Fish Passage GIS Analysis

Version 2

Methodology and Output Data Specifications

BC Ministry of Environment

Prepared by

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REVISION HISTORY

Date	Version	Author	Description of Changes
Oct 26, 2012	0.1	Simon Norris	Initial draft for Version 2. Much of text taken from Version 1 documentation.
Nov 6, 2012	0.2	Simon Norris/Craig Mount	Incorporate Craig's edits
Aug 11, 2015	0.3	Simon Norris	Modify text to reflect updates to Version 2.
Oct 1, 2015	0.4	Craig Mount	Further documentation of Version 2
Oct 30, 2015	0.5	Simon Norris	More changes

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1 OVERVIEW

In 2007, the Province of British Columbia, the Government of Canada and several provincial forest industry associations identified the need to address the issue of road stream crossings restricting fish passage and access to valuable freshwater fish habitat throughout BC. The multi-disciplinary and multi-agency Fish Passage Technical Working Group (FPTWG) has been working to mitigate these problems since that time.

One of the first challenges for the FPTWG was to quantify the size of the fish passage problem in BC. To define the magnitude of the problem and help guide prioritization of Fish Passage field activities, Version 1 of the Fish Passage GIS Analysis was completed in 2008. Using the Corporate Watershed Base (CWB) and other sources, a model was created to generate two primary outputs: 1) the extent of potential fish habitat on all BC streams, and 2) the location of road crossings likely to be culverts on these streams. Culverts are closed bottom structures and are the type of structure most likely to represent a barrier to fish passage. The modelled culverts were then classified as being on potentially fish bearing or non-fish bearing streams and indexed in order of priority for Fish Passage assessment and/or repair based on their position on the stream network. For a detailed description of the original analysis, see *GIS Modelling of Fish Habitat and Road Crossings for the Prioritization of Culvert Assessment and Remediation (https://www.for.gov.bc.ca/hfp/fish/Habitat%20Modelling.pdf)*.

While Version 1 of the model has proved valuable, several limitations have been identified:

- The CWB streams used as input have been superseded by the Freshwater Atlas (FWA) stream network. The FWA product is very similar to the CWB, but includes significant bug fixes and changes to the data model. The FWA is now BC's standard corporate stream database.
- Stream gradient input for Version 1 of the habitat model was based on deriving 'stream gradient reaches', continuous segments of stream with similar gradient derived from stream intersections with contour lines. As breaks in the gradient reaches were only created at points along the stream with a significant change in gradient, streams with gradual changes in gradient tended to overestimate potential fish habitat (i.e. gradient was calculated over a longer length of stream).
- Intermittent streams (defined channels that are usually dry depending on season) were not identified as barriers to fish passage. This likely led to an overestimation of inferred habitat.
- Software used to generate Version 1 was spread over several legacy systems, making changes to the model difficult and time consuming.

For Version 2, several changes have been adopted to address the above limitations:

- The current corporate standard FWA Stream Network is used as input.
- Stream gradient reaches are no longer created and contour lines are not used as an elevation source. Instead, stream gradient is based on the elevation (z values) held in the 3D FWA stream linework itself. Gradient is calculated as a running minimum

length interval along the entire stream. Rather than identify segments of stream with similar gradient, the calculations simply identify segments of >100m linear stream that are steeper than the set of user provided gradient thresholds (generally 10, 15, 20, 25, and 30%)

- Intermittent streams greater than 10% gradient are now considered barriers to fish passage. Intermittent streams of less than 10% gradient may still be classified as inferred fish habitat.
- Legacy systems have been removed and model scripts have been consolidated to a relatively small set of shell, Python and SQL functions operating on a single PostgreSQL database. Model parameters such as grade thresholds can now be easily modified and processing time has been greatly reduced. Scripts included in the model permit new users to replicate the model and modify to meet their requirements.

2 METHODOLOGY

2.1 MODEL POTENTIAL FISH HABITAT DISTRIBUTION

The logic behind the fish habitat model remains unchanged. In simple terms, all streams downstream of known fish observation sites are considered viable fish habitat. Moving upstream from known fish observation sites, a stream is inferred to be potentially fish bearing until a barrier to fish passage is encountered. Barriers to fish passage include sustained (>100 linear meters) channel gradients of a user specified percentage (any grade can be specified but the model default is a choice of any 5% increment between 10% and 30%. The gradient cut-off in Version 1 was simply 25%), waterfalls, dams, and other similar features. Although this model is simple and has not been field verified as a predictor of fish habitat, it can consistently be applied to all BC streams using standard datasets. As such, it is a comprehensive and valuable planning tool for prioritization of culvert assessments throughout the province, especially when combined with other information.

2.1.1 Extract input data

Prior to processing the model, input data are extracted from the BC Geographic Data Warehouse (BCGW) to a local database. Input data are:

2.1.1.1 Freshwater Atlas Stream Network

Name	WHSE_BASEMAPPING.FWA_STREAM_NETWORKS_SP
Description	1:20,000 stream flow network arcs (observed, inferred and constructed)
Metadata	http://catalogue.data.gov.bc.ca/dataset/freshwater-atlas-stream-network
Subset extracted	All features are included that are: • not isolated from the network (`fwa_watershed_code NOT LIKE '999-999%'`) • not indeterminately located side channels (`local_watershed_code IS NOT NULL`)

2.1.1.2 Known Fish Observations

Name	WHSE_FISH.FISS_FISH_OBSRVTN_PNT_SP
Description	Point locations of known and recorded fish observations
Metadata	http://catalogue.data.gov.bc.ca/dataset/known-bc-fish-observations-and-bc-fish-distributions
Subset extracted	All observations are extracted, but see Section 2.1.2 below for details on which points are retained.

2.1.1.3 Freshwater Atlas Obstructions

Name	WHSE_BASEMAPPING.FWA_OBSTRUCTIONS_SP
Description	Point locations of water obstacles (rapids, falls, etc.)
Metadata	http://catalogue.data.gov.bc.ca/dataset/freshwater-atlas-obstructions
Subset extracted	All features are included where obstruction_type is Dam or Falls

2.1.1.4 Provincial Obstacles to Fish Passage

Name	WHSE_FISH.FISS_OBSTACLES_PNT_SP
Description	Point locations of all known obstacles to fish passage from several fisheries datasets
Metadata	http://catalogue.data.gov.bc.ca/dataset/provincial-obstacles-to-fish-passage

Subset extracted	All features are included where:
	• obstacle_name is one of:
	  ○ Dam
	  ○ Hydro dam
	  ○ Regional District Dam
	  ○ Irrigation District Dam
	  ○ Fisheries Management Dam
	  ○ Water Management Storage Dam
	  ○ Weir
	  ○ Falls (AND height > 5m)
	• feature is within 50m of a stream network line or is associated with a waterbody

2.1.2 Locate observations on streams

For Version 1 of the model, an observation was included if:

- when not within a waterbody, within 50m of the stream network
- when within a waterbody (identified by spatial overlay), within 1000m of the stream network

Reviews of Version 1 revealed that observations were under-utilized. As observation locations are frequently based on 1:50,000 map features, they are often not precise enough to be retained by a 50m threshold or a spatial overlay with 1:20,000 FWA waterbodies. Therefore, to be included in Version 2 of the model, observations must be either:

- within 125m of the stream network
- within a lake or reservoir (as identified by presence of a valid waterbody_key in the observation attribute table) and within 10km of the stream network within the matching lake/reservoir. The seemingly large 10km threshold is used based on the assumption that an observation with a waterbody_key value *must* occur within

the matching waterbody regardless of the observation point's location imprecision (or error).

All observations meeting these criteria are retained as input for the model and the linear position on the stream network of each point is noted and indexed for upstream/downstream analysis.

2.1.3 Create barriers

2.1.3.1 Stream gradient barriers

Potential stream gradient barriers to fish passage are defined as segments of stream of at least 100 linear meters having a percent gradient within (user adjustable) classes of 10, 15, 20, 25, and 30 or greater. As potential barriers for each of these gradient classes are recorded, users of the fish passage model are then free to choose which gradient class(es) constitute a barrier for their area or species of interest. 25% was used as the maximum gradient for fish passage in Version 1 of the model and is still the gradient barrier threshold most often used.

Note that this method differs considerably from how stream gradient was calculated in Version 1 of the fish habitat model. For Version 1, gradient was calculated by segmenting a stream by contour lines then analyzing the lengths of the resulting segments to create 'gradient reaches' of similar gradient. As the source stream data (CWB) for Version 1 did not contain elevations, this was an expedient method to break up the streams and identify areas of steep slope. However, streams were only broken at points where slope changed significantly (where the difference in the lengths of two adjacent contour broken stream segments is greater than the standard deviation of the lengths of all the segments making up a given stream). A side effect of this stream segment creation logic was that streams in terrain with gradually changing slope were broken into relatively fewer segments. This averaged out slope over greater distances and tended to mask higher slope values and thus overestimated potential fish habitat.

For Version 2, the input FWA stream network lines hold standardized Z values; every vertex of a stream holds an associated elevation value (taken from the Provincial Digital Elevation Model (DEM) but also post-processed to ensure all streams flow downhill). Having this, it is possible to easily analyze the gradient of a stream at any point. To identify potential gradient barriers on a given stream, Version 2 starts at the mouth of the 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. Any section of stream with gradient falling within the noted gradient classes is identified as a potential gradient barrier.

<diagram>

2.1.3.2 Intermittent Flow and Ditches

The FWA Stream Network includes lines defining seasonal/intermittent flows (feature_code 'GA24850150', *a definite watercourse that is usually dry, depending upon the season and precipitation)* and ditch flows (feature_code 'GA08800110', *man-made trench in the earth used for drainage or irrigation)*.

These streams were not were not considered barriers to fish passage in Version 1 of the model but subsequent feedback and ground truthing indicated that this resulted in an overestimation of fish habitat in many areas. However, as close to 10% of observation records in WHSE_FISH.FISS_FISH_OBSRVTN_PNT_SP occur on intermittent streams, excluding all intermittent streams from inferred fish habitat would be an oversimplification of the issue. As over 85% of the observations on intermittent streams are downstream of stream segments of 10% grade or greater (for at least 100m), it is clear that fish only utilize the lowest gradient intermittent streams.

<graph>

Based on this analysis, for Version 2 the starting point of any intermittent stream segment upstream of a gradient barrier of 10% or more is identified as a barrier.

2.1.3.3 Network Connectors and Subsurface Flow

The FWA Stream Network includes inferred flow network connectors (*construction lines used to connect features that would normally be disconnected (e.g. sinkholes, isolated lakes, glaciers)* and subsurface flow connectors (*construction lines used to indicate a subsurface flow such as groundwater flow or storm sewer*). These stream flow lines are not actually streams and are thus not considered as potential fish habitat. The lowest point of each line is identified (edge_type IN (1410, 1425)) and identified as a barrier.

2.1.3.4 FWA Obstructions and FISS Obstacles

The FWA and FISS databases include features classified barriers on streams. As noted in Section 2.1.1, dams and falls (>5m in height) are identified as barriers and extracted from the source tables.

With all above barriers identified and recorded, the linear position on the stream network of each barrier (at its lowest point in the case of linear barriers) is noted and indexed for upstream/downstream analysis.

2.1.4 Assign potential fish habitat values

With all observations and barriers positioned on the stream network, the logic of the fish habitat model is applied to all streams. Steps are as follows:

1. Initiate the process with all input streams set to default “NON FISH HABITAT”

2. For all stream with an observation upstream, note that the stream is observed fish habitat, but also note if the segment is above a gradient barrier and if so, what class it is.
    a. Set all stream below any gradient barrier to 'FISH HABITAT - OBSERVED - 0-10PCT' (presuming 10% is the minimum gradient class used as a barrier input)
    b. Working upwards through each of the gradient classes, set all stream above a given (n) barrier class to 'FISH HABITAT - OBSERVED - <n>-<n+1>PCT' (i.e., for streams above a 20% gradient barrier, 'FISH HABITAT - OBSERVED - 20-25PCT'
3. For all stream with no observation upstream and no (non-gradient) barrier downstream, note that the stream is inferred fish habitat, but also note if the segment is above a gradient barrier and if so, what class it is.
    a. Set all stream above any observation and with no barriers downstream to 'FISH HABITAT - INFERRED - 0-10PCT' (again, presuming 10% is the minimum gradient class)
    b. For all streams with no barriers downstream, work upwards through each of the gradient classes except the final upper limit (which is already 'NON FISH HABITAT', and set all stream above a given (n) barrier class to 'FISH HABITAT - INFERRED - <n>-<n+1>PCT' (i.e., for streams above a 20% gradient barrier, 'FISH HABITAT - INFERRED - 20-25PCT'

2.2 MODEL PROBABLE CULVERT LOCATIONS

Using several road and railway databases, crossing points for all non-isolated, non-side channel streams are created. The crossings are then classified as either culverts or bridges. Crossings are classed as a bridge if the stream on which it occurs is a polygon / double line, or if TRIM data indicates that the crossing is a bridge. All other crossings are classified as culverts.

2.2.1 Extract input data

Any existing BCGW road (or railway) dataset may be added to the model to create crossings. Currently used road datasets are:

2.2.1.1 Digital Road Atlas

Name	WHSE_BASEMAPPING.DRA_DGTL_ROAD_ATLAS_MPAR_SP
Description	Digital Road Atlas Master Partially-Attributed Roads provides partial information about roads in British Columbia. For more information on the DRA program please visit http://geobc.gov.bc.ca/dra.html
Metadata	http://catalogue.data.gov.bc.ca/dataset/digital-road-atlas-dra-master-partially-attributed-roads
Subset extracted	All features are included

2.2.1.2 TRIM Transportation Lines

Name	WHSE_BASEMAPPING.TRIM_TRANSPORTATION_LINES
Description	Transportation features such as airfields, ferry route, roads, retaining walls, bridges, rail lines, tunnels, pipelines, transmission lines, etc. (see http://srmwww.gov.bc.ca/gis/trimfeatures.htm for full list)
Metadata	http://catalogue.data.gov.bc.ca/dataset/trim-transportation-lines

Subset extracted	Roads, Rail lines, bridges and tunnels:
	`fcode LIKE 'DA%' OR`
	`fcode LIKE 'DD93%' OR`
	`fcode LIKE 'DE%' OR`
	`fcode = 'DF28850000'`

2.2.1.3 Forest Tenure Road Segment Lines

Name	WHSE_FOREST_TENURE.FTEN_ROAD_SEGMENT_LINES_SVW
Description	Forest road tenures (Road Permits and Forest Service Roads)
Metadata	http://catalogue.data.gov.bc.ca/dataset/forest-tenure-road-segment-lines
Subset extracted	Active tenures only. `life_cycle_status_code NOT IN ('RETIRED', 'PENDING')`

2.2.1.4 OGC Petroleum Access Roads

Name	WHSE_MINERAL_TENURE.OG_PETRLM_ACCESS_ROADS_PUB_SP
Description	Petroleum Access Road applied to proposed construction of a road over any Crown Land without disposition preventing road construction, and when Petroleum Development Road designation was not necessary.
Metadata	http://catalogue.data.gov.bc.ca/dataset/ogc-petroleum-access-roads-public-version

Subset extracted	Active, non-winter road tenures:
	`petrlm_access_road_type != 'WINTER' AND`
	`deactivation_date IS NULL AND`
	`application_status NOT IN ('CANCELLED', 'WITHDRAWN')`

2.2.1.5 OGC Petroleum Development Roads

Name	WHSE_MINERAL_TENURE.OG_PETRLM_DEV_ROADS_PUB_SP
Description	Petroleum Development Road applied to proposed construction or to existing non status tenured roads over any Crown Land without disposition preventing road construction, and/or use of non-status, unencumbered existing access roads on Crown Land
Metadata	http://catalogue.data.gov.bc.ca/dataset/ogc-petroleum-development-roads-public-version
Subset extracted	Active, non-winter road tenures: `petrlm_development_road_type != 'WINTER' AND`

	`deactivation_date IS NULL AND application_status NOT IN ('CANCELLED', 'WITHDRAWN')`

2.2.1.6 OGC Petroleum Development Roads – Pre 2006

Name	WHSE_MINERAL_TENURE.OG_PETRLM_DEV_RDS_PRE06_PUB_SP
Description	Petroleum Access Roads prior to October 30, 2006
Metadata	http://catalogue.data.gov.bc.ca/dataset/ogc-petroleum-development-roads-pre-2006-public-version
Subset extracted	Non-winter road tenures: `petrlm_development_road_type != 'WINT'`

2.2.1.7 National Railway Network, Railway Track Line

Name	WHSE_BASEMAPPING.**GBA_RAILWAY_TRACKS_SP**
Description	Railway tracks within BC from GeoBase's National Railway Network (NRWN) dataset
Metadata	http://catalogue.data.gov.bc.ca/dataset/railway-track-line
Subset extracted	All features are included

2.2.2 Create unique crossings

A crossing point is created at the intersection of each of the above noted road/railway layers and the stream flow network (minus isolated lines and side channels). As the same road/railway may exist in multiple data sources at the same or different location (and also may be present more than once in a single data source), many duplicate crossings exist. To ensure crossings are unique:

- For crossings from a single road source, remove points less than 10m from another point (simply retaining the record with the lower ID)
- For crossings present in more than one road data source, remove crossings from lower priority sources that are within 20m of a crossing in a higher priority source. Generally speaking, the DRA is considered the definitive source for public roads, while FTEN is the definitive source for forestry roads (as FTEN attributes are most valuable for retention, not because their geometry is thought to be best). For full documentation of duplicate removal priority between various road sources, see **appendix/model code.**

2.2.3 Identify likely culverts

Prepared road-stream crossings are written to two output layers, culverts and other. The 'Other' collection consists of all points that are likely bridges or some other open bottom structure, defined as:

- points generated from roads that are identified in TRIM as bridges (`fcode LIKE 'DD%'`)
- points falling on double line streams (double line streams are at least 20m in width according to TRIM specifications) (`edge_type NOT IN (1000, 1050, 1100, 1150, 2000, 2300)`)

All other points are deemed likely to be culverts.

2.2.4 Add fish passage data

Once all potential culvert points are loaded and prepped within the culvert layer, their linear position on the stream flow network is determined and various fish habitat / fish passage attributes are added to the output layer, including, for a given crossing

- whether the crossing is on KNOWN, INFERRED or NON fish habitat
- how much potential fish habitat is upstream
- how many crossings are upstream
- how many crossings are downstream
- etc.

For a full list of attributes included in the output culvert table, see **Data Dictionary**

3 LIMITATIONS

Users of this dataset must recognize that the products documented here (Modelled Road-Stream Crossings Points and Modelled Fish Habitat Lines) are outputs of a non-ground truthed model, and that the model is subject to significant assumptions and uncertainties. In other words, the data show only the best possible guess of fish habitat potential on any given stream segment, within the limitations of the input data. The quality and accuracy of the outputs depend entirely upon the quality of the best-available, province-wide base data which have gone into the modelling exercise. This data is designed to quantify the potential scale of the fish passage problem in BC and to guide further fish passage assessment and remediation work. It is neither applicable nor intended for use in other applications.

3.1 KNOWN SOURCES OF ERROR AND UNCERTAINTY

3.1.1 Roads

FTEN Roads are roads for which tenure has been granted. While the majority of roads in this data source have been built, many have not. Unfortunately, there is no simple way to ascertain if a given FTEN road had been built. Therefore, modelled crossings can be generated for roads that do not exist and may never be built. This issue is present not only in areas where no road has been built at all, but also in areas where more than one tenure has been issued for a single road (but in locations more than 10m apart).

Furthermore, as comprehensive road status (deactivation, etc.) is not available for most road sources, some roads used in the model will be deactivated or overgrown.

3.1.2 Stream Network

The FWA stream network is derived from TRIM I stream linework (TRIM II streams are not included). TRIM features are delineated through airphoto interpretation and have varying degrees of accuracy – particularly when it comes to smaller streams. TRIM commonly under-represents the number of streams in the wetter, coastal areas of the province and field surveyors may regularly find small streams which do not exist in the model. Conversely, in the drier, interior portions of the province, TRIM may over-represent the number or magnitude of streams. These may be ephemeral or intermittent streams which only have water in them at the wettest times of the year. Field crews often report finding only a 'dry draw' at locations where a stream has been shown on the mapping.

3.1.3 Culverts vs Bridges

As noted in section 2.23, stream crossings are noted as bridges where indicated as such by TRIM and where the crossing is on a double line/polygon stream feature. This is most likely an under-representation of bridges, TRIM is not comprehensive for all road sources and could easily miss some bridge features. However, there are also known instances where a culvert assessment has been conducted on a closed bottom structure at a crossing where TRIM indicates a bridge. The culvert / bridge classification should be used with caution.

4 OUTPUT LAYER DATA SPECIFICATIONS

4.1 MODELLED CULVERTS

LAYER NAME: ModelledCulverts
LAYER DESCRIPTION: Probable point locations of culverts, derived form intersection of FWA streams and several road data sources.
FIELDS: See data_dictionary.csv for full descriptions of all fields

4.2 MODELLED FISH HABITAT LINES

LAYER NAME: ModelledFishHabitat
LAYER DESCRIPTION: Portions of FWA stream flow routes modelled with regard to fish habitat potential.
FIELDS: See data_dictionary.csv for full descriptions of all fields

5 DATA ACCESS

Data Steward: Craig Mount

Download Location: http://www.hillcrestgeo.ca/fishpassage

Format: ESRI File Geodatabase (available in other formats on request)

6 APPENDIX A – DATA DICTIONARY

layer	column_name	short_name	source	data_type	comments
ModelledFishHabitat	FISH_HABITAT_ID	FISHHAB_ID	model	Integer	A unique numeric identifier for the modeled fish habitat stream segment / edge.
ModelledFishHabitat	BLUE_LINE_KEY	BLLNK	FWA	integer	Uniquely identifies a single flow line such that a main channel and a secondary channel with the same watershed code would have different blue line keys (the Fraser River and all side channels have different blue line keys).
ModelledFishHabitat	WATERSHED_KEY	WTRSHDK	FWA	integer	A key that identifies a stream system (for example the Fraser River mainstem and all its side channels the same watershed key). There is a 1:1 match between a watershed key and watershed code. The watershed key will match the blue line key for the mainstem.
ModelledFishHabitat	FWA_WATERSHED_CODE	FWWTRSHDCD	FWA	Text	A 143 character code derived using a hierarchy coding scheme. Approximately identifies where a particular stream is located within the province.
ModelledFishHabitat	DOWNSTREAM_ROUTE_MEASURE	DWNSTRMRTM	model	Float	The distance, in meters, along the route from the mouth of the route to the feature. This distance is measured from the mouth of the containing route to the downstream end of the feature.
ModelledFishHabitat	LENGTH_METRE	LNGTHMTR	model	Float	The length in meters of the linear object.
ModelledFishHabitat	WATERSHED_GROUP_CODE	WTRSHDGRPC	FWA	Text	The watershed group code associated with the polygon.
ModelledFishHabitat	GNIS_NAME	GNIS_NAME	FWA	Text	The BCGNIS (BC Geographical Names Information System) name associated with the GNIS feature id (an English name was used where available, otherwise another language was selected).
ModelledFishHabitat	WATERBODY_KEY	WTRBDK	FWA	Integer	The waterbody key of the waterbody the stream segment / edge is contained within.
ModelledFishHabitat	FWA_FCODE_LABEL	FTRCDLABEL	FWA	Text	Label (description) associated with the feature code of the stream segment / edge.
ModelledFishHabitat	OBSERVATION_ID	OBSRVTN_ID	FISS	Integer	Unique ID of the most upstream Fish Observation, if one exists
ModelledFishHabitat	GRADIENT_BARRIER_10_ID	GRDBR10_ID	model	Integer	Unique ID of the most downstream barrier created by a 10% gradient more than 100m long, if one exists
ModelledFishHabitat	GRADIENT_BARRIER_15_ID	GRDBR15_ID	model	Integer	Unique ID of the most downstream barrier created by a 15% gradient

					more than 100m long, if one exists
ModelledFishHabitat	GRADIENT_BARRIER_20_ID	GRDBR20_ID	model	Integer	Unique ID of the most downstream barrier created by a 20% gradient more than 100m long, if one exists
ModelledFishHabitat	GRADIENT_BARRIER_25_ID	GRDBR25_ID	model	Integer	Unique ID of the most downstream barrier created by a 25% gradient more than 100m long, if one exists
ModelledFishHabitat	GRADIENT_BARRIER_30_ID	GRDBR30_ID	model	Integer	Unique ID of the most downstream barrier created by a 30% gradient more than 100m long, if one exists
ModelledFishHabitat	INTERMITTENT_ID	INTRMT_ID	model	Integer	Unique ID of the most downstream barrier created by an Intermittent Flow, if one exists
ModelledFishHabitat	FISH_OBSTACLE_POINT_ID	OBSTCL_ID	FISS	Integer	Unique ID of the most downstream barrier created by a FISS Obstacle, if one exists
ModelledFishHabitat	OBSTRUCTION_ID	OBSTR_ID	FWA	Integer	Unique ID of the most downstream barrier created by a FWA Obstruction, if one exists
ModelledFishHabitat	SUBSURFACE_FLOW_ID	SUBSUR_ID	model	Integer	Unique ID of the most downstream barrier created by a Subsurface Flow, if one exists
ModelledFishHabitat	FISH_HABITAT	FSHHABITAT	model	Text	Modelled potential fish habitat value for the stream segment / edge. Modelled potential fish habitat values include 'OBSERVED' (there is a recorded fish observation upstream) or 'INFERRED' (while no recorded observation upstream exists, there is no known barrier to fish passage present) and 'NON FISH HABITAT' (no recorded observation uptream, and a barrier to fish passage is present downstream (as identified by the barrier IDs noted above)). Modelled potential fish habitat is further broken down by presence of downstream stream gradient barriers (greater than 100m) for user customization. For example, a user interested in a species that cannot pass stream gradients of greater than 15% would extract fish habitat for the given species by using a query that includes all oberved habitat and all inferred habitat below 15% ie: "WHERE fish_habitat LIKE 'FISH HABITAT - OBSERVED%' OR fish_habitat IN ('FISH HABITAT - INFERRED - 0-10PCT', 'FISH HABITAT - INFERRED - 10-15PCT')"
ModelledCulverts	CROSSING_ID	CROSS_ID	model	Integer	A unique numeric identifier for the modeled fish habitat stream segment / edge.
ModelledCulverts	DIGITAL_ROAD_ATLAS_LINE_ID	DRA_LINEI	DRA	Integer	DIGITAL ROAD ATLAS LINE ID is a unique numeric road segment identifier e.g. 453567.
ModelledCulverts	HIGHWAY_ROUTE_NUMBER	HWYRTENUM	DRA	Text	HIGHWAY ROUTE NUMBER is the Highways and Arterials numbers,

					delimited by a plus sign, e.g. 1+5+97.
ModelledCulverts	ROAD_CLASS	ROAD_CLASS	DRA	Text	ROAD CLASS is the navigational road classification, e.g alleyway, arterial, collector, etc.
ModelledCulverts	ROAD_NAME_FULL	RDNAME	DRA	Text	ROAD NAME FULL is the complete name for the road made up of the concatenation of the individual road name components, e.g. Elk Valley Hwy.
ModelledCulverts	ROAD_SURFACE	RDSURFACE	DRA	Text	ROAD SURFACE is the road surface type, e.g boat, decommissioned, loose, overgrown, paved, rough, unknown.
ModelledCulverts	TRIM_TRANSPORTATION_LINES_ID	TRIM_ID	TRIM	Text	TRIM_TRANSPORTATION_LINES_ID is a system generated unique numeric identifier for TRIM transportation features. This ID does not exist in the source BCGW layer, it is generated on export for model processing
ModelledCulverts	FTEN_ROAD_SEGMENT_LINE_ID	FTEN_ID	FTEN	Text	FTEN_ID is a system generated unique numeric identifier for FTEN road segment lines. This unique ID was taken from the internal ID of the source layer and may not link back to the BCGW layer.
ModelledCulverts	FOREST_FILE_ID	FFID	FTEN	Text	File identification assigned to Provincial Forest Use files. Assigned file number. Usually the Licence, Tenure or Private Mark number.
ModelledCulverts	ROAD_SECTION_ID	RD_SECT_ID	FTEN	Text	Identifies one section of a road within a road permit.
ModelledCulverts	ROAD_RESPONSIBILITY_TYPE_CODE	RD_RESP_CD	FTEN	Text	Identifies the owner of a Forest Service Road. Valid values include "BCTS", and "Forest Services".
ModelledCulverts	RETIREMENT_DATE	RETIRE_DT	FTEN	date	Date the Road Section feature was retired.
ModelledCulverts	FILE_STATUS_CODE	FILE_ST_CD	FTEN	Text	The current status of the forest land use, eg., Pending - Planned, Harvesting - Suspended, Active. This is a subset of Timber_Status_Code.
ModelledCulverts	FILE_TYPE_CODE	FILE_TP_CD	FTEN	Text	The code to indicate the type of file, and often synonymous with a tenure or a project.
ModelledCulverts	FILE_TYPE_DESCRIPTION	FIL_TP_DSC	FTEN	Text	Description of the file type.
ModelledCulverts	CLIENT_NUMBER	CLIENT_NUM	FTEN	Text	Sequentially assigned number to identify a ministry client.
ModelledCulverts	CLIENT_NAME	CLIENT_NM	FTEN	Text	The name of the Ministry Client - Company or Individual. Entered as: the full corporate name if a Corporation; the full registered name if a Partnership; the legal name if an Individual.
ModelledCulverts	LIFE_CYCLE_STATUS_CODE	LIFE_ST_CD	FTEN	Text	The life cycle state of the item. One of Pending, Active or Retired.
ModelledCulverts	MAP_LABEL	MAP_LABEL	FTEN	Text	The default label to be used when displaying the feature on a map. Consists of the FOREST_FILE_ID

					,ROAD_SECTION_ID, and START_STATION.
ModelledCulverts	OG_PETRLM_ACCESS_ROAD_PUB_ID	GPTRLMCCSS	OG ACCESS ROADS	Integer	OG PETRLM ACCESS ROAD PUB ID is a system generated identifier to ensure row uniqueness.
ModelledCulverts	OG_PETRLM_DEV_ROAD_PUB_ID	GPTRLMDVRD	OG DEV ROADS	Integer	OG PETRLM DEV ROAD PUB ID is a system generated identifier to ensure row uniqueness.
ModelledCulverts	OG_PETRLM_DEV_RD_PRE06_PUB_ID	DVRDPRE06	OG DEV ROADS PRE06	Integer	OG PETRLM DEV RD PRE06 PUB ID is a system generated identifier to ensure row uniqueness.
ModelledCulverts	TRACK_SEGMENT_ID	TRACKSEGID	NRN	Text	TRACK SEGMENT ID: Identifier assigned to the portion of a Track Segment with uniform characteristics. This is a UUID (Universal Unique Identifier) represented by a 32-character hexadecimal string. e.g., b5654a8c9dd64509b7c33dec919d6614
ModelledCulverts	TRACK_NAME	TRACKNAME	NRN	Text	TRACK NAME: Name associated to the Track by a national or sub national agency. e.g., Seymour Industrial
ModelledCulverts	TRACK_CLASSIFICATION	TRACKCLASS	NRN	Text	TRACK CLASSIFICATION: Functional classification based on the importance of the role that the Track performs in the connectivity of the rail network. e.g., Main
ModelledCulverts	USE_TYPE	USETYPE	NRN	Text	USE TYPE: Identification of what is transported on the Track. e.g., Freight
ModelledCulverts	GAUGE	GAUGE	NRN	Text	GAUGE: Nominal distance between the two outer rails (gauge) of a railway track. e.g., Standard
ModelledCulverts	STATUS	STATUS	NRN	Text	STATUS: Status of the Track feature. e.g., Operational
ModelledCulverts	OPERATOR_ENGLISH_NAME	OPERATOENA	NRN	Text	OPERATOR ENGLISH NAME: Information relative to the rail company that operates the track. e.g., Canadian Pacific
ModelledCulverts	OWNER_NAME	OWNERENA	NRN	Text	OWNER NAME: Name of the company that owns the track system. e.g., Canadian National
ModelledCulverts	FCODE	FCODE	TRIM	Text	From TRIM transportation line, FCODE contains a value based on the Canadian Council of Surveys and Mapping's (CCSM) system for classification of geographic features.
ModelledCulverts	FCODE_LABEL	FCODELABEL	TRIM	Text	Plain English definition of the feature. One to three sentences, understandable by a layman with high school education
ModelledCulverts	UTM_ZONE	UTM_ZONE	model	Integer	UTM ZONE is the 2 digit numeric code identifying the UTM Zone in which the UTM EASTING and UTM NORTHING lie.
ModelledCulverts	UTM_EASTING	TMSTNG	model	Float	UTM EASTING is the UTM Easting

					value within the specified UTM ZONE for this observation point.
ModelledCulverts	UTM_NORTHING	TMNRTHNG	model	Float	UTM NORTHING is the UTM Northing value within the specified UTM ZONE for this observation point.
ModelledCulverts	LINEAR_FEATURE_ID	LNRFTRD	FWA	Integer	A unique numeric identifier used to link the arc to the database.
ModelledCulverts	BLUE_LINE_KEY	BLLNK	FWA	Integer	Uniquely identifies a single flow line such that a main channel and a secondary channel with the same watershed code would have different blue line keys (the Fraser River and all side channels have different blue line keys).
ModelledCulverts	EDGE_TYPE	EDGE_TYPE	FWA	Integer	A 4 digit numeric code used by the Freshwater Atlas to identify the various types of water network linear features. eg. 1050.
ModelledCulverts	DOWNSTREAM_ROUTE_MEASURE	DWNSTRMRTM	FWA	Float	The distance, in meters, along the route from the mouth of the route to the feature. This distance is measured from the mouth of the containing route to the downstream end of the feature.
ModelledCulverts	FWA_FCODE	FWA_FCODE	FWA	Text	Taken from FWA stream, a value based on the Canadian Council of Surveys and Mapping's (CCSM) system for classification of geographic features.
ModelledCulverts	FWA_FCODE_LABEL	FTRCDLABEL	FWA	Text	Label (description) associated with the feature code of the stream segment / edge.
ModelledCulverts	FWA_WATERSHED_CODE	FWWTRSHDCD	FWA	Text	A 143 character code derived using a hierarchy coding scheme. Approximately identifies where a particular stream is located within the province.
ModelledCulverts	LOCAL_WATERSHED_CODE	LCLWTRSHDC	FWA	Text	The 143 character code similar to the fwa watershed code that further subdivides remnant polygons to provide an approximate location along the mainstem.
ModelledCulverts	WATERSHED_GROUP_CODE	WTRSHDGRPC	FWA	Text	The watershed group code associated with the polygon.
ModelledCulverts	DOWNSTREAM_EVENT_ID	DNSTREV_ID	model	Integer	CROSSING_ID of the crossing immediately downstream of given record, if one exists
ModelledCulverts	FISH_HABITAT	FSHHABITAT	model	Text	Modelled potential fish habitat value for the stream segment / edge. Modelled potential fish habitat values include 'OBSERVED' (there is a recorded fish observation upstream) or 'INFERRED' (while no recorded observation upstream exists, there is no known barrier to fish passage present) and 'NON FISH HABITAT' (no recorded observation uptream, and a barrier to fish passage is present downstream (as identified by the

					barrier IDs noted above)). Modelled potential fish habitat is further broken down by presence of downstream stream gradient barriers (greater than 100m) for user customization. For example, a user interested in a species that cannot pass stream gradients of greater than 15% would extract fish habitat for the given species by using a query that includes all oberved habitat and all inferred habitat below 15% ie: "WHERE fish_habitat LIKE 'FISH HABITAT - OBSERVED%' OR fish_habitat IN ('FISH HABITAT - INFERRED - 0-10PCT', 'FISH HABITAT - INFERRED - 10-15PCT')"
ModelledCulverts	uphab_l_total_inf_0_10	Hbttlinf10	model	Float	Total length of inferred modelled potential fish habitat upstream of the given crossing, with no section of stream of >10% grade for 100m or more
ModelledCulverts	uphab_l_total_inf_10_15	Hbttlinf15	model	Float	Total length of inferred modelled potential fish habitat upstream of the given crossing, with no section of stream of >15% grade for 100m or more
ModelledCulverts	uphab_l_total_inf_15_20	Hbttlinf20	model	Float	Total length of inferred modelled potential fish habitat upstream of the given crossing, with no section of stream of >20% grade for 100m or more
ModelledCulverts	uphab_l_total_inf_20_25	Hbttlinf25	model	Float	Total length of inferred modelled potential fish habitat upstream of the given crossing, with no section of stream of >25% grade for 100m or more
ModelledCulverts	uphab_l_total_inf_25_30	Hbttlinf30	model	Float	Total length of inferred modelled potential fish habitat upstream of the given crossing, with no section of stream of >30% grade for 100m or more
ModelledCulverts	uphab_l_total_obs_0_10	hbttlobs10	model	Float	Total length of observed modelled potential fish habitat upstream of the given crossing, with no section of stream of >10% grade for 100m or more
ModelledCulverts	uphab_l_total_obs_10_15	hbttlobs15	model	Float	Total length of observed modelled potential fish habitat upstream of the given crossing, with no section of stream of >15% grade for 100m or more
ModelledCulverts	uphab_l_total_obs_15_20	hbttlobs20	model	Float	Total length of observed modelled potential fish habitat upstream of the given crossing, with no section of stream of >20% grade for 100m or more
ModelledCulverts	uphab_l_total_obs_20_25	hbttlobs25	model	Float	Total length of observed modelled potential fish habitat upstream of the

					given crossing, with no section of stream of >25% grade for 100m or more
ModelledCulverts	uphab_l_total_obs_25_30	hbttlobs30	model	Float	Total length of observed modelled potential fish habitat upstream of the given crossing, with no section of stream of >30% grade for 100m or more
ModelledCulverts	uphab_l_net_inf_0_10	hbnetinf10	model	Float	Net (below any upstream crossing) length of inferred modelled potential fish habitat upstream of the given crossing, with no section of stream of >10% grade for 100m or more
ModelledCulverts	uphab_l_net_inf_10_15	hbnetinf15	model	Float	Net (below any upstream crossing) length of inferred modelled potential fish habitat upstream of the given crossing, with no section of stream of >15% grade for 100m or more
ModelledCulverts	uphab_l_net_inf_15_20	hbnetinf20	model	Float	Net (below any upstream crossing) length of inferred modelled potential fish habitat upstream of the given crossing, with no section of stream of >20% grade for 100m or more
ModelledCulverts	uphab_l_net_inf_20_25	hbnetinf25	model	Float	Net (below any upstream crossing) length of inferred modelled potential fish habitat upstream of the given crossing, with no section of stream of >25% grade for 100m or more
ModelledCulverts	uphab_l_net_inf_25_30	hbnetinf30	model	Float	Net (below any upstream crossing) length of inferred modelled potential fish habitat upstream of the given crossing, with no section of stream of >30% grade for 100m or more
ModelledCulverts	uphab_l_net_obs_0_10	hbnetobs10	model	Float	Net (below any upstream crossing) length of observed modelled potential fish habitat upstream of the given crossing, with no section of stream of >10% grade for 100m or more
ModelledCulverts	uphab_l_net_obs_10_15	hbnetobs15	model	Float	Net (below any upstream crossing) length of observed modelled potential fish habitat upstream of the given crossing, with no section of stream of >15% grade for 100m or more
ModelledCulverts	uphab_l_net_obs_15_20	hbnetobs20	model	Float	Net (below any upstream crossing) length of observed modelled potential fish habitat upstream of the given crossing, with no section of stream of >20% grade for 100m or more
ModelledCulverts	uphab_l_net_obs_20_25	hbnetobs25	model	Float	Net (below any upstream crossing) length of observed modelled potential fish habitat upstream of the given crossing, with no section of stream of >25% grade for 100m or more
ModelledCulverts	uphab_l_net_obs_25_30	hbnetobs30	model	Float	Net (below any upstream crossing) length of observed modelled

					potential fish habitat upstream of the given crossing, with no section of stream of >30% grade for 100m or more
ModelledCulverts	uphab_total_sub20	hbttl_u20	model	Float	Total length of inferred and observed modelled potential fish habitat, with no section of stream of >20% for 100m or more
ModelledCulverts	uphab_total_sub25	hbttl_u25	model	Float	Total length of inferred and observed modelled potential fish habitat, with no section of stream of >25% for 100m or more
ModelledCulverts	dnstr_crossings	nx_dnstr	model	Integer	Number of crossings upstream of the given record
ModelledCulverts	upstr_crossings	nx_upstr	model	Integer	Number of crossings downstream of the given record