328 5481377	4			Resource
201347	092F113			354336 5477511	1.1			Resource
201348	092F113			352262 5477079	2.9			Resource
201350	092F113			354206 5478013	0.5			Resource
201361	092F112			337027 5476414	0.1			Resource
201365	092F112	Ramsay Ck		337247 5483084	9.1	30.4	CT,RB,ST,TR	Resource
201366	092F112			337481 5483049	0.2			Resource
201370	092F112			329769 5478636	0.4			Resource
201377	092F112			334265 5479727	2.4		CT,RB,ST	Resource
201381	092F112			334091 5479681	0.4			Resource
201389	092F112			334806 5475415	0.2			Resource
201394	092F112			333890 5475585	0.1			Resource
201416	092F108			355247 5473359	5.8			Resource
201421	092F108			352642 5469736	1.3			Resource
201439	092F108			351777 5469257	0.7			Resource
201440	092F108			349990 5473204	1.6			Resource
201442	092F108			347637 5473323	1.1			Resource
201444	092F108			348698 5473184	0.5			Resource
201445	092F108			348107 5473015	0.1			Resource
201446	092F108	Lanterman Ck		354186 5473612	30.3	11.9	CO,CT,RB	Resource
201542	092F112			334774 5481120	0.8			Unclassified
201552	092F112			336841 5477258	0.3			Unclassified
201553	092F112			336809 5477192	0.3			Unclassified
201558	092F112	Ramsay Ck		338185 5483335	11.1	30.5	CT,RB,ST,TR	Unclassified
201559	092F112	Ramsay Ck		337472 5483197	9.4	30.4	CT,RB,ST,TR	Unclassified
201560	092F112	Ramsay Ck		338398 5483302	11.6	30.5	CT,RB,ST,TR	Unclassified
201561	092F112			337683 5483191	0.5			Unclassified
201562	092F112	Ramsay Ck		337914 5483296	10.8	30.5	CT,RB,ST,TR	Unclassified
201563	092F112	Ramsay Ck		338116 5483323	11	30.5	CT,RB,ST,TR	Unclassified
201564	092F112			338364 5483311	0.2			Unclassified
201565	092F112	Ramsay Ck		338292 5483345	11.2	30.5	CT,RB,ST,TR	Unclassified
201566	092F112	Ramsay Ck		338443 5483270	11.6	30.5	CT,RB,ST,TR	Unclassified
201567	092F112	Ramsay Ck		338261 5483344	11.2	30.5	CT,RB,ST,TR	Unclassified
201568	092F112	Ramsay Ck		339014 5483208	13.6	30.5	CT,RB,ST,TR	Unclassified
201569	092F112			338960 5483179	0.4			Unclassified

Crossing ID	Map ID	Stream Name	Road Name	UTM (10U)	Habitat Gain (km)	Lake/ Wetland (ha)	Species Upstream	*Road Tenure
201584	092F112			338968 5483144	0.3			Unclassified
201613	092F112			328038 5480164	0.3			Resource
201614	092F112			328222 5480090	0.2			Resource
201626	092F112			334673 5480451	0.1			Resource
201627	092F112			334895 5480855	0.1			Resource
201628	092F112			334918 5480991	0.2			Resource
201629	092F112			334715 5480544	0.1			Resource
201630	092F112			334433 5479839	0.1			Resource
201631	092F112	Ramsay Ck		335478 5482628	6	17.8	CT,RB,ST,TR	Resource
201633	092F112			335086 5481414	0.1			Resource
201634	092F112			335069 5481524	0.2			Resource
201648	092F112			336843 5477178	0.4			Resource
201649	092F112			337368 5478230	0.8			Resource
201650	092F112			337260 5478141	0.5			Resource
201651	092F112			333631 5477942	0.1			Resource
201654	092F112			333665 5477841	0.1			Resource
201656	092F112			333167 5478993	5.5		CT,RB,ST	Resource
201661	092F112			337943 5478860	0.2			Resource
201663	092F112			339541 5479648	0.2			Resource
202246	092F112			334798 5475672	0.5			Unclassified
202300	092F112			335704 5475808	1.4			Resource
202315	092F112			331710 5474974	5			Unclassified
202430	092F113			346244 5483435	0.7			Unclassified
202434	092F113			343179 5480088	2.8			Unclassified
202435	092F113			343353 5480109	0.6			Unclassified
202437	092F113			348701 5482366	4.5			Resource
202438	092F113	Katlum Ck		347459 5484116	3.5		CT	Resource
202439	092F113			346479 5483417	0.4			Unclassified
202440	092F113			347147 5484142	7		CT,TR	Unclassified
202441	092F113			346005 5484015	0.1			Unclassified
202442	092F113			348705 5483097	1.1			Resource
202443	092F113			348628 5483186	0.9			Resource
202444	092F113			350100 5481830	1.4			Resource
202445	092F113			350364 5481236	1.4	3.1		Resource
202446	092F113			349960 5481210	1.9	3.1		Resource
202447	092F113			349899 5481272	2.1			Resource
202448	092F113			349408 5481734	0.4	1		Resource
202451	092F113			352467 5482246	2.8			Resource
202453	092F113			353229 5479752	0.3			Resource
202454	092F113			353326 5479475	1			Resource
202455	092F113			353179 5479840	0.3			Resource
202456	092F113			352935 5480308	0.2			Resource
202457	092F113			351488 5478880	0.7			Resource
202458	092F113			347944 5480175	0.2			Resource

Crossing ID	Map ID	Stream Name	Road Name	UTM (10U)	Habitat Gain (km)	Lake/ Wetland (ha)	Species Upstream	*Road Tenure
202475	092F112			338667 5483540	0			Resource
202478	092F113			341301 5482482	0.2			Resource
202479	092F113			343157 5482529	0.1			Resource
202480	092F113			344953 5482710	3.2		RB,ST	Resource
202486	092F113			342772 5482516	0.2			Resource
202487	092F113			342194 5482657	0.1			Resource
202493	092F113			343258 5480281	0.4			Resource
202494	092F113			342559 5481335	0.3			Resource
202495	092F113			342749 5481443	0.1			Resource
202501	092F113			341488 5482224	0			Resource
203096	092F113			356822 5474843	1.4			Unclassified
203097	092F113			356825 5474803	1.5			Unclassified
203098	092F113			356881 5474801	0.4			Unclassified
203100	092F113			348900 5475997	2	18.3	CT	Unclassified
203101	092F113			356171 5474316	10.6		CT,RB	Unclassified
203108	092F108			354928 5471390	0.5			Unclassified
203109	092F108			354193 5470588	0.4			Unclassified
203121	092F113			356643 5474556	2.3			Resource
203130	092F113			355930 5475160	2.1		RB	Unclassified
203131	092F113			354267 5475500	3.3			Resource
203132	092F113			353656 5475479	4.2	2.3		Resource
203133	092F113			353992 5476854	1.8			Resource
203134	092F113			353585 5477027	2.5	2.3		Resource
203145	092F108	Wolf Ck		356349 5473210	17.2		CO,CT,L,RB	Resource
203146	092F113			356147 5474214	10.8		CT,RB	Resource
203147	092F113			354700 5473979	5			Resource
203148	092F113			353954 5474592	5.2	2.3		Resource
203149	092F113			356035 5474635	10.3		CT,RB	Resource
203150	092F113			349198 5475735	2.4	19.1	CT	Resource
203151	092F108			347825 5473306	1.3			Resource
203154	092F108			353871 5473443	5.4	4	CO	Resource
203155	092F108			352884 5473830	1.2	4		Unclassified
203156	092F108			351750 5472354	0.4			Resource
203157	092F108			353952 5473388	6.1	4	CO	Resource
203158	092F108			354106 5471067	14.1	78.8	CO,CT,PMB,RB,SB	Resource
203159	092F108	Wolf Ck		355793 5472294	25.5		CO,CT,L,RB	Resource
203160	092F108			349884 5472449	0.3			Resource
203161	092F108			349621 5472987	0.9			Resource
203164	092F108			351633 5471137	0.6			Resource
203167	092F108			352099 5469579	1.2			Resource
203168	092F108			355474 5470411	1.7			Resource
203169	092F108			354303 5470932	1.3	4.3		Resource
203175	092F108			355278 5471161	1			Unclassified
203176	092F108			352819 5469590	1			Resource

Crossing ID	Map ID	Stream Name	Road Name	UTM (10U)	Habitat Gain (km)	Lake/ Wetland (ha)	Species Upstream	*Road Tenure
203187	092F108			351892 5472255	0.6			Unclassified
204367	092F112		GH220-1	333514 5474590	0.2			WFP
204444	092F113		WOLFA	356082 5474008	11		CT,RB	WFP
204445	092F113		WOLFA	356117 5474153	10.8		CT,RB	WFP
204702	092F112		GH300	334648 5475587	0.7			WFP
205212	092F108		WOLFMAIN	356210 5473553	3.5		CO,RB	WFP
205213	092F108		WOLFMAIN	356242 5473686	3.3		CO,RB	WFP
205214	092F112		GL340	331857 5475438	0.1			WFP
205290	092F112		GL200	334668 5475667	0.8			WFP
205291	092F112		GL200	334940 5475634	0.9			WFP
205293	092F112		GL200	334829 5475644	0.5			WFP
205424	092F107		ME721A1	330181 5474121	0.2			WFP
205425	092F107		ME721A1	330236 5474337	0.1			WFP
205448	092F112		GH301	334593 5475387	0.5			WFP
205864	092F112		GL230	333777 5475292	0.5			WFP
205865	092F112		GL230	332953 5475344	0.2			WFP

*WFP = Western Forest Products Ltd.

Appendix 2

Key to Attachment 2 - Digital Summary of Modelled Crossing Characteristics on Known and Potential Fish Habitat

Table heading	**Column Name (BC data distribution)**	**Details/attribute**	**Source/URL**
crossing_id		Unique crossing ID	Fish Habitat Model
map_tile	map_tile	1:50,00 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 before 3.5% gradient is exceeded 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 before 5.5% gradient is exceeded for more than 100 m.	Fish Habitat Model
habitat_gain_threshold_sub13		Linear length (m) of inferred or observed fish habitat upstream of the crossing before 13.5% gradient is exceeded for more than 100 m.	Fish Habitat Model
habitat_gain_threshold_sub20		Linear length(m) of inferred or observed fish habitat upstream of the crossing before 20.5% gradient is exceeded for more than 100 m.	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
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
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
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
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

Table heading	**Column Name (BC data distribution)**	**Details/attribute**	**Source/URL**
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 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 crossings located downstream of the subject modelled crossing.	Fish Habitat Model