# British Columbia's Provincial Stream

# Biomonitoring Program

## Technical Documentation

## GIS Tools for

## Reference Site Selection

## and

## Upstream Watershed Analysis

**Prepared for**
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Ministry of Environment
Province of British Columbia

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# 1 BACKGROUND

The first action identified in British Columbia's water plan, *Living Water Smart*, specifies that "land and water managers will know what makes a stream healthy" (Ministry of Environment, 2009). As health cannot be accurately measured without inclusion of the biological component of aquatic ecosystems, biological monitoring of aquatic systems is an essential tool for implementing this action. The Provincial Stream Biomonitoring Program is British Columbia's tool for monitoring aquatic ecosystem health. The program uses standardized national (Canadian Aquatic Biomonitoring Network (CABIN)) protocols to monitor changes to stream health and improve understanding of the effects of ecosystem stressors such as chemical contaminants and/or habitat disturbance (Gaber 2011).

In brief, the CABIN protocols are a set of methods for field collection and analysis of biological monitoring data using the Reference Condition Approach (RCA) (Environment Canada, 2012). In the RCA, benthic invertebrate community data and habitat descriptors from a large number of relatively undisturbed (reference) sites are used to build a predictive model that allows comparison of a test site with an appropriate reference condition. If the test site falls within the range of natural variability found at reference sites, the site is considered to be not stressed. If the site falls outside of the range natural variability found at the reference sites, the site is considered to be stressed. (Bennett, 2011).

Therefore, to conduct biomonitoring using the RCA, two summaries of habitat descriptor / land use data are required. First, to select reference sites, areas of low anthropogenic influence must be identified. Second, for test sites to be compared to the appropriate reference condition, habitat characteristics of the sites and their upstream watersheds must be summarized.

To efficiently generate these summaries in a repeatable manner, a set of GIS tools/scripts have been developed that use the BC Freshwater Atlas (FWA) as a base to query against corporate land use databases and other standard sources. This report documents the GIS tools' processing logic, all input data sources, and the output data generated.

# 2 REFERENCE SITE SELECTION

## 2.1 OVERVIEW

A reference site for BC's Provincial Stream Biomonitoring Program is an aquatic biomonitoring sampling site in an area where anthropogenic effects are minimal. Reference sites with similar natural characteristics such as climate, geology, etc are grouped and used to define the 'reference condition' for other sites with similar natural characteristics. The divergence between the benthic invertebrate communities at a test site and the corresponding reference condition indicates the extent of stresses to the aquatic ecosystem at the test site (Environment Canada, 2012).

Potential reference site locations are identified using a set of spatial (GIS) queries to provincial land and resource databases. These queries perform two tasks:

1. Identify watersheds that contain levels of disturbance below set (regionally variable) thresholds. The indicators used are:

    a. Percent watershed area harvested since 1980 (%HARV)

    b. Percent watershed burned since 2003 (%BURN)

    c. Percent watershed affected by moderate or greater Mountain Pine Beetle infestation (%MPB)

    d. Percent watershed that is agricultural land (%AGR)

    e. Percent watershed that is urban (%URB)

    f. Road density of watershed (km/ha) (RD_DEN)

2. Within the watersheds selected above, identify sections along streams within the watershed where location of a reference site is possible. Possible locations of reference sites along streams are governed by the following criteria:

    a. Distance upstream from site to a waterbody (any lake or wetland)

    b. Distance upstream and downstream from site to a flow control structure

    c. Distance upstream from site to an industrial point discharge

    d. Distance upstream and downstream from site to a road crossing

    e. Presence of a mine upstream of a site and distance downstream from site to a mine

f. No human disturbance (such as burns, harvesting, roads, agricultural) is present within the riparian area (30m) surrounding the stream.

The processing methodology for selecting watersheds and stream segments for reference site are detailed in following sections. Baseline provincial disturbance thresholds for the various criteria are outlined in Tables 1 and 2. These thresholds are varied slightly regionally based on location specific differences in human disturbance.

| **Watershed Disturbance Indicator** | **Provincial baseline threshold** |
|---|---|
| Forestry (harvest since 1980) - %HARV | <20% |
| Wildfire (in previous 5 years) -%BURN | <20% |
| Mountain Pine Beetle (moderate or greater infestation in previous 10 years) - %MPB | <10% |
| Agriculture - %AG | <30% |
| Urbanization - %URB | < 8% |
| Road density - RD_DEN | <0.5km/km$^2$ |

**Table 1. Provincial baseline criteria for reference watershed selection**.

| **Stream Disturbance Indicator** | **Provincial baseline threshold** |
|---|---|
| Downstream distance from waterbodies <5km$^2$ | >2km |
| Downstream distance from waterbodies >5km$^2$ | >5km |
| Downstream distance from flow structures | 500m |
| EMS sites - stream order restriction | None on 1st and 2nd order streams |
| EMS sites - allowed distance downstream on allowed stream orders | >10km, stream order >3 |
| Upstream distance from road crossings | >50m upstream from any crossing |
| Downstream distance from road crossings | >500m downstream |
| Upstream distance from current and past producing mines within 100m of stream | >500m |

| | |
|---|---|
| Downstream from current and past producing mines within 100m of stream | None permitted |
| Riparian (30m from stream) vegetation disturbance | None permitted |

**Table 2. Provincial baseline criteria for reference stream selection**.

## 2.2 PROCESS WATERSHEDS

The reference site selection is performed for a user specified region and with user specified watershed disturbance thresholds.

A user specifies a region as a collection of watershed groups (from the BC Freshwater Atlas (FWA) watershed groups layer, see Figure 1 for sample boundaries) and provides a list of thresholds for the watershed disturbance indicators. For example, the 2011 reference site selection processing area for the Okanagan region was defined as the set of [OKAN, SIML, KETL, USHU] watershed groups, with thresholds of [10, 20, 10, 10, 2, 0.5] for [%HARV, %BURN, %MPB, %AGR, %URB, RD_DEN] respectively.

The reference site selection GIS tools iterate through the provided watershed groups, performing a set of queries on each area individually.

### 2.2.1 Define watersheds

The first step in reference site watershed selection is defining individual watershed boundaries of interest within the watershed group. Watershed boundaries are derived from the FWA's 1:20,000 first order/fundamental watersheds layer (average size 30ha). These watersheds are individually too small for biomonitoring, but their hierarchical coding allows for grouping into larger watersheds. For reference site selection, third order (nested within higher order) watersheds are selected. This level was chosen as third order watersheds are the smallest size practical for computing over large areas and are also generally the most ecologically relevant scale for invertebrate biomonitoring purposes (Gaber, 2011).

The resulting watershed boundaries are used for overlays with disturbance indicator data and subsequent eligibility selection; with the exception that watersheds of 6th order and greater may be broken up in later processing due to their large size (see Section 2.2.3).

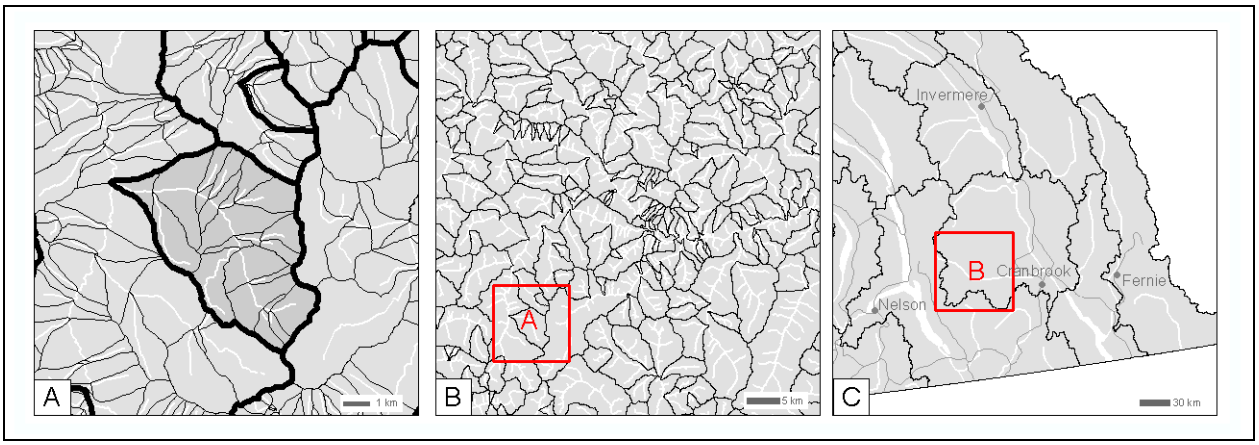


**Figure 1. Watershed definition and regional context**. Map A shows the source first order/fundamental watersheds and highlights a watershed created by grouping the source polygons into third order watersheds. Map B shows an overview of resulting third order watersheds over a larger area. Map C shows the regional context and watershed group boundaries.

### 2.2.2 Extract and prepare disturbance indicator data

As outlined, disturbances considered for reference site selection are forest harvest, burns, mountain pine beetle infestation, agriculture, urbanization and road density. Once the watersheds are defined, spatial data defining the extents of these disturbances is extracted from the sources outlined in Table 1. Data are extracted from the BC Geographic Data Warehouse (BCGW) except as noted. Where applicable, multiple inputs are combined into a single layer and attributes are simplified to indicate only where disturbances occur. For complete data definitions including layer names, queries and metadata links, see Appendix 1.

| DISTURBANCE INDICATOR | DATA SOURCE(S) |
|---|---|
| Forestry (harvest since 1980) - %HARV | Forest Vegetation Cover (VRI)<br><br>RESULTS - Openings<br><br>Forest Tenure Cutblock Polygons (FTEN cutblocks) |
| Wildfire (in previous 5 years) -%BURN | Fire Perimeters - Historical<br><br>Fire Perimeters - Current |
| Mountain Pine Beetle (moderate or greater infestation in previous 10 years) - %MPB | Pest Infestation Polygons<br><br>Forest Health Overview Survey Data, 2008-2010 (taken from MFLNRO Forest Health ftp site) |

| | |
|---|---|
| Agriculture - %AG | Baseline Thematic Mapping (BTM) |
| Urbanization - %URB | Baseline Thematic Mapping (BTM) |
| Road density - RD_DEN | Digital Road Atlas (DRA) |

**Table 1. Disturbance data sources for Reference Site selection**

### 2.2.3 Overlay data, select watersheds meeting criteria

Once all input data are extracted and merged/simplified as required, each resulting disturbance layers is overlaid with the watersheds generated in Section 2.2.1 and the results are queried and summarized.

Using the overlay result summaries, three resultant layers are generated. Each resultant is a spatial file of watershed polygons holding attributes for all of the selection criteria statistics: the total amount of each disturbance within each watershed, the percentage area/density of each disturbance within each watershed, and finally a Boolean field identifying whether the reference site selection criteria are met for a given watershed.

The first resultant set includes all the watersheds as defined in Section 2.2.1. Because of the order based method by which these watersheds are derived, there are many large remainder watershed polygons (areas outside of third order watersheds) with order greater than 3. While an entire large remainder watershed may not meet selection criteria (for example, due to logging in a lower portion of the watershed), there may be distinct upstream areas that are undisturbed and large enough to be useful for reference site location. To better identify all possible areas for reference site selection, two additional watershed layers are created as resultants.

The second resultant is created by selecting watersheds of order six and greater which did not meet the selection criteria within the first resultant set. The lower one-third area of these watersheds is removed, and selection criteria are applied to the new, smaller watersheds. See Figure 2A.

The third resultant is created by selecting from the second resultant all watersheds of order six and greater which still did not meet the selection criteria. The lower one-third area of these watersheds is removed (effectively removing two-thirds of the original watershed, see Figure 2B). Selection criteria are then applied to the new, smaller watersheds.

See Section 2.4 and Appendix 2 for full specifications of the output resultant data layers and attributes.

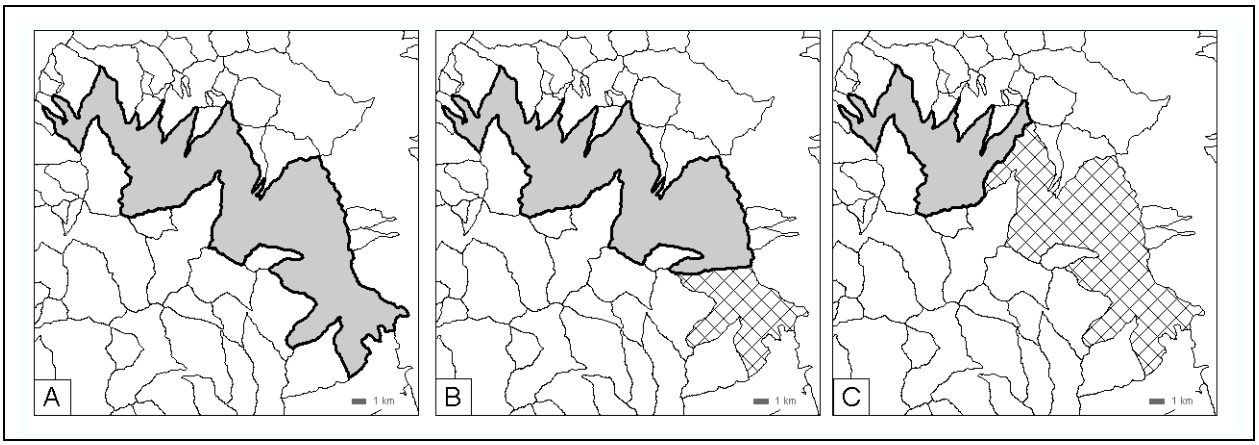


**Figure 2. Editing large remainder watersheds for different resultant layers**. Map A shows the original sixth order watershed, retained in the first resultant. Map B shows the removal of the bottom third of the watershed (hatched areas) leaving only the top two thirds of the watershed in the second resultant. Map C shows the third resultant; the second third of the watershed has been removed, leaving only the top third of the original watershed.

## 2.3 PROCESS STREAMS

### 2.3.1 Stream eligibility criteria

Once watersheds meeting the reference site selection criteria have been identified, streams within the watersheds are evaluated along their lengths against several criteria. Lengths of stream not meeting the criteria are removed, leaving a set of stream segments along which a reference sampling site may be located. The stream evaluation process is as follows:

Within all watersheds defined in Resultant Set 3:

1. Extract streams from the FWA stream network. Build a local stream network data structure suitable for upstream/downstream traces.

2. Extract lakes, wetlands and manmade waterbodies from the FWA. Merge the source layers into a single layer, merge adjacent features, and calculate area of the resulting waterbody polygons. Identify as ineligible all stream segments that are a) within a waterbody, b) <2km downstream of waterbodies <5km$^2$, or c) <5km downstream of waterbodies >5km$^2$.

3. Extract stream obstructions (dams, weirs, beaver dams etc) from the FWA and locate all points within 1m of a stream on the stream network. Identify as ineligible all stream segments that are a) within 500m downstream of a flow control structure, or b) within 50m upstream of a flow control structure.

4. Extract industrial discharge monitoring (EMS) points from BCGW and locate all points within 50m of a stream on the stream network. Identify as ineligible all stream segments that are a) first or second order streams and have an EMS point present

anywhere on the stream, or b) third order and greater and have an EMS point <10km upstream.

5. Extract roads from Digital Road Atlas (DRA) and Forest Tenure Roads (FTEN) and identify points where roads cross streams. Identify as ineligible all stream segments that are a) <50m upstream of a road-stream crossing, or b) <500m downstream of a road-stream crossing.

6. Extract past and producing mines (point locations) from the MINFILE database and locate all points within 100m of a stream on the stream network. Identify as ineligible all stream segments that are a) downstream of a mine (any distance), or b) <500m upstream of a mine.

7. Buffer each of the following disturbance data by 30m:

    a. BTM (Agricultural, Urban, Transportation, etc. See Appendix 1 for full query)

    b. Harvested areas (as defined in Section 2.2.2)

    c. Burned areas (as defined in Section 2.2.2)

    d. Roads (as defined in #5 above)

    Combine these buffered areas into a single 'non-natural' polygon layer and overlay with the streams. Identify all stream segments that intersect with the buffered areas as ineligible for site selection; non-natural vegetation occurs in the 30m riparian area.

Streams within all watersheds defined in Resultant Set 3 (eligible and ineligible) are included in this analysis.

Note that to ensure inclusion of features outside of the watersheds of interest but still within the upstream/downstream thresholds specified, the source data extraction area is defined by buffering the watersheds by a distance related to the thresholds. Also note that precise thresholds for all criteria are adjusted regionally as required.

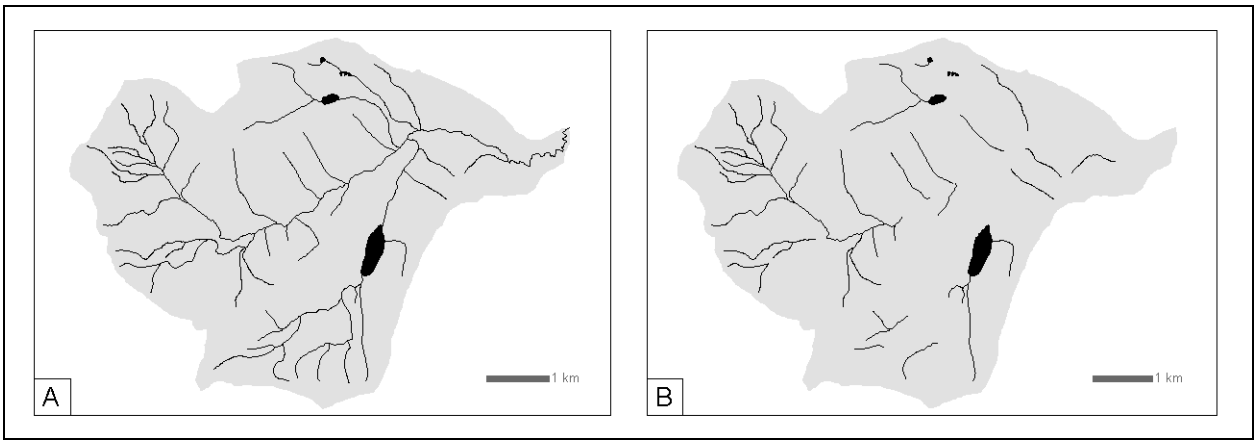


**Figure 3. Stream eligibility selection**. Map A shows the entire stream network within a watershed eligible for reference site location. Map B shows the remaining potentially reference streams after removal of streams that do not meet eligibility criteria.

### 2.3.2 Additional stream characterization

Once eligible segments have been identified, streams are further analyzed to prioritize which segments may be best suited for a reference sampling site location. Streams are characterized by ease of access and land ownership. The queries are processed as follows:

1. Using the FTEN and DRA road layers previously extracted, identify streams within 500m of a road.

2. Extract Integrated Cadastral Fabric (ICF) from BCGW and overlay with streams to identify (approximately) whether a stream is in a private or crown owned parcel.

## 2.4 OUTPUT SUMMARY

Results of the reference site selection processing are output to a standard data package for delivery to regional land managers. A typical data package includes (for each watershed group within the region defined):

1. Shapefiles defining watersheds for each of three resultants, including selection criteria attributes.

2. A shapefile including all streams of interest within the watershed group, including selection criteria and additional attributes.

3. Excel spreadsheets summarizing watershed selection (all resultants) and stream selection. These include the same information as the shapefiles but without the spatial component.

4. For convenient mapped browsing of results, an ArcMap .lyr file is included. The file links to included shapefiles as well as all of the analysis source data available in the BCGW (provided the user has access).

Precise definitions of the attributes in the output data are provided in Appendix 2.

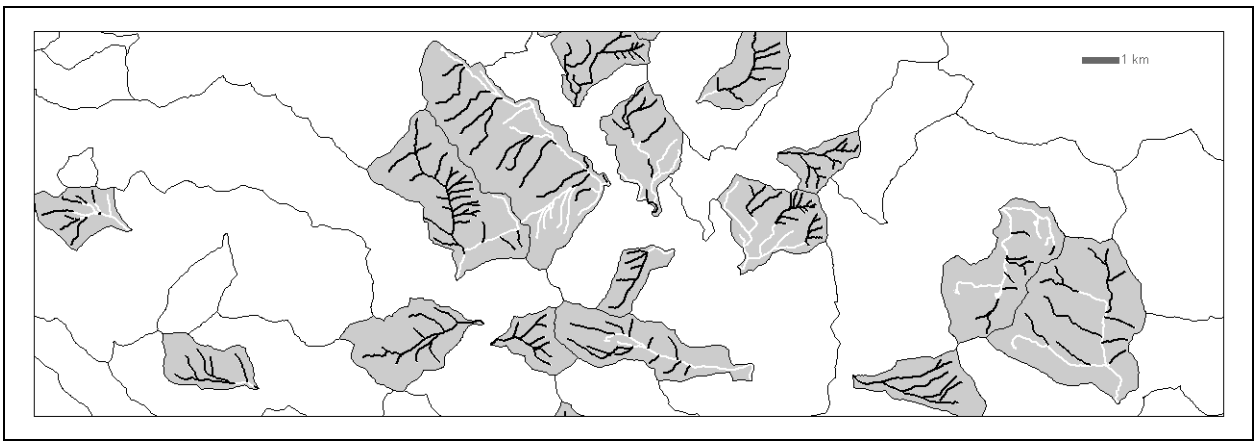


**Figure 4. Reference site selection output**. Watersheds meeting reference criteria are highlighted. Within the watersheds, streams meeting reference criteria are highlighted.

# 3 UPSTREAM WATERSHED ANALYSIS

## 3.1 OVERVIEW

Once site locations (reference and test) have been selected for a biomonitoring study, the landscape habitat characteristics (climate, geology, land use, disturbances) of the upstream watershed must be summarized for each of the sites. These data are analyzed in combination with local habitat and invertebrate community data collected at the site. Reference sites with similar habitat and communities are grouped by a predictive model, creating a set of reference condition benchmarks. At test sites, upstream watershed habitat data is used to match a site with an expected reference condition. If a site falls outside of expected natural variability of the matching reference condition, the site is considered to be stressed by anthropogenic disturbance.

The methods for upstream watershed analysis are similar to those used for reference site selection; watersheds of interest are derived then overlaid with a set of resource and disturbance layers.

## 3.2 PROCESS

### 3.2.1 Identify stream nearest to site

Bioassessment site locations are generally supplied as GPS coordinates collected in the field. Supplied coordinates are converted to point features which are adjusted to intersect with the nearest stream in the FWA stream network. This adjustment is required in order to locate the relative position of the site on the stream network and extract the relevant watershed codes needed to define the upstream watershed.

### 3.2.2 Define watershed

In order to extract and measure landscape level habitat variables that influence the sites, the upstream watershed for each sampling site is defined. This is a two step process.

First, by querying the watershed codes of FWA first order/fundamental watersheds the watershed polygons upstream of a sampling point are extracted. These are combined to form a single 'preliminary' watershed boundary. Second, if a site is located between stream confluences (more than 75m from a confluence), or on a double line river, the lower-most portion of the preliminary watershed is refined.

Refinement of the watershed boundary is only (potentially) necessary within the first order/fundamental watershed polygon in which the site itself falls. The source watershed polygons are defined to end at stream confluences; therefore if a site is not located at a

confluence, there may be significant downstream watershed area included in the preliminary watershed definition. The portion of the first order/fundamental watershed upstream of the sampling site point is defined as best as possible by processing the 1:20,000 25m DEM using ArcGIS Spatial Analyst tools Fill, FlowDirection and Watershed. In some cases (some flat areas where heights of land are indefinite, and some double line rivers where fundamental watersheds split the river ) this automated processing may not be successful and the bottom of the watershed must be defined manually.

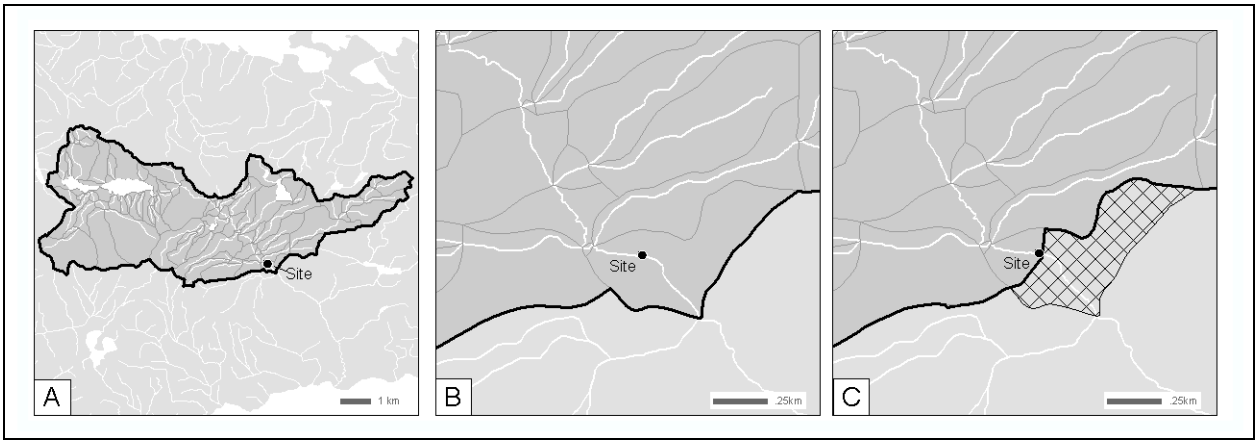


**Figure 5. Refining the first order/fundamental watershed in which the site falls.** Map A shows the entire watershed as first defined. Map B shows detail of the watershed as defined at the site - the site is more than 75m from a stream confluence and there is significant area downstream included in the initial watershed definition. Map C shows the removal of area downstream of the site (hatched area) and resulting new watershed definition.

### 3.2.3 Extract and prepare indicator data

To characterize the watersheds (and site points themselves in some cases), databases of climatic, geologic, and ecological indicators are used, plus many of the same disturbance data used in the reference site selection. All data listed in Table 2 are extracted from the Province of BC's BCGW except as indicated. Precise definitions of each data source (queries, metatada links, etc) are available in Appendix 1.

| INDICATOR | DATA SOURCE(S) |
|---|---|
| Ecoregion/Ecozone | Ecoregions of Canada, Environment Canada |
| Biogeoclimatic Zone (by area and at site) | Biogeoclimatic Ecosystem Classification (BEC) |
| Stream length (total), areas of lakes/rivers/wetlands/ice | Freshwater Atlas (FWA) |
| Forest age categories, by area | Forest Vegetation Cover (VRI) |

| | |
|---|---|
| Burned area | Fire Perimeters - Historical |
| Forest Harvesting (since 1980) | Forest Vegetation Cover (VRI)<br><br>RESULTS - Openings |
| Land use (Agricultural, Alpine, Mining, Range, Urban, etc) | Baseline Thematic Mapping (BTM) |
| Roads | Digital Road Atlas (DRA) |
| Active mines | MINFILE |
| Elevation/slope characteristics | 1:20,000 25m Digital Elevation Model (DEM) |
| National Parks (area and count) | Canada Lands Administrative Boundaries |
| Agricultural Land Reserve (ALR) area | Agricultural Land Reserve Polygons, BC Agricultural Land Commission |
| Bedrock type by area | Bedrock Geology, BC Ministry of Energy and Mines |
| Climate (temperature, precipitation, etc) | 1961-1990, 1971-2000 Climate Normals, Environment Canada |

**Table 2. Upstream watershed analysis data sources**

Note that additional in-stream (length) indicators not noted in the table above (such as minimum upstream distance from site to a lake or wetland) have also been calculated for some areas. However, as the logic currently available in the upstream watershed analysis tools ignores side channels when making in-stream length calculations, these indicators are not included in current outputs. Future efforts may be directed towards building tools that can include side channels in upstream distance calculations.

## 3.3 OUTPUT SUMMARY

Each indicator data source is overlaid with the watershed boundaries defined in Section 3.2.2 (and/or the site point as required) and the results are summarized.

Outputs provided from the upstream watershed analysis are:

1. Site locations, as a point shapefile, with attributes such as name, CABIN code, watershed code and other site specific information. This file is created if sites are provided as a table or list of coordinates.

2. Upstream watersheds for each site, as a polygon shapefile.

3. An Excel worksheet listing each site as a row, and summarizing each indicator in each column

Precise definitions of each output dataset are provided in Appendix 2.

# 4 REFERENCES


Bennett, S.A. 2011. A revised predictive model for bioassessment of streams in northwest British Columbia using the reference condition approach: Skeena model. Report prepared by Bio Logic Consulting for Environmental Protection Division, Ministry of Environment, Skeena Region. 35p.

Environment Canada. 2012. Canadian Aquatic Biomonitoring Network (CABIN). http://www.ec.gc.ca/rcba-cabin. (Accessed February 2012).

Gaber, Leon. 2011. British Columbia Biomonitoring Program Information Note. (Personal communication, February 2012).

Ministry of Environment. 2009. Living Water Smart: British Columbia's Water Plan. http://livingwatersmart.ca/actions.html. (Accessed February 2012).

# APPENDIX 1 - DATA SPECIFICATIONS - REFERENCE SITE SELECTION

## WATERSHED CRITERIA INPUTS

| INDICATOR | SOURCE(S) | TABLE/LAYER | METADATA |
|---|---|---|---|
| Watersheds | BC Freshwater Atlas (**FWA**) | WHSE_BASEMAPPING.FWA_WATERSHEDS_POLY | http://tinyurl.com/c5rv5ec |
| Agricultural areas | Baseline Thematic Mapping (**BTM**) | WHSE_BASEMAPPING.BTM_PRESENT_LAND_USE_V1_SP | http://tinyurl.com/7t4d7hv |
| Urban areas | Baseline Thematic Mapping (**BTM**) | WHSE_BASEMAPPING.BTM_PRESENT_LAND_USE_V1_SP | http://tinyurl.com/7t4d7hv |
| Roads | Digital Road Atlas (**DRA**) | WHSE_BASEMAPPING.DRA_DIGITAL_ROAD_ATLAS_LINE_SP | http://tinyurl.com/7h39j6f |
| Areas affected by Mountain Pine Beetle in past 10 years (severity moderate and above) | **Pest Infestation Polygons** (2001-2007) | WHSE_FOREST_VEGETATION.PEST_INFESTATION_POLY | http://tinyurl.com/85ld46j |
| | 2008 **Forest Health Survey Data** | 2008_bc_overview_polygon.shp | http://tinyurl.com/88usugk |
| | 2009 **Forest Health Survey Data** | prov_fhf_poly_20091214.shp | http://tinyurl.com/88usugk |
| | 2010 **Forest Health Survey Data** | 2010_fhf_poly.shp | http://tinyurl.com/88usugk |
| Areas harvested since 1980 | Forest Vegetation Composite Polygons (**VRI** Forest Cover) | WHSE_FOREST_VEGETATION.VEG_COMP_LYR_R1_POLY | http://tinyurl.com/6wwxk5d |
| | Results Openings (**RESULTS**) | WHSE_FOREST_VEGETATION.RSLT_OPENING_SVW | http://tinyurl.com/86n8rpb |
| | Forest Tenure Cut Block Polygons (**FTEN**) | WHSE_FOREST_TENURE.FTEN_CUT_BLOCK_POLY_SVW | http://tinyurl.com/7j3pdnz |
| Areas burned in the past five years | **Fire Perimeters - Historical** | WHSE_LAND_AND_NATURAL_RESOURCE.PROT_HISTORICAL_FIRE_POLYS_SP | http://tinyurl.com/6stgt2u |
| | **Fire Perimeters - Current** | WHSE_LAND_AND_NATURAL_RESOURCE.PROT_CURRENT_FIRE_POLYS_SP | http://tinyurl.com/7jkxzko |

## STREAM CRITERIA INPUTS

| INDICATOR | SOURCE(S) | TABLE/LAYER | METADATA |
|---|---|---|---|
| Streams | BC Freshwater Atlas (**FWA**) Streams | WHSE_BASEMAPPING.FWA_STREAM_NETWORKS_SP | http://tinyurl.com/c9cjsce |
| Waterbodies | BC Freshwater Atlas (**FWA**) Lakes | WHSE_BASEMAPPING.FWA_LAKES_POLY | http://tinyurl.com/cxyfk2o |
| | BC Freshwater Atlas (**FWA**) Wetlands | WHSE_BASEMAPPING.FWA_WETLANDS_POLY | http://tinyurl.com/bmq8qo |
| | BC Freshwater Atlas (**FWA**) Manmade waterbodies | WHSE_BASEMAPPING.FWA_MANMADE_WATERBODIES_POLY | http://tinyurl.com/d8b7fe6 |
| Mines - current and past producers | **MINFILE** | MinFile-pc.mdb | http://tinyurl.com/7rwpham |
| Land status - public or private | Integrated Cadastral Fabric (**ICF**) | WHSE_CADASTRE.CBM_INTGD_CADASTRAL_FABRIC_SVW | http://tinyurl.com/7o3xuxc |
| Point discharges | BC Environmental Monitoring Locations (**EMS**) | WHSE_WASTE.BC_ENV_MONITOR_LOCNS | http://tinyurl.com/7nugzxe |
| Roads | Digital Road Atlas (**DRA**) | WHSE_BASEMAPPING.DRA_DIGITAL_ROAD_ATLAS_LINE_SP | http://tinyurl.com/7h39j6f |
| | Forest Tenure Road Segment Lines (**FTEN**) | WHSE_FOREST_TENURE.FTEN_ROAD_SEGMENT_LINES_SVW | http://tinyurl.com/87vp47q |
| Flow structures | **FWA** Obstructions | WHSE_BASEMAPPING.FWA_OBSTRUCTIONS_SP | http://tinyurl.com/7ovegyf |
| Riparian area human impacts (within 30m of stream) | Baseline Thematic Mapping (**BTM**) | WHSE_BASEMAPPING.BTM_PRESENT_LAND_USE_V1_SP | http://tinyurl.com/7t4d7hv |
| | Digital Road Atlas (**DRA**) | WHSE_BASEMAPPING.DRA_DIGITAL_ROAD_ATLAS_LINE_SP | http://tinyurl.com/7h39j6f |
| | Forest Tenure Road Segment Lines (**FTEN** Roads) | WHSE_FOREST_TENURE.FTEN_ROAD_SEGMENT_LINES_SVW | http://tinyurl.com/87vp47q |
| | Forest Vegetation Composite Polygons (**VRI** Forest Cover) | WHSE_FOREST_VEGETATION.VEG_COMP_LYR_R1_POLY | http://tinyurl.com/6wwxk5d |
| | Results Openings (**RESULTS**) | WHSE_FOREST_VEGETATION.RSLT_OPENING_SVW | http://tinyurl.com/86n8rpb |
| | Forest Tenure Cut Block Polygons (**FTEN** Cutblocks) | WHSE_FOREST_TENURE.FTEN_CUT_BLOCK_POLY_SVW | http://tinyurl.com/7j3pdnz |
| | Fire Perimeters - Historical | WHSE_LAND_AND_NATURAL_RESOURCE.PROT_HISTORICAL_FIRE_POLYS_SP | http://tinyurl.com/6stgt2u |
| | Fire Perimeters - Current | WHSE_LAND_AND_NATURAL_RESOURCE.PROT_CURRENT_FIRE_POLYS_SP | http://tinyurl.com/7jkxzko |

# OUTPUT DATA

## Watershed Selection Shapefile and Excel File

| .XLS FIELD NAMES | .DBF/.SHP FIELD NAMES | DESCRIPTION | SOURCE/QUERY |
|---|---|---|---|
| WATERSHED_ORDER | WS_ORDER | Watershed Order | **FWA** watersheds<br>Dissolved 1st and 2nd order watersheds into 3rd order and greater watersheds. |
| WATERSHED_MAGNITUDE | WS_MGN | Watershed Magnitude | **FWA** watersheds |
| GNIS_NAME_1 | GNIS_NAME_ | Watershed Name - populated only for larger watersheds. | **FWA** watersheds |
| FWA_WATERSHED_CODE | FWA_WS_CD | Watershed Code | **FWA** watersheds |
| FWA_WS_NOZERO | FWA_WS_NOZ | Watershed Code without trailing zeros. | **FWA** watersheds |
| TOTAL_HA | TOTAL_HA | Total watershed hectares | **FWA** watersheds, as combined |
| HARV_HA | HARV_HA | Total hectares of harvesting since 1980 | **VRI**: HARVEST_DATE newer than January 1st, 1980<br>**RESULTS**: DISTURBANCE_START_DATE or DISTURBANCE_END_DATE > January 1st, 1980 and DENUDATION_1_DISTURBANCE_CODE or DENUDATION_1_DISTURBANCE_CODE = 'L'<br>**FTEN**: DISTURBANCE_START_DATE or DISTURBANCE_END_DATE > January 1st, 1980 |
| HARV_PCT | HARV_PCT | Percentage of watershed harvested since 1980 | from HARV_HA |
| BURN_HA | BURN_HA | Total hectares of burned area since 2003 | **Fire Perimeters - Historical**: FIRE_YEAR >= 2005<br>**Fire Perimeters - Current** |
| BURN_PCT | BURN_PCT | Percentage of watershed burned since 2003 | FROM BURN_HA |
| MPB_HA | MPB_HA | Total hectares of MPB infestation (Moderate, Severe, Very Severe) | **2005-2007**: **Pest Infestation Polygons:** PEST_SPECIES_CODE = 'IBM', CAPTURE_YEAR >= 2000, PEST_SEVERITY_CODE IN ('S','V','M')<br>**2008-2010**: **Forest Health Survey Data:** FHF = 'IBM, SEVERITY IN ('S','V','M')<br>Unioned together MPB data, dissolved data to create a 'flat' file with no overlaps |
| MPB_PCT | MPB_PCT | Percentage of watershed with MPB infestation | from MPB_HA |
| AGR_HA | AGR_HA | Hectares of Agriculture land | **BTM**: PRESENT_LAND_USE_CODE IN ('AGR','AGRX') |

| | | | |
|---|---|---|---|
| AGR_PCT | AGR_PCT | Percentage of watershed that is agriculture land | from AGR_HA |
| URBAN_HA | URBAN_HA | Hectares of Urban area | **BTM**: PRESENT_LAND_USE_CODE = 'URB' |
| URBAN_PCT | URBAN_PCT | Percentage of watershed that is urban | from URBAN_HA |
| ROADS_KM | ROADS_KM | Total KMs of roads | **DRA**: FEATURE_TYPE = 'Road', ROAD_SURFACE NOT IN ('boat',' decommissioned', 'overgrown') |
| ROADS_DENS | ROADS_DENS | Road Density (KM/KM^2) | from ROADS_KM |
| MEET_CRITERIA | MEET_CRITE | 'Y' if it meets regional criteria. 'N' if it does not. | See Table 1 in document body |

## Stream Selection Shapefile and Excel File

| .XLS FIELD NAMES | .DBF/.SHP FIELD NAMES | DESCRIPTION | SOURCE/QUERY |
|---|---|---|---|
| WATERSHED_CRITERIA | WSHD_CRITE | 'Y' if the watershed meets watershed criteria, 'N' if it does not. | Watershed Selection Table |
| LINEAR_FEATURE_ID | LF_ID | Unique ID for each stream segment | **FWA** streams |
| FWA_WATERSHED_CODE | FWA_WS_CD | Watershed Code | **FWA** streams |
| LOCAL_WATERSHED_CODE | LOCL_WS_CD | Watershed Code | **FWA** streams |
| STREAM_ORDER | STR_ORDER | Stream Order | **FWA** streams |
| ROAD_ACCESS | ROAD_ACCESS | 'Y' if within 500m of a road | **DRA**: FEATURE_TYPE = 'Road', ROAD_SURFACE NOT IN ('boat', 'decommissioned', 'overgrown')<br>**FTEN** Roads:: LIFE_CYCLE_STATUS_CODE <> 'RETIRED' |
| OWNERSHIP_CLASS | OWNERSHIP | Indicates the ownership class of the land the stream runs through:<br>CROWN, PRIVATE, UNDETERMINED | **ICF:** WHSE_CADASTRE.CBM_INTGD_CADASTRAL_FABRIC_SVW |
| NATURAL_VEG | NATUR_VEG | | Not within 30m of:<br>**BTM:** PRESENT_LAND_USE_CODE IN ('AGR','AGRX','HWY','LOG','LOGS','MINE','REC','TRAN','URB')<br>**Harvesting -** from watershed criteria<br>**Forest Fires** - from watershed criteria<br>**Roads** - from above ROAD_ACCESS source |

| | | | |
|---|---|---|---|
| WATERBODY | WATERBODY | The stream segment is a waterbody | **FWA** lakes/wetlands/manmade waterbodies |
| DOWNSTREAM_FROM_SM_WATERBODY | DN_SM_WB | Within the downstream distance of a waterbody smaller than 5km^2 | **FWA** lakes/wetlands/manmade waterbodies < 5km^2 |
| DOWNSTREAM_FROM_LG_WATERBODY | DN_LG_WB | Within the downstream distance of a waterbody larger than 5km^2 | **FWA** lakes/wetlands/manmade waterbodies > 5km^2 |
| DOWNSTREAM_FROM_OBST | DN_OBST | Within the downstream distance of flow structures | **FWA** obstructions |
| UPSTREAM_FROM_OBST | UP_OBST | Within the upstream distance of flow structure. | **FWA** obstructions |
| EMS_STREAM_ORDER | EMS_ST_ORD | EMS site exists on a prohibited stream order | **EMS** sites |
| DOWNSTREAM_FROM_EMS | DN_EMS | Within the downstream distnace of an EMS site | **EMS** sites |
| UPSTREAM_FROM_ROAD | UP_ROAD | Within the upstream distance of a road | **DRA**: FEATURE_TYPE = 'Road', ROAD_SURFACE NOT IN ('boat', 'decommissioned', 'overgrown')<br>**FTEN** Roads**:** LIFE_CYCLE_STATUS_CODE <> 'RETIRED' |
| DOWNSTREAM_FROM_ROAD | DN_ROAD | Within the downstream distance from a road | As above |
| UPSTREAM_FROM_MINE | UP_MINE | Within the upstream distance from a producing or past producing mine site. | **MINFILE** points: STATUS_D IN ('Past Producer', 'Producer') |
| DOWNSTREAM_FROM_MINE | DN_MINE | Downstream from a producing or past producing mine site | As above |
| MEET_CRITERIA | MEET_CRITE | 'Y' if it meets criteria (passes all the above tests). 'N' if it does not. | See Table 2 in document body |

# APPENDIX 2 - DATA SPECIFICATIONS - UPSTREAM WATERSHED ANALYSIS

### Output upstream watershed analysis Excel file

| FIELD | DESCRIPTION | SOURCE(S) | QUERY |
|---|---|---|---|
| SITE_LONGITUDE | Longitude of the sample site (decimal degrees) | Provided by the client | Adjusted to centreline of nearest FWA stream segment |
| SITE_LATITUDE | Latitide of the sample site (decimal degrees) | Provided by the client | Adjusted to centreline of nearest FWA stream segment |
| ECOREGION | Federal ecoregion at sample site | Ecoregions of Canada, Environment Canada | |
| ECOZONE | Federal ecozone at samplesite | Ecoregions of Canada, Environment Canada | |
| BEC_ZONE_AT_SITE | BEC (Biogeoclimatic Ecosystem Classification) zone at sample site | WHSE_FOREST_VEGETATION. BEC_BIOGEOCLIMATIC_POLY | |
| WATERSHED_AREA | Area (ha) of the watershed upstream of sample site | WHSE_BASEMAPPING. FWA_STREAM_NETWORKS_SP, WHSE_BASEMAPPING. FWA_WATERSHEDS_POLY, BC DEM | see body text for description of processing |
| STREAMS_LENGTH | Length (km) of Freshwater Atlas streams (including along the centreline of lakes, wetlands, and wide "double-line" river segments) within sample site watershed. | WHSE_BASEMAPPING. FWA_STREAM_NETWORKS_SP | |
| STREAM_ORDER_20K_FWA | Stream order at sample site, based on 1:20,000 scale Freshwater Atlas | WHSE_BASEMAPPING. FWA_STREAM_NETWORKS_SP | |
| STREAM_ORDER_50K_WA | Stream order at sample site, based on 1:50,000 scale Watershed Atlas | WHSE_FISH. WDIC_WATERBODY_STREAM_LINE_SVW | |
| LAKES_AREA | Pct watershed area of lakes and man-made reservoirs within sample site watershed. | WHSE_BASEMAPPING.FWA_LAKES_POLY, WHSE_BASEMAPPING. FWA_MANMADE_WATERBODIES_POLY | WHSE_BASEMAPPING.FWA_RIVERS_POLY; and WHSE_BASEMAPPING.FWA_MANMADE_WATERBODIES_POLY where FEATURE_CODE in ('GB24300000','GB90100000', 'GB90100110') |

| | | | |
|---|---|---|---|
| RIVERS_AREA | Pct watershed area of wide (mapped with a "double-line") segments of rivers and man-made canals within sample site watershed. | WHSE_BASEMAPPING.FWA_RIVERS_POLY, WHSE_BASEMAPPING. FWA_MANMADE_WATERBODIES_POLY | WHSE_BASEMAPPING.FWA_RIVERS_POLY; and WHSE_BASEMAPPING.FWA_MANMADE_WATERBODIES_POLY where FEATURE_CODE = 'GA03950000' |
| WETLANDS_AREA | Pct watershed area of wetlands within sample site watershed. | WHSE_BASEMAPPING.FWA_WETLANDS_POLY | |
| ICE_AREA | Pct watershed area of ice within sample site watershed. | WHSE_BASEMAPPING.FWA_GLACIERS_POLY | |
| FOREST_YOUNG | Pct watershed area of forest with age less than 140 years and greater than 6 m in height, and that has NOT been harvested since 1980 | WHSE_FOREST_VEGETATION. VEG_COMP_LYR_R1_POLY, calculated area of FOREST_HARVESTED_1980_AFTER | WHSE_FOREST_VEGETATION.VEG_COMP_LYR_R1_POLY where PROJ_AGE_1 < 140 and PROJ_HEIGHT_1 > 6; with subtraction of data generated for FOREST_HARVESTED_1980_AFTER variable |
| FOREST_100 | Pct watershed area of forest with age greater than or equal to 100 years | WHSE_FOREST_VEGETATION. VEG_COMP_LYR_R1_POLY | PROJ_AGE_1 >= 100 |
| FOREST_OLD_GROWTH | Pct watershed area of forest with age greater than 140 years and greater than 6 m in height | WHSE_FOREST_VEGETATION. VEG_COMP_LYR_R1_POLY | PROJ_AGE_1 >= 140 AND PROJ_HEIGHT_1 > 6 |
| FOREST_BURNED_1988_AFTER | Pct watershed area of forest burned after 1988 (but after 2008, since the project is for 2008 sample sites) | WHSE_LAND_AND_NATURAL_RESOURCE. PROT_HISTORICAL_FIRE_POLYS_SP | FIRE_YEAR >= 1988 and FIRE_YEAR<= 2008 |
| FOREST_BURNED_2000_BEFORE | Pct watershed area of forest burned before 2000 | WHSE_LAND_AND_NATURAL_RESOURCE. PROT_HISTORICAL_FIRE_POLYS_SP | FIRE_YEAR < 2000 |
| FOREST_HARVESTED_1980_AFTER | Pct watershed area of forest harvested after 1980 | WHSE_FOREST_VEGETATION. VEG_COMP_LYR_R1_POLY, WHSE_FOREST_VEGETATION. RSLT_OPENING_SVW | WHSE_FOREST_VEGETATION.VEG_COMP_LYR_R1_POLY where (HARVEST_DATE IS NOT NULL) AND (HARVEST_DATE >= date '1980-01-01 00:00:00') AND (HARVEST_DATE < date '2008-01-01 00:00:00'); and<br><br>WHSE_FOREST_VEGETATION.RSLT_OPENING_SVW where ((DISTURBANCE_START_DATE >= date '1980-01-01 00:00:00' AND DISTURBANCE_START_DATE < date 2008-01-01 00:00:00') OR (DISTURBANCE_END_DATE >= date '1980-01-01 00:00:00' AND DISTURBANCE_END_DATE < date '2008-01-01 00:00:00')) AND DENUDATION_1_DISTURBANCE_CODE IN ('L') |
| AGRICULTURE_AREA | Total Pct watershed area classified as agriculture | WHSE_BASEMAPPING. BTM_PRESENT_LAND_USE_V1_SVW | PRESENT_LAND_USE_LABEL = 'Agriculture' |
| ALPINE_AREA | Pct watershed area classified as alpine | WHSE_BASEMAPPING. BTM_PRESENT_LAND_USE_V1_SVW | PRESENT_LAND_USE_LABEL = 'Alpine' |
| AVALANCHE_AREA | Pct watershed area classified as sub-alpine avalanche chute | WHSE_BASEMAPPING. BTM_PRESENT_LAND_USE_V1_SVW | PRESENT_LAND_USE_LABEL = 'Sub alpine Avalanche Chutes' |

| | | | |
|---|---|---|---|
| BARREN_AREA | Pct watershed area classified as barren surfaces | WHSE_BASEMAPPING. BTM_PRESENT_LAND_USE_V1_SVW | PRESENT_LAND_USE_LABEL = 'Barren Surfaces' |
| MINING_AREA | Pct watershed area classified as mining | WHSE_BASEMAPPING. BTM_PRESENT_LAND_USE_V1_SVW | PRESENT_LAND_USE_LABEL = 'Mining' |
| URBAN_AREA | Pct watershed area classified as urban | WHSE_BASEMAPPING. BTM_PRESENT_LAND_USE_V1_SVW | PRESENT_LAND_USE_LABEL = 'Urban' |
| RANGELANDS_AREA | Pct watershed area classified as range lands | WHSE_BASEMAPPING. BTM_PRESENT_LAND_USE_V1_SVW | PRESENT_LAND_USE_LABEL = 'Range Lands' |
| RES_AGRI_AREA | Pct watershed area classified as residential agriculture mixtures | WHSE_BASEMAPPING. BTM_PRESENT_LAND_USE_V1_SVW | PRESENT_LAND_USE_LABEL = 'Residential Agriculture Mixtures' |
| ROADS_LENGTH | Length (km) of roads within sample site watershed | WHSE_BASEMAPPING. DRA_DIGITAL_ROAD_ATLAS_LINE_SP | |
| MINES_ACTIVE | Number of active/producing mines | WHSE_MINERAL_TENURE. MINFIL_MINERAL_FILE | STATUS_CODE IN ('PROD') |
| SITE_ELEVATION | The elevation (meters) of the sample site. | BC DEM | calculated by python script using ArcGIS tools |
| WATERSHED_MAX_ELEVATION | Maximum elevation (meters) of the watershed upstream of sample site | BC DEM | calculated by python script using ArcGIS tools |
| WATERSHED_MIN_ELEVATION | Minimum elevation (meters) of the watershed upstream of sample site | BC DEM | calculated by python script using ArcGIS tools |
| WATERSHED_MEAN_ELEVATION | Mean elevation (meters) of the watershed upstream of sample site | BC DEM | calculated by python script using ArcGIS tools |
| SLOPE_LT30PCNT | Pct watershed area with slope less than 30% | BC DEM | calculated by python script using ArcGIS tools |
| SLOPE_3050PCNT | Pct watershed area with slope 30% to 50% | BC DEM | calculated by python script using ArcGIS tools |
| SLOPE_5060PCNT | Pct watershed area with slope 50% to 60% | BC DEM | calculated by python script using ArcGIS tools |
| SLOPE_GT60PCNT | Pct watershed area with slope greater than 60% | BC DEM | calculated by python script using ArcGIS tools |
| PROTECTEDAREAS_PROV_COUNT | Number of Provincial Protected Areas (provincial parks, ecological reserves, protected areas, recreation areas, conservancy areas, wildlife management areas) | WHSE_TANTALIS. TA_ADMIN_AREA_SHAPES, TA_ADMIN_AREAS | WHSE_TANTALIS.TA_ADMIN_AREA_SHAPES joined to table TA_ADMIN_AREAS where ADMIN_AREA_CDE IN ('CVA', 'OI', 'PA', 'PP', 'RC', 'WMA') AND EXPIRY_DATE IS NULL |

| | | | |
|---|---|---|---|
| PROTECTEDAREAS_PROV_AREA | Pct watershed area of Provincial Protected Areas (provincial parks, ecological reserves, protected areas, recreation areas, conservancy areas, wildlife management areas) | WHSE_TANTALIS. TA_ADMIN_AREA_SHAPES, TA_ADMIN_AREAS | WHSE_TANTALIS.TA_ADMIN_AREA_SHAPES joined to table TA_ADMIN_AREAS where ADMIN_AREA_CDE IN ('CVA', 'OI', 'PA', 'PP', 'RC', 'WMA') AND EXPIRY_DATE IS NULL |
| PARKS_NATIONAL_COUNT | Number of National Parks | WHSE_ADMIN_BOUNDARIES. CLAB_NATIONAL_PARKS | |
| PARKS_NATIONAL_AREA | Pct watershed area designated as National Parks | WHSE_ADMIN_BOUNDARIES. CLAB_NATIONAL_PARKS | |
| ALR_AREA | Pct watershed area designated as Agricultural Land Reserve use (ALR) | WHSE_ADMIN_BOUNDARIES. ALC_AGRI_LAND_RESERVE_POLYS | |
| BEDROCK_SEDIMENTARY_AREA | Pct watershed area of bedrock classified as sedimentary | WHSE_MINERAL_TENURE. GEOL_BEDROCK_UNIT_POLY_SVW | ROCK_CLASS = 'sedimentary rocks' |
| BEDROCK_INTRUSIVE_AREA | Pct watershed area of bedrock classified as intrusive | WHSE_MINERAL_TENURE. GEOL_BEDROCK_UNIT_POLY_SVW | ROCK_CLASS = 'intrusive rocks' |
| BEDROCK_VOLCANIC_AREA | Pct watershed area of bedrock classified as volcanic | WHSE_MINERAL_TENURE. GEOL_BEDROCK_UNIT_POLY_SVW | ROCK_CLASS = 'volcanic rocks' |
| BEDROCK_METAMORPHIC_AREA | Pct watershed area of bedrock classified as metamorphic | WHSE_MINERAL_TENURE. GEOL_BEDROCK_UNIT_POLY_SVW | ROCK_CLASS = 'metamorphic rocks' |
| BEDROCK_ULTRAMAFIC_AREA | Pct watershed area of bedrock classified as ultramafic | WHSE_MINERAL_TENURE. GEOL_BEDROCK_UNIT_POLY_SVW | ROCK_CLASS = 'ultramafic rocks' |
| BEC_ZONE_BAFA_AREA | Pct watershed area of BEC (Biogeoclimatic Ecosystem Classification) zone classified as BAFA | WHSE_FOREST_VEGETATION. BEC_BIOGEOCLIMATIC_POLY | ZONE = 'BAFA' |
| BEC_ZONE_BG_AREA | Pct watershed area of BEC zone classified as BG | WHSE_FOREST_VEGETATION. BEC_BIOGEOCLIMATIC_POLY | ZONE = 'BG' |
| BEC_ZONE_BWBS_AREA | Pct watershed area of BEC zone classified as BWBS | WHSE_FOREST_VEGETATION. BEC_BIOGEOCLIMATIC_POLY | ZONE = 'BWBS' |
| BEC_ZONE_CDF_AREA | Pct watershed area of BEC zone classified as CDF | WHSE_FOREST_VEGETATION. BEC_BIOGEOCLIMATIC_POLY | ZONE = 'CDF' |
| BEC_ZONE_CMA_AREA | Pct watershed area of BEC zone classified as CMA | WHSE_FOREST_VEGETATION. BEC_BIOGEOCLIMATIC_POLY | ZONE = 'CMA' |
| BEC_ZONE_CWH_AREA | Pct watershed area of BEC zone classified as CWH | WHSE_FOREST_VEGETATION BEC_BIOGEOCLIMATIC_POLY | ZONE = 'CWH' |
| BEC_ZONE_ESSF_AREA | Pct watershed area of BEC zone classified as ESSF | WHSE_FOREST_VEGETATION. BEC_BIOGEOCLIMATIC_POLY | ZONE = 'ESSF' |
| BEC_ZONE_ICH_AREA | Pct watershed area of BEC zone classified as ICH | WHSE_FOREST_VEGETATION .BEC_BIOGEOCLIMATIC_POLY | ZONE = 'ICH' |
| BEC_ZONE_IDF_AREA | Pct watershed area of BEC zone classified as IDF | WHSE_FOREST_VEGETATION. BEC_BIOGEOCLIMATIC_POLY | ZONE = 'IDF' |

| | | | |
|---|---|---|---|
| BEC_ZONE_IMA_AREA | Pct watershed area of BEC zone classified as IMA | WHSE_FOREST_VEGETATION.BEC_BIOGEOCLIMATIC_POLY | ZONE = 'IMA' |
| BEC_ZONE_MH_AREA | Pct watershed area of BEC zone classified as MH | WHSE_FOREST_VEGETATION.BEC_BIOGEOCLIMATIC_POLY | ZONE = 'MH' |
| BEC_ZONE_MS_AREA | Pct watershed area of BEC zone classified as MS | WHSE_FOREST_VEGETATION.BEC_BIOGEOCLIMATIC_POLY | ZONE = 'MS' |
| BEC_ZONE_PP_AREA | Pct watershed area of BEC zone classified as PP | WHSE_FOREST_VEGETATION.BEC_BIOGEOCLIMATIC_POLY | ZONE = 'PP' |
| BEC_ZONE_SBPS_AREA | Pct watershed area of BEC zone classified as SBPS | WHSE_FOREST_VEGETATION.BEC_BIOGEOCLIMATIC_POLY | ZONE = 'SBPS' |
| BEC_ZONE_SBS_AREA | Pct watershed area of BEC zone classified as SBS | WHSE_FOREST_VEGETATION.BEC_BIOGEOCLIMATIC_POLY | ZONE = 'SBS' |
| BEC_ZONE_SWB_AREA | Pct watershed area of BEC zone classified as SWB | WHSE_FOREST_VEGETATION.BEC_BIOGEOCLIMATIC_POLY | ZONE = 'SWB' |
| CLIMATEDATA_1961_1990_NORMALS_BIO_01 - various fields | 1961-1990 climate normals data: The calculated mean value for each climate variable. | raster surfaces representing various climate data, as provided by the Canadian Forest Service | calculated by python script using ArcGIS tools |
| CLIMATEDATA_1971_2000_NORMALS_BIO_01 - various fields | 1971-2000 climate normals data: The calculated mean value for each climate variable. | raster surfaces representing various climate data, as provided by the Canadian Forest Service | calculated by python script using ArcGIS tools |