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National Scale Frameworks HYDROLOGY
Version 6.0
A practical guide to the datasets

The National Scale Frameworks datasets are available for download from the GeoGratis web site (http://geogratis.gc.ca). Metadata for these datasets is also available from GeoGratis. This document is intended as a guide to understanding and using the various datasets within the Hydrology Frameworks Theme. This document is not meant to replace the metadata, but rather to complement it.

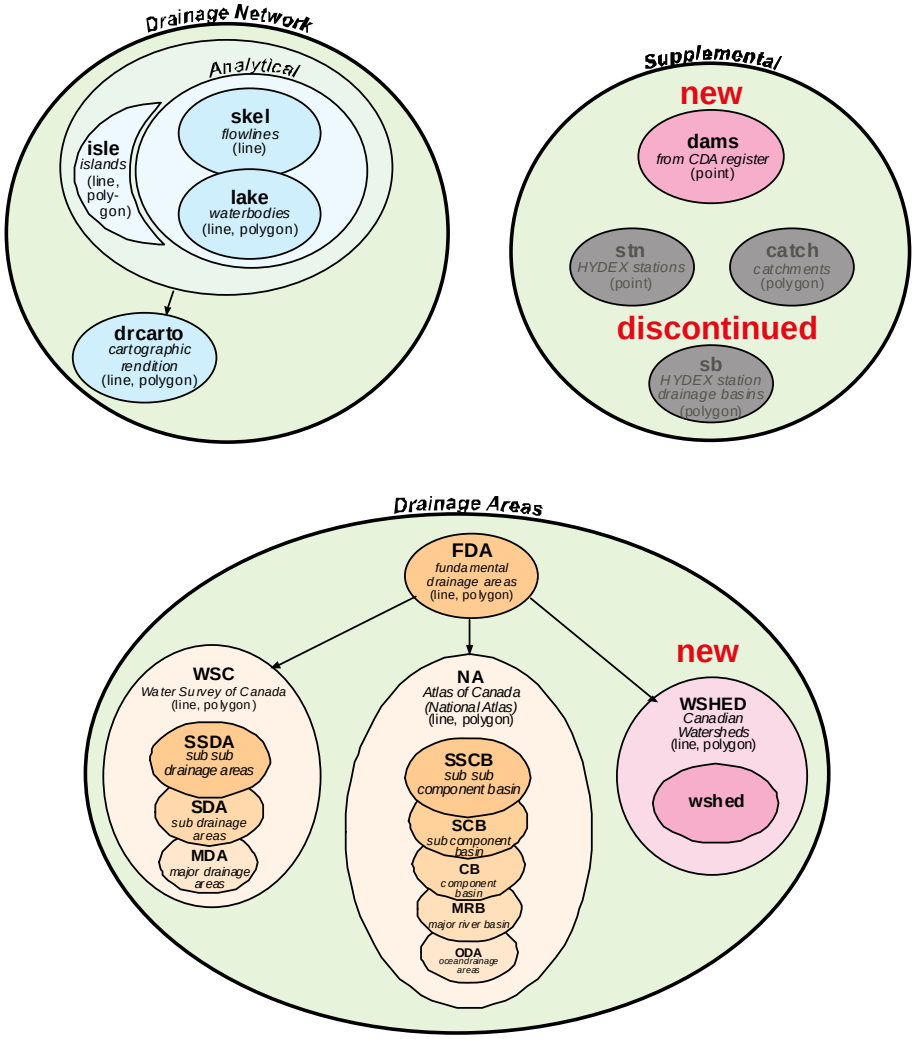

Figure 1: Hydrology datasets.
Arrows indicate derivation (e.g. **drcato** is derived from the **skel, lake** and **isle** datasets).

Table of Contents

1. Introduction

1.1 Atlas of Canada's National Scale Frameworks

The Atlas of Canada's National Scale Frameworks are a collection of integrated geospatial datasets at the 1:1 000 000 scale representing physical, human and environmental themes. This collection consists of the following themes:

- Atlas of Canada 1,000,000 National Frameworks Data, Administrative Boundaries
- Atlas of Canada 1,000,000 National Frameworks Data, Hydrology - Drainage Network
- Atlas of Canada 1,000,000 National Frameworks Data, Rail Network
- Atlas of Canada 1,000,000 National Frameworks Data, Road Network
- Atlas of Canada 1,000,000 National Frameworks Data, Hydrology - Drainage Areas
- Atlas of Canada 1,000,000 National Frameworks Data, Hydrology - Dams
- Atlas of Canada 1,000,000 National Frameworks Data, Protected Areas
- Atlas of Canada 1,000,000 National Frameworks Data, Canadian Place Names
- Atlas of Canada 1,000,000 National Frameworks Data, Census Subdivisions and Population Ecumene

The datasets in these themes have been derived from a variety of sources and integrated so that the data's relative positions are correct. This data is for use at the 1:1 000 000 scale, and reflects the accuracy and detail appropriate to a national scale view. These frameworks are available free of charge on-line via the GeoConnections Discovery Portal at www.geogratis.gc.ca.

In addition, the Atlas of Canada's National Scale Frameworks collection forms a base to which an increasing number of national-scale thematic frameworks from other Federal Government agencies are being integrated (e.g. Ecological Regions, Administrative Boundaries, Census Sub-divisions).

1.2 Lineage of Hydrology datasets

The Vector Map (VMAP) data product is a global digital dataset produced and maintained by the United States National Imagery and Mapping Agency. This agency, known as NIMA, is at http://www.nima.mil. VMAP data is produced at several nominal scales, known as Level 0, Level 1, and Level 2. The Atlas of Canada adapted the hydrographic layers of the 1:1-million VMAP Level 0 data for use as a framework to which thematic layers can be added, and from which frameworks for other, smaller map scales can be created. The original data is hereinafter referred to as VMAP0.

The VMAP0 data was first released, in 1992, as the DCW (Digital Chart of the World), the first digital multi-theme dataset at such a large scale to be available in the public domain. The DCW was, in turn, digitized from the 1:1-million ONC (Operational Navigational Chart) series of paper maps, which was co-produced by the military mapping agencies of Canada, United States, United Kingdom, and Australia. This series of maps was designed for air navigation, and has been used for military operation planning and intelligence briefings.

Despite its success, DCW data was known to have some deficiencies. Various revised versions have been subsequently issued. Although the quality of the North American data in VMAP0 Revision 4 was much better than in previous versions, it still needed considerable further improvement before it could be used by the Atlas of Canada.

The Atlas of Canada made extensive modifications to the geometry and attributes of the VMAP0 data and released it on Natural Resources Canada's **GeoGratis** website in December 2000. "National Scale Frameworks Hydrology" version 5.0, released in 2003, added Drainage Areas, Hydrometric Stations, "catchments" and drainage areas for hydrometric stations to the collection.

Version 6.0 was released in December 2008, with additional improvements to completeness and accuracy. A selection of dams was added, but neither catchments nor drainage areas for hydrometric stations have been updated.

For more information, see the process sections of the metadata for the various National Scale Frameworks Hydrology datasets, available through http://geogratis.gc.ca.

1.3 Accuracy and Completeness

The data completeness and accuracy of National Scale Frameworks Hydrology, version 5.0, reflects the content of the original VMAP0 revision 4 hydrographic layers except where revision editing has been performed. In general, the positional accuracy is within 1300 metres. The selection of features is intended for a scale of 1:1 000 000. Users are cautioned that attempts to integrate this data with larger-scale datasets will meet with varying degrees of success.

As of December 2000, much work had gone into building a hydrologic **network** from VMAP0 data, including corrections to the directionality, connectivity, and attribution. The current release of the National Scale Framework Hydrology (version 6.0) has undergone a further round of improvement as a result of its integration with the drainage area database of the Water Survey of Canada (WSC). Errors in connectivity, directionality, and completeness were discovered and corrected throughout the area covered by the WSC (all of Canada, and extending somewhat into the USA), but particularly in areas adjacent to WSC drainage area boundaries. Many of the corrections were made using the topographic maps (1:250 000 scale) from the National Topographic Data Base (NTDB) as a guide.

The parts of the drainage network extending into the United States were checked for connectivity and directionality against USGS (United States Geological Survey) Hydrologic Unit Boundaries compiled at 1:2-million. The drainage within each USGS Hydrologic Cataloging Unit was tested to ensure it did not cross a Unit boundary, and that it drained though the correct point on the Unit boundary. Corrections were made using, as a guide, the 1:500 000 Hydrologic Unit Map series (1974) from the United States Geological Survey. Drainage in the USA that was not verified has been excluded from the dataset.

1.4 Feature attribute codes

Where possible, the feature coding scheme and attribute items conform to the Feature Attribute Coding Catalogue (FACC) of the Digital Geographic Information Exchange Standard (or DIGEST). Some features are not included in the FACC, so new attributes and feature code values were created. The codes used in the Hydrology Frameworks Theme are listed in section 2.5. (For more information on DIGEST, see http://www.digest.org)

1.5 Data file formats

The Atlas of Canada National Scale Frameworks datasets are offered in both shapefile and e00 formats. The datasets were created and maintained in the ArcInfo coverage format, but to make the data as software-independent as possible the widely-used shapefile format is also provided. There are some differences in how the feature classes (point, line, polygon) are stored in ArcInfo coverages and shapefiles. In particular, the term "polygon" means different things in each format. See Appendix 1 for an explanation.

1.6 Downloading the data: geographic extents

Most of the Atlas of Canada National Scale Frameworks datasets are provided as full-country datasets. However, due to their large size, processing some of the hydrology datasets was often inefficient and sometimes impossible. Therefore, early in their evolution, it was determined that the hydrology datasets must be divided into pieces that were of manageable size. It was important that these divisions were made along natural drainage divides so as not to interfere with network analysis. However, neither of the national drainage area hierarchies (those of the Water Survey of Canada or the Atlas of Canada) provided a satisfactory way of dividing up the country— some of the resulting divisions would still have been too large. Several different schemes have been used in past releases. For the most recent Frameworks release (version 5.0) the Hydrology datasets were maintained and processed as thirteen hydrologically distinct Drainage Processing Units (DPUs): Albany, Arctic, Hudson, Mackenzie, Maritimes, Mississippi, Nelson, Newfoundland, Nwquebec, Pacific, Queen, Stlawrence, and Yukon (see figure 2).

For release, most of the Hydrology datasets are offered in either a full-country dataset or as single DPUs. The full-country datasets have been reassembled from the thirteen DPUs.

Filenames for the Hydrology datasets begin with the first five characters of the DPU name (e.g. alban, arcti, etc) or, for a full-country dataset with "canad".

The boundaries between DPUs normally follow heights-of-land, but there are several places where rivers or lakes must necessarily cross the DPU boundaries due to human redirection of water flow.

Because of their relatively small file size, the ten drainage area datasets (1 FDA, 3 WSC, 5 NA, 1 WSHED) are available only as full-country datasets — offering each drainage area dataset by DPU would have required the user to choose from an additional 117 download files!

Figure 2: Drainage Processing Units (DPUs)

Dataset	available as full country	available in 13 DPUs	available by province
drnetwork: network skeleton (skel)	√	√	-
drnetwork: waterbodies (lake)	√	√	-
drnetwork: islands (isle)	√	√	-
cartographic (drcarto)	√	-	√
drainage areas (fda, wsc, na)	√	-	-
dams (dam)	√	-	-

Figure 3

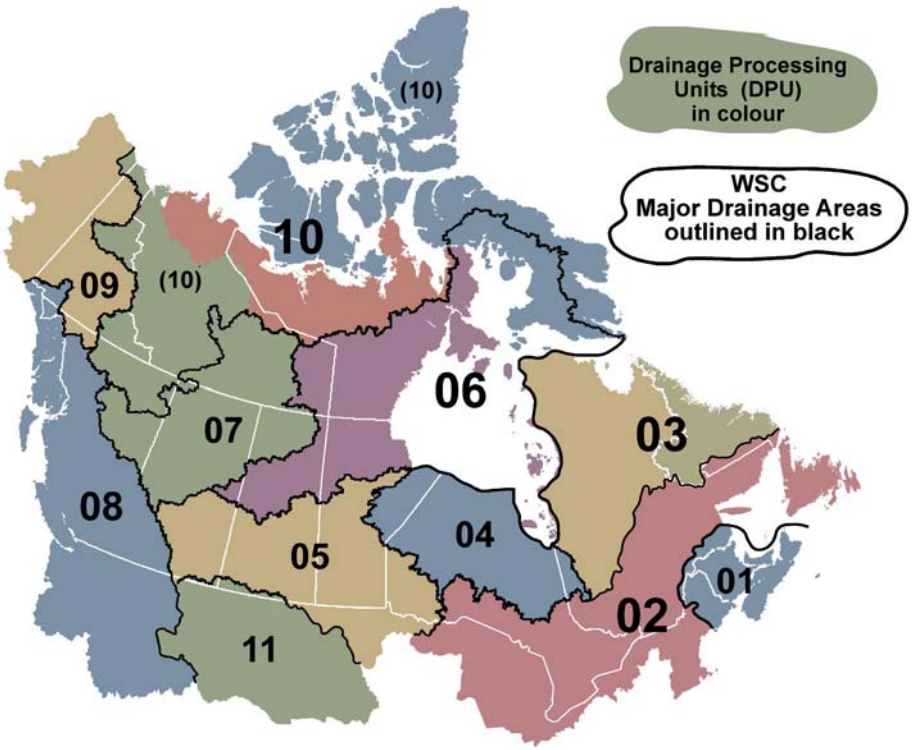

Figure 4: Comparison of WSC Major Drainage Areas and DPUs

Figure 5: Comparison of National Atlas Ocean Drainage Areas and DPUs

The following list shows which Drainage Processing Units are needed to acquire data contained in a complete WSC Major Drainage Area. A "perfect match" means the relevant boundaries of the DPU and the WSC drainage area match exactly. But for WSC Major Drainage Areas 06, 07, or 10, the required DPUs contain pieces of other Major Drainage Areas. Refer to figures 4 and 2.

WSC Major Drainage Area	**Drainage Processing Unit**
01	Maritimes *(perfect match)*
02	Stlawrence *(perfect match)*
03	Newfoundland, Nwquebec *(perfect match)*
04	Albany *(perfect match)*
05	Nelson *(perfect match)*
06	Arctic, Hudson
07	Mackenzie
08	Pacific *(perfect match)*
09	Yukon *(perfect match)*
10	Arctic, Mackenzie, Queen
11	Mississippi *(perfect match)*

Note that drainage is diverted from one Major Drainage Area to another in two cases:

1. WSC Major Drainage Area: from 06 to 05
   (Drainage Processing Units: from Hudson to Nelson)

2. WSC Major Drainage Area: from 04 to 02
   (NA Ocean Drainage Areas: Hudson Bay to Atlantic)
   (Drainage Processing Units: from Albany to Stlawrence)

The following list shows which Drainage Processing Units are needed to acquire a complete National Atlas Ocean Drainage Area. Refer to figures 5 and 2.

NA Ocean Drainage Area	**Drainage Processing Unit**
Atlantic	Maritimes, Newfoundland, Stlawrence *(perfect match)*
Hudson Bay	Arctic, Albany, Hudson, Nelson, Nwquebec
Arctic	Arctic, Mackenzie, Queen
Pacific	Pacific, Yukon *(perfect match)*
Gulf of Mexico	Mississippi *(perfect match)*

2. Drainage Network datasets

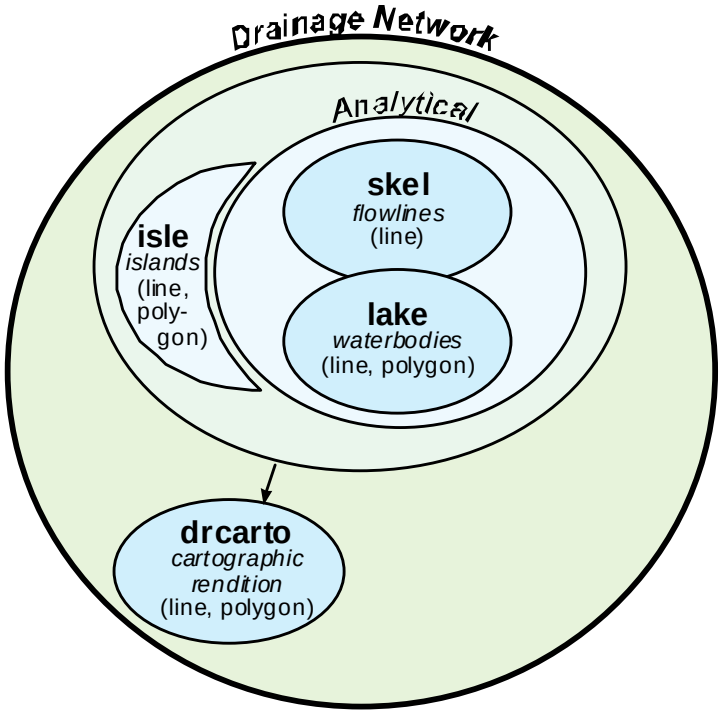

Figure 6

A simplified diagram of relationships between the Drainage Network datasets.

The **skel** and **lake** datasets are the "analytical" datasets – they have the topological and attribute relationships that support drainage network analysis (connectivity, stream ordering, sink/source attributes, etc). For download, they are bundled together with the relatively small isle dataset.

The **drcarto** dataset, derived from elements of the skel, lake and isle datasets, is a cartographic rendition of the drainage network.

More complete descriptions of these datasets follow:

Relationship of Drainage network datasets

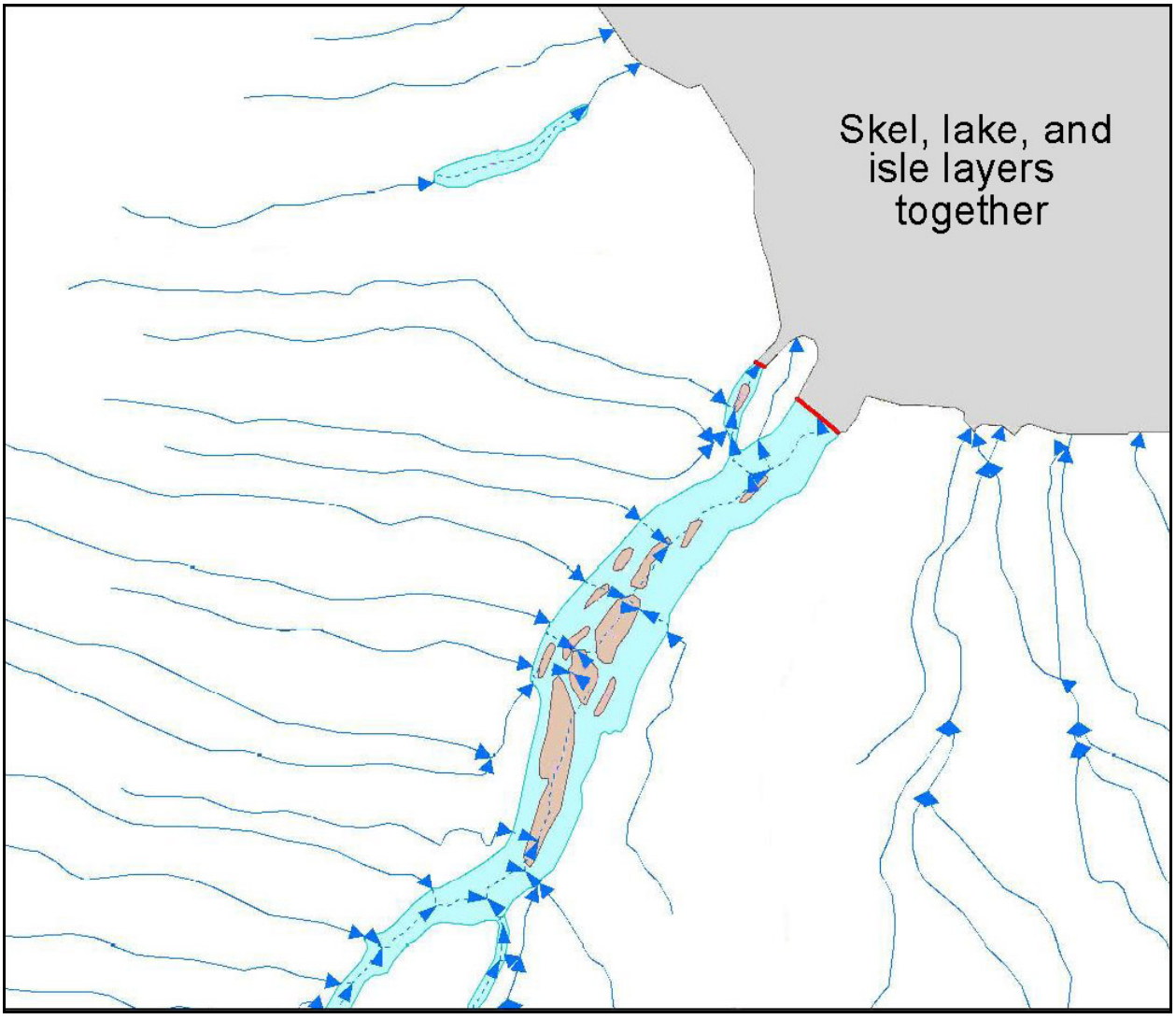

Figure 7

Skel, lake and isle datasets overlaid one upon the other.
Compare this figure with figures 8, 10 and 12 showing each dataset in isolation.

2.1 **Drainage network skeleton** ("skel")

Dataset: Drainage network skeleton
Filename tag: skel (e.g. alban**skel**_l.shp, canad**skel**.e00)
Contained in: files with the **drnetwork** tag (e.g. arcti**drnetwork**_v6.0_shp.zip)
Extents available: Full country, or any of 13 DPUs
Feature Classes: line only

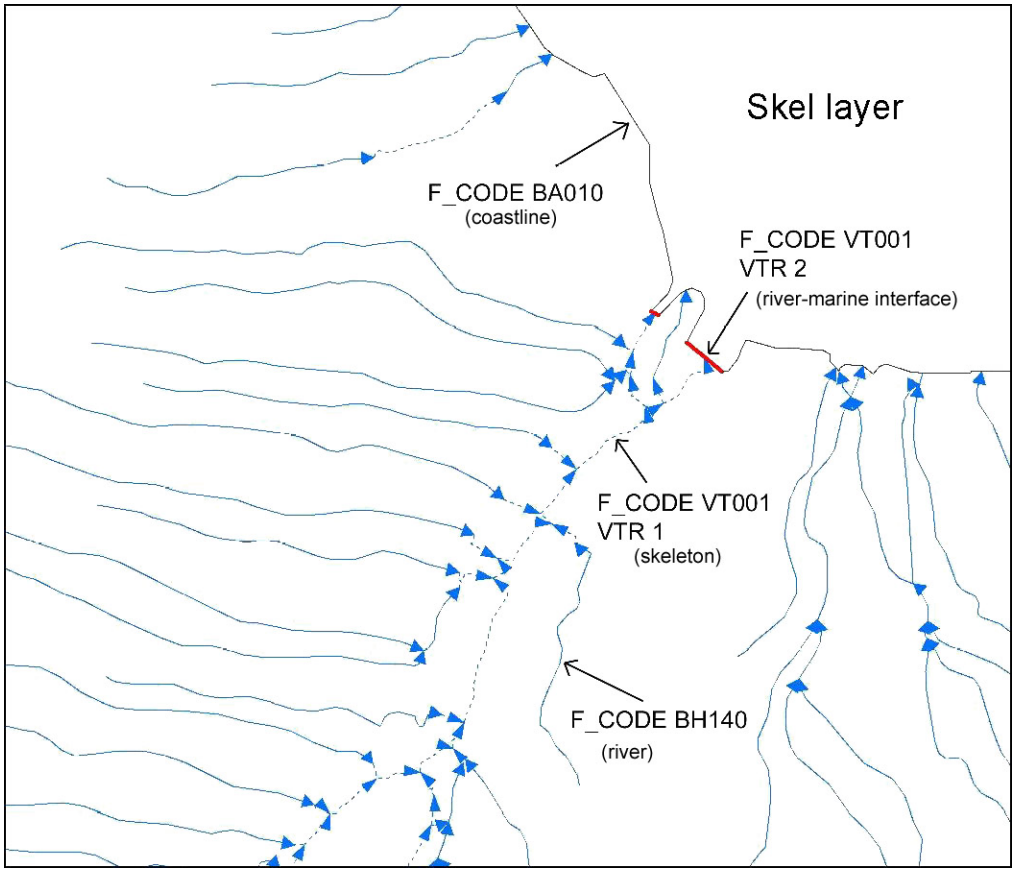

Figure 8

Features in the skel dataset (compare with figure 7.)

The **skel** dataset contains rivers, river skeletons (flow lines through lakes), and coastline (including ocean islands). There are also several types of virtual features such as the river-marine interface, used to stand in for the coastline when a double-line river meets the ocean. Datasets downloaded as a DPU (i.e. not the full country) also have a "neatline" separating the DPU from adjacent DPUs.

The directions of river and skeleton arcs have been corrected where needed to ensure they all flow in the right direction (downhill, to the coast).

The skel dataset also includes names of many rivers. The names included are those found in the *Concise Gazetteer of Canada*, a 1997 publication of the Geographical Names Board of Canada. The rivers are tagged with the five-letter unique ID (the CGNDB name key), the 32-character CGNS key, and with the English and French versions of the feature name.

SKEL: line attributes

	NAME	WIDTH	OUTPUT	TYPE
Unique Identifier ←	UID_V6	4	12	B
Drainage Attributes {	F_CODE	5	5	C
	HYC	2	6	B
	VTR	2	6	B
Sink/Source ←	YSS	4	6	B
ID of Lake polygon ←	LAKEUID	4	12	B
CGNDB Names {	NAME_EN	88	88	C
	NOM_FR	88	88	C
CGNDB Keys {	CGNDB_EN	5	5	C
	CGNDB_FR	5	5	C
CGNS Feature ID ←	CGNS_FID	32	32	C
Edit Date ←	DATE_E	8	8	C

Figure 9

Line attributes for the skel dataset.

(Note: The attribute description tables in this document are taken from the ArcInfo coverages. In these tables **Width** is the width of the data field; **Output** is the number of ASCII characters used to displaying attribute values; **Type** can be **B**inary, **F**loating point, **I**nteger, or **C**haracter.)

UID_V6: Unique feature identifier.

F_CODE: The DIGEST feature code. This is the principal feature code used in this dataset. Most values are found in the DIGEST standard, but several non-standard values had to be introduced to describe features not covered by the DIGEST (www.digest.org). For example, all "virtual" features (e.g. river skeletons, river-marine interfaces, etc.) have an F_CODE value of VT001, which are further qualified by the VTR attribute. See the table of Drainage Network feature codes, section 2.5.

HYC: A DIGEST code. Qualifies a feature as either permanent (value 8) or non-permanent (value 6). For example, rivers that dry up seasonally have HYC = 6.

VTR: Non-DIGEST code to qualify features with F_CODE = VT001. See the table of Drainage Network feature codes, section 2.5.

YSS: Non-DIGEST code to signify sink nodes (value 1) or source nodes (value 2). Certain processing steps require that sinks and sources be identified. Each river or skeleton arc has a "from-node" and a "to-node" in agreement with the direction of flow. Most nodes in the network are shared by at least 2 river/skel arcs, and most are neither sink nor source. By default, to-nodes that occur on the coastline (or on a river-marine interface) are sinks, and from-nodes that are not shared by two or more arcs are sources. A small number of nodes don't fall into these categories and must be explicitly coded as source or sink (e.g. a river that disappears into a bog or a salt lake).
Originally the nodes were coded with YSS values, but technical problems arose and the feature attributes of nodes were becoming corrupted. So the YSS attribute is being carried by the arc just upstream of a sink node, or just downstream of a source node, effectively creating sink and source arcs. When required, the attribute can be transferred back to the nodes just prior to processing.

LAKEUID: Water flowing through the drainage network passes through rivers (arcs) and lakes (polygons). In order to simplify network analysis, the flow through lakes is represented by linear "lake skeleton" features. In some applications it is desirable to identify or link a lake

polygon with the skeleton feature that flows through it. The LAKEUID attribute is simply the UID of the corresponding lake polygon in the LAKE polygon dataset.

NAME_EN, NOM_FR: Official names from the Canadian Geographical Names Data Base (http://geonames.nrcan.gc.ca/index_e.php) were attached to those features in Drainage Network that also appear in the *Concise Gazetteer of Canada*. The majority of features have a single name in the CGNDB — for these, the same name has been used for both NAME_EN and NOM_FR. The small number of features that have more than one official name (e.g. Lake Ontario and Lac Ontario) have different values for NAME_EN and NOM_FR.

CGNDB_EN, CGNDB_FR: This is a modification of the naming system used by the Canadian Geographical Names Data Base (CGNDB). In the CGNDB, each official name for each distinct feature has a unique 5-character key. This key helps distinguish between different features with the same official name. For example, there are 24 different Salmon Rivers in the CGNDB — one Salmon River in Newfoundland has the key "AAWYX"; one in British Columbia has "JAYKU".

The modification to the CGNDB's system is due to the fact that some features cross provincial or territorial boundaries. Even where a feature has the same name in different provinces, the CGNDB has a unique key for that feature in every province/territory. Rather than having multiple keys for the same feature, the values of CGNDB_EN and CGNDB_FR are consistent for the full extent of the feature in this data. For example, the Saskatchewan River in Manitoba has the key GAYJF, but in Saskatchewan it has the key HAHJI. For the CGNDB_EN attribute, the value GAYJF was arbitrarily chosen for the entire river. Its official French name (Rivière Saskatchewan) in Manitoba has the key GBFJX, which was used as the French name for all parts of the river.

Note that CGNDB keys are associated with the names of geographic features, not with the features themselves.

CGNS_FID: The unique feature identifier for geographic features. . "The **Geographical Names Section** of Natural Resources Canada has recently upgraded the technology it uses to provide geographical names data to the public. The new facility is called the **Canadian Geographical Names Service** (CGNS)." (http://gnss.nrcan.gc.ca/index_e.html). The feature ID is a 32-character code associated with the feature itself, so that if the name of the feature changes in the future, the features unique identifier remains unchanged. Features with separate English and French names have a single CGND_FID. For instance. the Saskatchewan River has a French form, Rivière Saskatchewan, but the river itself has the Feature ID "1ec4f6a2ba3411d892e2080020a0f4c9" -- both forms of the name are associated with this Feature ID.

DATE_E: The date the feature was last edited.

The stream order attributes **BASIN, ORDER1, ORDER2, ORDER3** are no longer maintained at version 6.

2.2 **Waterbodies** ("lake")

Dataset: waterbodies

Filename tag: **lake** (e.g. alban**lake** _v6.0_geog.shp.zip, canad**lake** _p.shp)
Contained in: files with the **drnetwork** tag (e.g. arcti**drnetwork**_v6.0_shp.zip)
Extents available: Full country coverage, or any of 13 DPUs
Feature Classes: e00 format: arc, polygon
shapefile: line, polygon

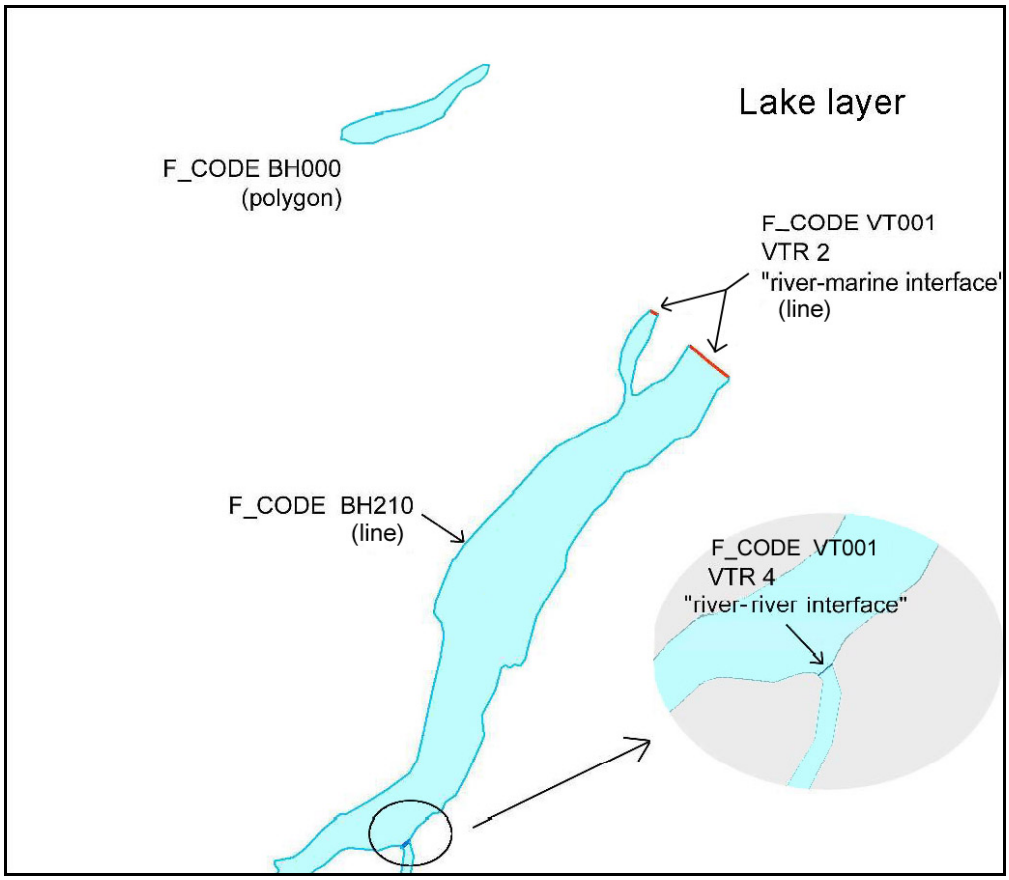

Figure 10

Features in the lake dataset (compare with figure 7.)

The lake dataset contains lake and wetland polygons and "double-line" river polygons (for those rivers too wide to be depicted as a single-line river, such as the Mackenzie River or St. Lawrence River).

Note that double-line rivers are treated (and coded) exactly as if they were lakes. Some area features have been subdivided and several types of virtual linear features serve to separate them. For example, in figure 9, when two different double-line rivers meet, a “river-river interface” is used to separate them.

There are a number of isolated small lakes with no river in the skel dataset to connect them to the drainage network. The Drainage Network coverages (skel, lake, isle) were derived from VMAP0, which was ultimately digitized from aeronautical charts. The generalization of these charts shows a preference for keeping the smaller lakes even though the small rivers connecting them to the drainage network have been dropped.

Also inherited from VMAP0 are a large number of estuaries that are represented and coded as lakes or double-line rivers. Each estuary is closed at the mouth by a virtual arc. In the **skel** dataset, the flow to the ocean is extended to this virtual arc.
For the relationship of lakes to the rivers and islands, see the descriptions of the **skel** and **isle** coverages, and figure 7.

LAKE: line attributes

	NAME	WIDTH	OUTPUT	TYPE
Unique Identifier ←	UID_V6	4	12	B
Drainage Attributes {	F_CODE	5	5	C
	HYC	2	6	B
	VTR	2	6	B
Edit Date ←	DATE_E	8	8	C

LAKE: area attributes

	NAME	WIDTH	OUTPUT	TYPE
Unique Identifier ←	UID_V6	4	12	B
Drainage Attributes {	F_CODE	5	5	C
	HYC	2	6	B
CGNDB Keys {	CGNDB_EN	5	5	C
	CGNDB_FR	5	5	C
CGNDB Names {	NAME_EN	88	88	C
	NOM_FR	88	88	C
CGNS Feature ID ←	CGNS_FID	32	32	C
Edit Date ←	DATE_E	8	8	C

Figure 11

Line and area attributes for the **lake** dataset.
For a description of attributes, see the attributes for the **skel** dataset.

2.3 **Islands** ("isle")

Dataset: islands
Filename tag: **isle** (e.g. alban**isle**_v6.0_geog.e00.zip, canad**isle**_l.shp)
Contained in: files with the **drnetwork** tag (eg arcti**drnetwork**_v6.0_geog.shp.zip)
Extents available: Full country, or any of 13 DPUs
Feature Classes: e00 format: arc, polygon
shapefile: line, polygon

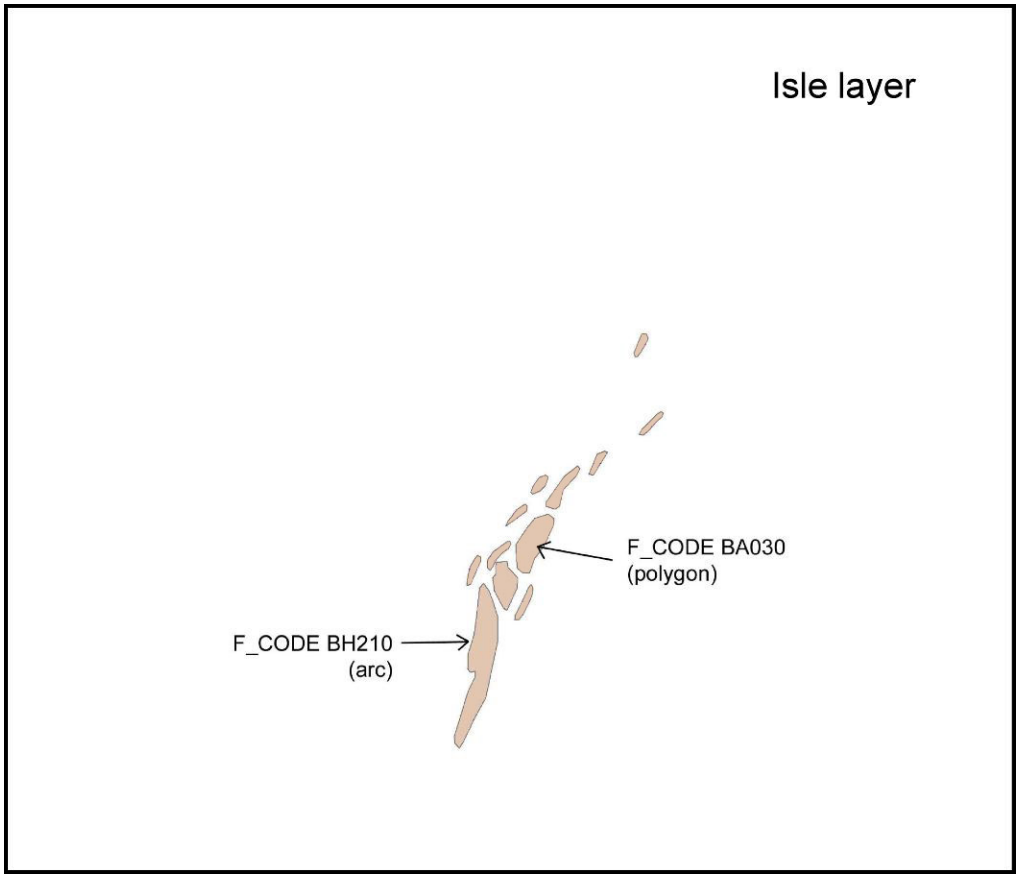

Figure 12

Features in the isle dataset (compare with figure 7.)

The **isle** dataset contains polygons representing the islands lying within lakes. (Islands in oceans are represented by coastline in the skel coverage.) Note that the island dataset is not integrated into the drainage network, and is not meant to be included in drainage network analysis. It exists to complete the cartographic representation of Canadian hydrology. Some islands themselves contain small lakes and rivers, though not significant enough for drainage network analysis. However, such lakes and rivers are included in the isle coverage to complete the cartographic representation.

Note that flowlines within lakes have not been forced to flow around islands. In a few exceptional cases, islands had to be represented by "holes" in the polygons in the lake dataset.

Note also that island boundaries (arcs) are coded as lake boundaries (F_CODE = BH210). LAKEUID is the UID of the lake polygon (in the **lake** dataset) within which the island lies.

ISLE: line attributes

	NAME	WIDTH	OUTPUT	TYPE
Unique Identifier ←	UID_V6	4	12	B
Drainage Attributes {	F_CODE	5	5	C
	HYC	2	6	B
ID of Lake polygon ←	LAKEUID	4	12	B
Edit Date ←	DATE_E	8	8	C

ISLE: line attributes

	NAME	WIDTH	OUTPUT	TYPE
Unique Identifier ←	UID_V6	4	12	B
Drainage Attributes {	F_CODE	5	5	C
	HYC	2	6	B
ID of Lake polygon ←	LAKE_UID	4	12	B
CGNDB Names {	NAME_EN	88	88	C
	NOM_FR	88	88	C
CGNDB Keys {	CGNDB_EN	5	5	C
	CGNDB_FR	5	5	C
CGNS Feature ID ←	CGNS_FID	32	32	C
Edit Date ←	DATE_E	8	8	C

Figure 13

Line and area attributes for the **isle** dataset.
For a description of attributes, see the attributes for the **skel** dataset.

2.4 **Cartographic** ("drcarto")
Dataset: cartographic
Filename tag: **drcarto** (e.g. alban**drcarto**_v6.0_geog.e00.zip, canaddrcarto_l.shp)
Extents available: Full country, or 13 Drainage Processing Units
Feature Classes: e00 format: arc, polygon
shapefile: line, polygon

The Cartographic dataset is suitable for cartographic or display purposes, but not for analysis. It is a derived dataset consisting of a selection of features from the drainage network skeleton, waterbodies, and islands datasets but does not include, for instance, flowlines within lakes. The attributes of this data are a subset of the attributes of the skel, lake and isle datasets.

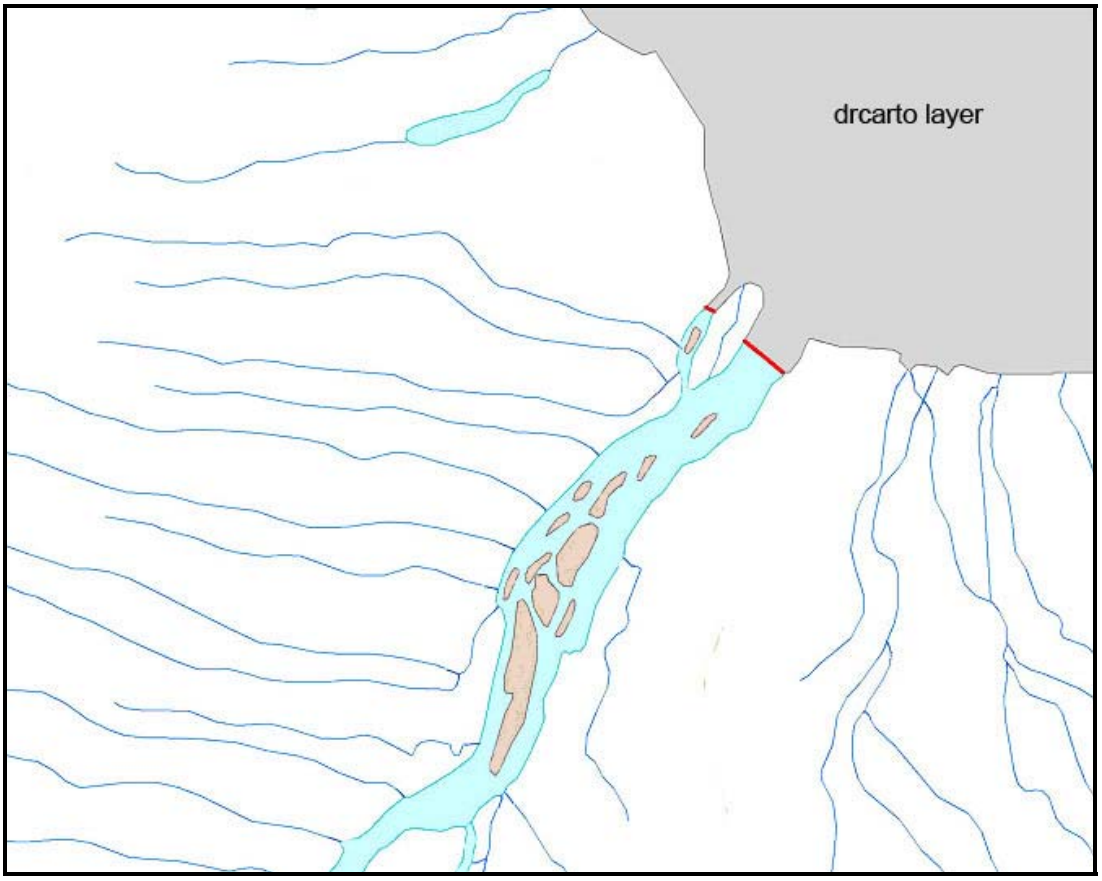

Figure 14

Features in the drcarto dataset (compare with figure 7)

(Note: In the drcarto dataset, there are a small number of lake polygons that were divided into two or more polygons during the process of combining the skel, lake and isle datasets. This occurs where a stream (permanent or intermittent) runs through an intermittent lake. In the drcarto dataset, this divides the intermittent lake into two or more polygons with the same value for UID_V6.

DRCARTO: line attributes

	NAME	WIDTH	OUTPUT	TYPE
Unique Identifier ←	UID_V6	4	12	B
Drainage Attributes {	F_CODE	5	5	C
	HYC	2	6	B
	VTR	2	6	B
CGNDB Names {	NAME_EN	88	88	C
	NOM_FR	88	88	C
CGNDB Keys {	CGNDB_EN	5	5	C
	CGNDB_FR	5	5	C
CGNS Feature ID ←	CGNS_FID	32	32	C
Edit Date ←	DATE_E	8	8	C

DRCARTO: area attributes

	NAME	WIDTH	OUTPUT	TYPE
Unique Identifier ←	UID_V6	4	12	B
Drainage Attributes {	F_CODE	5	5	C
	HYC	2	6	B
CGNDB Names {	NAME_EN	88	88	C
	NOM_FR	88	88	C
CGNDB Keys {	CGNDB_EN	5	5	C
	CGNDB_FR	5	5	C
CGNS Feature ID ←	CGNS_FID	32	32	C
Edit Date ←	DATE_E	8	8	C

Figure 15

Line and area attributes for the **drcarto** dataset.
For a description of attributes, see the attributes for the **skel** dataset.

2.5 Table of selected feature codes

Values for **F_CODE**, **HYC**, and **VTR**, used in Drainage Network datatsets (see descriptions of the attributes in section 2.1).

Line Types	**Dataset**	**F_CODE**	**HYC**	**VTR**
Coastline	Skel	BA010		
River	Skel, lake (boundary between 2 wetlands)	BH140	8	
Lake Boundary	Lake, isle	BH210	8	
Wetland Boundary	lake	BH141		
Lake Skeleton	skel	VT001		1
River-Marine Interface	skel, lake	VT001		2
Lake-Lake Interface	lake	VT001		3
River-River Interface	lake	VT001		4
Marine-Wetland Interface	skel, lake	VT001		5
Underground water connection	skel	VT001		8
Neat Line (DPU boundary)	skel	IA010		
Null Line	potentially any dataset	VT002		
Line that is duplicated from another line	potentially any dataset	VT003		
Polygon Types				
Area of Permanent water – Lakes and Double Line rivers	lake	BH000	8	
Area of Intermittent water	lake	BH000	6	
Islands	isle, lake	BA030		
Null Area	potentially any dataset	VT002		
Area that is duplicated from another line	potentially any dataset	VT003		

3. Drainage Areas

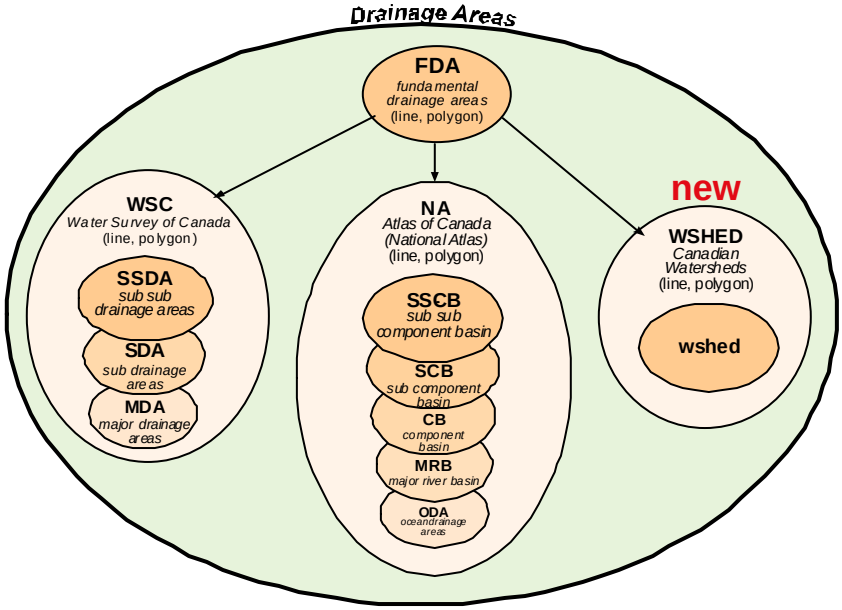

Figure 16

A simplified diagram of relationships between the Drainage Network datasets.

The Fundamental Drainage Areas dataset is the single dataset of drainage areas that is **maintained** by the Atlas of Canada. Built into this dataset, however, are all the features and attributes need to derive the Water Survey of Canada drainage areas, the Atlas of Canada drainage basins, and the Canadian Watersheds.

The Water Survey of Canada's classification scheme for drainage areas has three levels of hierarchy.

Similarly, the National Atlas of Canada's classification scheme has five levels of hierarchy.

The third classification scheme, "Canadian Watersheds", was added at version 6. It is more closely related to the Water Survey of Canada's scheme. For simplicity, it is ignored in this document until section 3.2.3, after the comparison of the other two schemes.

3.1 Overview

3.1 Two National Drainage Area Hierarchies

(See also section 3.2.4 for a description of "Canadian Watersheds", a third drainage area hierarchy added at version 6 in 2008.)

There are two distinct classification schemes for drainage areas at the national level: one classification was defined by the Water Survey of Canada (Environment Canada) and the other by the National Atlas of Canada (now Atlas of Canada). Since each serves a different purpose and both are in use, both are supported and offered here. The following descriptions by Rupert Brooks summarize each well:

> "The Water Survey of Canada (or, as it was known then, the Department of the Interior, Dominion Water Power Branch) first developed, in 1922, a Water Resources Index Inventory as a convenient and logical system for recording and filing water resources data. It was designed for the storage of such information as the location of waterpower sites, waterpower developments, storage reservoirs, stream measurement stations, and meteorological stations. The Water Survey of Canada delineations involved the division, sub-division and sub-sub-division of Canada into suitably sized areas based on the drainage, for administrative purposes. Although the boundaries are based on drainage, the intent was to include all of Canada's land mass and waters within this drainage area hierarchy to facilitate the identification of hydrometeorological sites. Therefore, the WSC drainage areas do not necessarily define individual river basins, but can represent intervening areas along the coast or include islands.
>
> "In 1985, the National Atlas of Canada produced a 1:7.5M-scale "5th Edition - National Atlas of Canada - Drainage Basins" map which depicts the drainage basins for many of the larger rivers of Canada. The National Atlas basin hierarchy has 5 levels, the first of which defines Canada's five ocean drainage areas and covers all of Canada's land mass and waters. The second level defines major river basins and intervening areas and also covers Canada's entire land mass, while the remaining three levels define important river basins without defining the intervening areas or islands. The major criterion used to define a National Atlas basin was a mean annual discharge of at least 280 m3/s at the mouth or confluence of the river. (The exceptions to this are the Assiniboine, Qu'Appelle, Souris, Battle, Red Deer and Oldman rivers).
> [see http://atlas.gc.ca/site/english/archives/5thedition/environment/water/mcr4055]
>
> "Clearly, the WSC classification and the National Atlas classification had very different design goals. Nevertheless, [there is] a high degree of similarity between the two hierarchies. [T]he correlation between the National Atlas drainage areas and the WSC areas is very high. Approximately 95% of the National Atlas boundaries are also WSC boundaries – meaning that, with few exceptions, the National Atlas basins can be derived from the WSC sub-sub-division areas."

(from" Building a Canadian Digital Drainage Area Framework" R. Brooks et al, 2002)

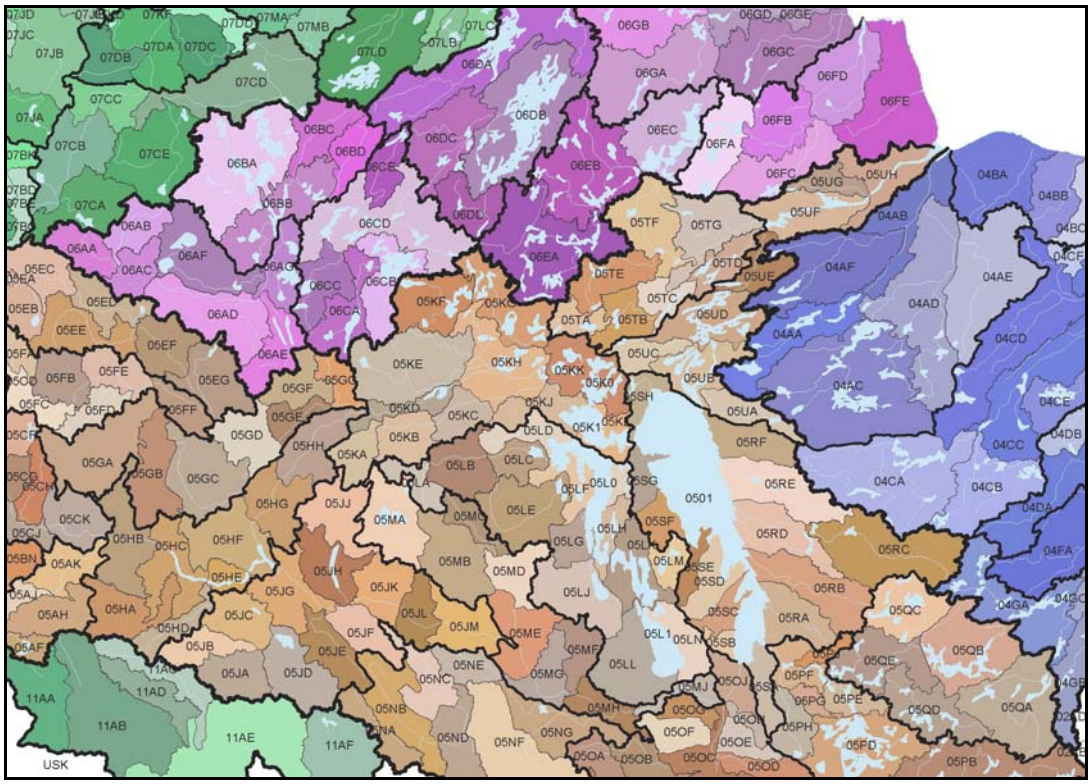

Figure 17: Water Survey of Canada classification scheme (see notes below).

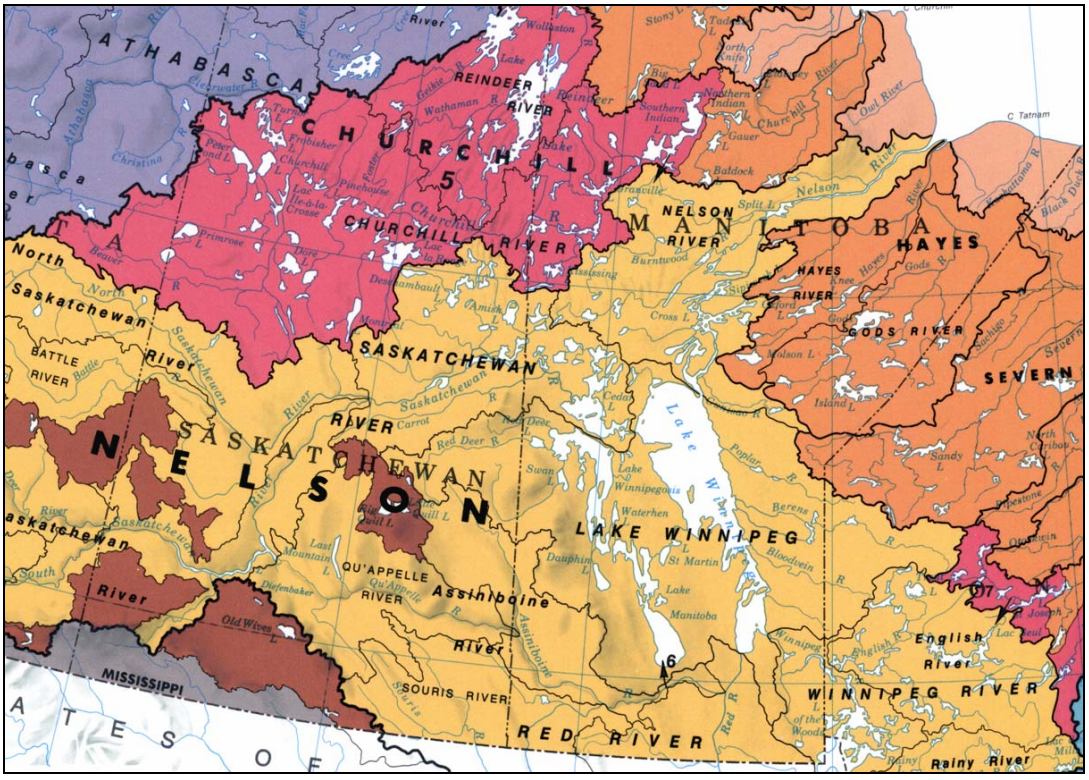

Figure 18: National Atlas of Canada classification scheme (see notes below)

Notes for figures 17 and 18: Figure 17 shows the full Water Survey of Canada classification scheme, with separate colours for each sub-sub-drainage area. WSC Major Drainage Area 05 corresponds to the Nelson River drainage basin. Figure 18 is a section of a printed map showing the same area in the National Atlas of Canada classification scheme. The entire Nelson River drainage basin is in yellow, with its Major River Basins delineated by black lines. The Major River Basins are further subdivided, as needed, using differing type fonts (for example: the Red River, Assiniboine River, and Qu' Appelle River). This map shows internal drainage areas in brown, and uses red to show areas of redirected drainage. *(Compare with Figure 27 in section 3.2.4, showing a third classification scheme, Canadian Watersheds, released with version 6.0 in 2008.)*

Note the distinction made in the WSC and NA datasets between drainage areas and drainage basins, particularly in their file and attribute names. Strictly, in the Hydrology Frameworks Theme, a drainage **basin** is an area that drains all precipitation received as runoff and base flow (from groundwater sources) into a river or stream system **that has a common outlet,** such as a lake, ocean, or a confluence of rivers. In contrast, a drainage **area** can enclose any arbitrary area, and may or may not drain through a single outlet.

Hence the National Atlas classification scheme, built on drainage basins, has large areas of land which are not associated with any drainage basin—they are assigned simply to "ocean seaboard". The WSC classification scheme has many units that are true drainage basins, but also many true basins that have been arbitrarily divided, for administrative purposes, into "drainage areas."

3.1.2 Coding schemes

The WSC hierarchy was designed for administrative purposes. It has three levels of hierarchy and a simple 4-character coding scheme (eg 04CF).

- The first two characters refer to one of the eleven Major Drainage Areas into which the country is divided (01,02,03...11).
- The third character specifies a Sub-Drainage Area within the Major Drainage Area (04A, 04B, 04C, etc.).
- The fourth character specifies a Sub-Sub-Drainage Area (04CA, 04CB, 04CC, etc.).

This coding scheme provides a logical way of moving up or down the level of hierarchy by truncating or extending the code, and every drainage area has an identity at each level of hierarchy.

In contrast, the Atlas of Canada's hierarchy is not as tidy because it only identifies basins whose outflow exceeds a certain threshold. At its broadest level, it does divide the complete country into five ocean drainage areas. However, the sub-partitioning of basins below this level becomes increasingly inconsistent in terms of average size and percentage of the country covered. The first sub-level, Major River Basins, excludes about 30% of the Canadian landmass, and the size of Major River Basins ranges from 3,900 km2 for Wannok in B.C. to 1.7 million km2 for the Mackenzie River. At successively lower levels of the hierarchy, fewer and fewer drainage basins meet the criterion for inclusion. Thus, there are only 15 entities at the most detailed level, the Sub-Sub-Component Basins, versus 40 Major River Basins.

Also, in contrast to the compact, orderly 4-character WSC coding scheme, the National Atlas of Canada drainage areas are identified only by proper names. (The National Atlas of Canada scheme was designed for small-scale maps, and works well for this purpose.)

3.1.3 Fundamental Drainage Area units

In order to maintain both schemes efficiently in a single dataset, a composite set of units called Fundamental Drainage Areas was created to reconcile them. These fundamental units are generally the same as the Water Survey sub-sub-drainage areas, but some sub-sub-drainage areas have been split to accommodate unusual situations.

There were four circumstances where WSC units had to be split.

a) **Water Survey and Atlas Units do not match.** The most common cause for splitting a Water Survey unit occurs when the definitions of drainage areas in the two schemes do not match. A good example of how this is handled is shown by looking at the drainage basin of the Rivière Betsiamites in Quebec (see Figure 19). The Atlas drainage unit corresponds exactly to this river's drainage basin (as defined by starting from the mouth of this river). The drainage basin is covered by two Water Survey sub-sub-divisions: all of 02SA, and part of 02SB. Therefore, to reconcile the Atlas and Water Survey schemes, the Water Survey unit 02SB was split into 02SBA and 02SBB. (Figure 22 shows the way these records would appear in the Fundamental Drainage Area dataset).

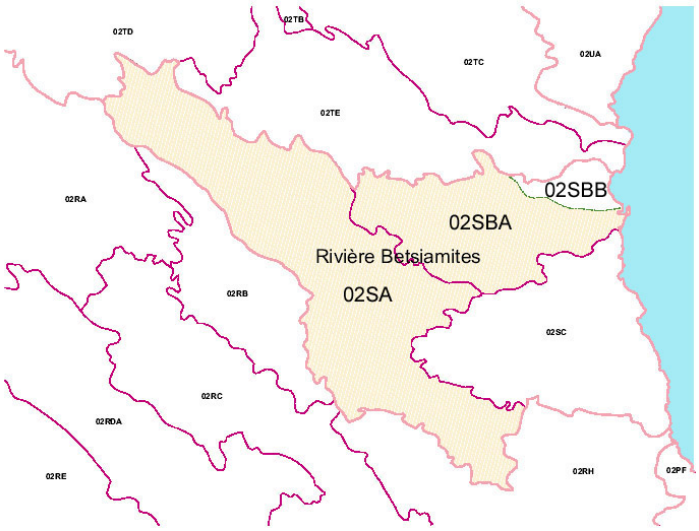

Figure 19

Creating the Betsiamites drainage basin from Water Survey units
(from" Building a Canadian Digital Drainage Area Framework" R. Brooks et al, 2002)

b) Identifying areas of internal drainage. One feature of the National Atlas scheme that is not found in Water Survey units is internal drainage. It is desirable that internal drainage be incorporated into the composite dataset so that "non-contributing" units within a drainage basin can be identified. Figure 20, which shows part of the South Saskatchewan River basin, illustrates this. WSC Sub-sub-drainage areas 05HF and 05HG, which are bounded in red, include some internal drainage (i.e. river networks that have no outlet to the ocean). In the Fundamental Drainage Area scheme, 05HF and 0HG are each split so that the internal drainage areas form separate units. These are the gray areas in Figure 20 labeled 05HFB and 05HGB. These two units are coded as "internal drainage" in the Fundamental Drainage Area dataset. In the WSC dataset, only SSDAs 05HF and 05HG appear, which is why the attribute INTERNAL does not appear in the WSC dataset.

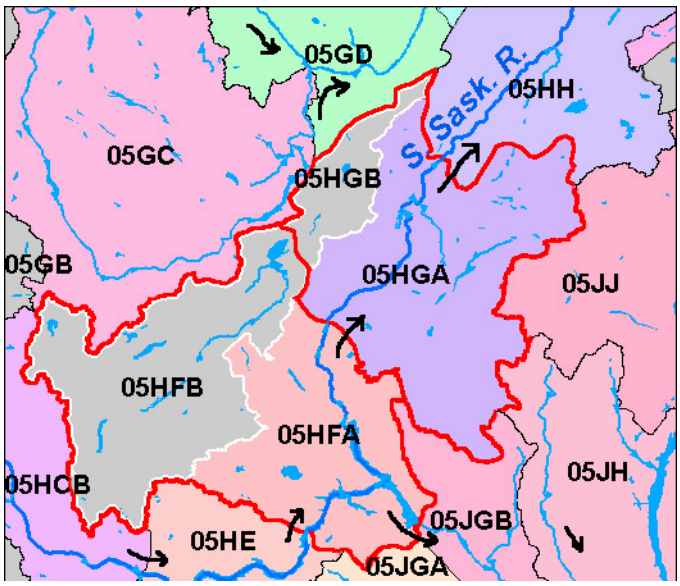

Figure 20

c) Diversions: Twenty areas of diverted drainage (transfers of water from one basin to another) were identified in the National Atlas scheme – see the pink areas in Figure 18. Just as with internal drainage (above), WSC drainage units had to be subdivided to support these diversions. In 2007, the creation of the Canadian Watersheds scheme (see section 3.2.4) required the delineation of an expanded set of smaller diversions.

d) **Inconsistencies in the flow hierarchy:** The data model used at the FDA level stipulates that stream flow may not exit and then re-enter the same drainage unit. In other words, a given fundamental drainage area cannot be both upstream and downstream of another single fundamental drainage area. However, when the WSC drainage areas were superimposed on the 1:1-million drainage network, some violations of this rule became evident. Most (if not all) violations were probably due to the inferior mapping available when the WSC drainage areas were originally delineated. In some cases, the violation was resolved by redefining the Water Survey drainage area outlines. In other cases, however, the Water Survey units were not changed, but they were split for the Fundamental classification. Figure 21 gives an example. On the island of Newfoundland, a small piece of 02YO drains into 02YN, while further downstream 02YN empties into 02YO. In canadFDA the small offending piece of 02YO was split off and renamed 02YO**A**, the remainder now being 02YO**B**. Now 02YOA flows into 02YN which flows into 02YOB.

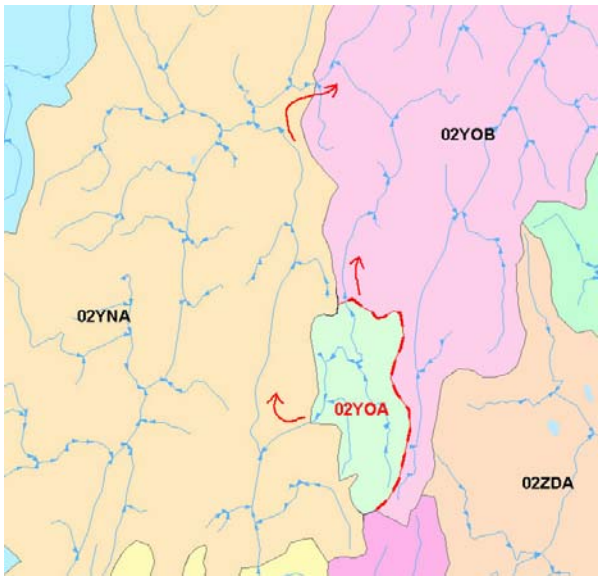

Figure 21

Note that WSC drainage units that are split appear only in the Fundamental Drainage Area dataset, and can be recognized by their 5-character codes. When the WSC or National Atlas drainage areas are derived from the Fundamental Drainage Area dataset, certain polygons are recombined as needed to yield the correct WSC or National Atlas drainage areas.

Following is a selection of the attributes for the two Fundamental Drainage Areas (02SA and 02SBA) highlighted in figure 19. Note that these two FDAs will be part of the same polygon at any level of the National Atlas hierarchy. In the WSC hierarchy, they belong to different Sub-Sub-Drainage Areas but will be merged at the level of Sub-Drainage Area or Major Drainage Area.

```
FDA                          = 02SA
WSC Sub-Sub-Drainage Area    = 02SA
WSC Sub-Drainage Area        = 02S
WSC Major Drainage Area      = 02
WSCSSDA_EN                   = Upper Betsiamites
WSCSDA_EN                    = Betsiamites - Coast
WSCMDA_EN                    = St. Lawrence Drainage Area
NA Sub-Sub-Component Basin   =  <null>
NA Sub-Component Basin       = Rivière Betsiamites
NA Component Basin           = Saint Lawrence River
```

```
NA Major River Basin       = Saint Lawrence
NA Ocean Drainage Area     = Atlantic Ocean

FDA                        = 02SBA
WSC Sub-Sub-Drainage Area  = 02SB
WSC Sub-Drainage Area      = 02S
WSC Major Drainage Area    = 02
WSCSSDA_EN                 = Lower Betsiamites
WSCSDA_EN                  = Betsiamites - Coast
WSCMDA_EN                  = St. Lawrence Drainage Area
NA Sub-Sub-Component Basin =  <null>
NA Sub-Component Basin     = Rivière Betsiamites
NA Component Basin         = Saint Lawrence River
NA Major River Basin       = Saint Lawrence
NA Ocean Drainage Area     = Atlantic Ocean
```

Figure 22

(Note: With this release, the WSC scheme for the first time also includes English and French proper names for each Drainage Area, Sub-Drainage Area and Sub-Sub-Drainage Area.)

3.1.4 FDA Treatment of Large Water Bodies

(from" Building a Canadian Digital Drainage Area Framework" R. Brooks et al, 2002)

Limitations introduced by lakes

"Lakes introduce some complexity into the modelling process. In most cases, it is difficult to state exactly what is meant by being upstream of half a lake. Nevertheless, WSC boundaries are in some cases defined to partition large lakes. The network model would not easily support this model, so large lakes were defined as their own basin, and the basins draining into them defined as stopping at the shore. For reference purposes, there [will be] a cartographic supplement to the area coverage that defines the WSC area boundaries inside those lakes."

These measures were only taken for water bodies which are not wholly contained within a single Fundamental Drainage Area. In fact, after the Brooks paper was released, several stretches of double-line river were added to the list, such as the Restigouche River and several components of the St. Lawrence River. There are now 22 such water bodies:

01B1 - Restigouche River
0201 - 0211 - Great Lakes to the St. Lawrence River (**11 bodies**)
0501 - Lake Winnipeg
05K0 - South Moose Lake
05K1 - Cedar Lake
05L0 - Lake Winnipegosis
05L1 - Lake Manitoba
07B0 - Lesser Slave Lake
0710 - Lake Athabasca
0701 - Great Slave Lake
1001 - the lower Mackenzie River
10J1 - Great Bear Lake

It should be noted that, although they are not true WSC drainage areas, these 22 drainage areas persist in the derived WSC datasets. These four-character FDA codes are related to WSC SSDA codes, but if the fourth character is a numeral then the FDA is a waterbody. I

In the derived National Atlas drainage area datasets, they obligingly disappear, being "dissolved" into various drainage basins.

3.2 Drainage Area datasets

(See also section 3.2.4 for a description of "Canadian Watersheds", a third drainage area hierarchy added at version 6 in 2008.)

Descriptions of all three datasets (FDA, WSC and NA) are given below. As the Fundamental dataset contains all of the data elements of the Water Survey and National Atlas datasets, only the Fundamental dataset is described in detail here.

3.2.1 Fundamental Drainage Areas

Dataset: fundamental drainage areas
Filename tag: **fda** (e.g. canad**fda**_v6.0_geog.shp.zip, canad**fda**_v6.0_geog.e00.zip)
Extents available: full country coverage only
Feature Classes: e00 format: arc, polygon, region
shapefile format: line, polygon

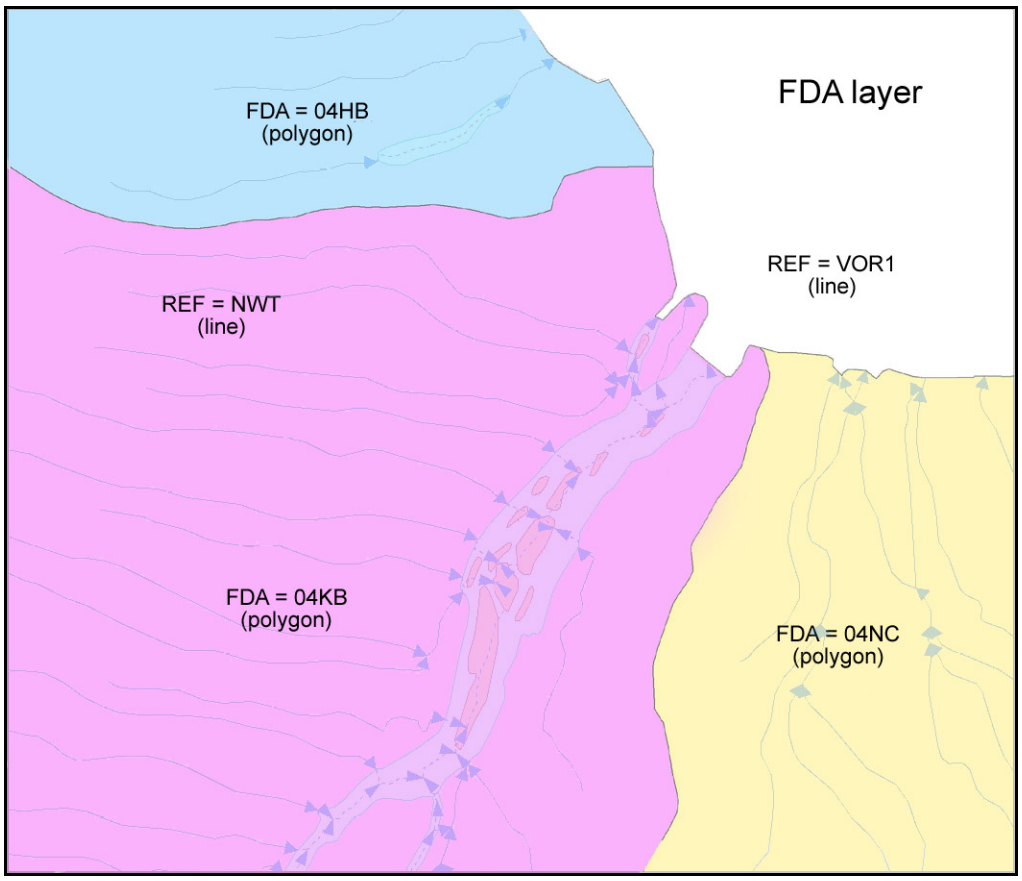

Figure 23

Drainage areas, superimposed on the drainage network.
Note that most lakes are contained within drainage areas, but there are exceptions.

The FDA dataset consists of a set of polygons required to create either the WSC or the NA datasets. FDA contains two additional attributes not found in the WSC or NA datasets: INTERNAL and DIVERSION.

FDA drainage area boundary attributes (lines)

DRAINAGE AREAS: line attributes

	NAME	WIDTH	OUTPUT	TYPE
Unique Identifier ←	UID_V6	4	12	B
Source of arc ←	REF	4	4	C
Edit Date ←	DATE_E	8	8	C
Boundary types {	TYPE_NA	2	2	I
	TYPE_WSC	2	2	I
	TYPE_WSHED	2	2	I

Figure 24

UID_V6: Unique feature identifier.

REF: This attribute shows which reference dataset the lines came from. The lines comprising the boundaries of the drainage basins are coded with the REF attribute. A more accurate drainage area framework was constructed by drawing from a number of reference datasets at various scales. Values for REF follow. Unless otherwise noted, dates reflect the date of acquisition of the reference data by the Atlas, not necessarily the production date of the reference data.

PFRA: Prairie Farm Rehabilitation Administration (Agriculture and Agri-Food Canada), 2001. (1:50,000)
PF2: A version of the PFRA dated 2005, generalized by the Atlas of Canada.
MB: Manitoba WSC boundaries supplied by PFRA in 2007.
LSSB: BC Ministry of Environment – Fisheries Branch, as modified by Environment Canada, Pacific and Yukon Region (Vancouver Office) 2001. (1:50,000)
MSSB: Environment Canada, Pacific and Yukon Region (Vancouver Office) 2001.(1:1,000,000)
BND: In certain areas (BC-AB, NF-QC) the administrative boundary coincides with the height-of-land, and therefore, by definition, with the drainage basin boundaries. In these areas, the arcs from our legal boundary dataset were used to facilitate clipping the country into provincial datasets.
NWT: Environment Canada, Prairie and Northern Region (Yellowknife Office). Adjusted by Doug Kirk, Wallace Engineering, 2002. (1:250,000)
PEI: PEI Dept of Fisheries, Aquaculture and Environment. 2001. (1:10,000)
NS: Nova Scotia Geomatics Centre; Nova Scotia Department of Environment and Labour, 2001. (1:50,000)
NB: New Brunswick: NB Aquatic Data Warehouse, Canadian Rivers Institute, University of New Brunswick. Watersheds (dated 2005) based on Service New Brunswick's 1:10 000 scale digital elevation data.
ON: Environment Canada, Ontario Region (Ontario Ministry of Natural Resources, Ontario Hydro, Ontario Ministry of Environment), 2001. (1:250,000)
ONGN: Water Resources Information Project, Ministry of Natural Resources, and other Ontario ministries. "Ontario Watersheds" dataset (2002) based on 10- and 20-meter DEMs at mapping scales of 1:10,000 and 1:20,000. Acquired by the Atlas in 2004 and generalized.

QBC: Centre d'expertise hydrique du Quebec, ministère du Développement durable, de l'Environnement et des Parcs, Gouvernement du Québec. Limites des basins hydrographiques a l'échelle 1/250 000 (dated 2004). Generalized by the Atlas in 2007.
WSL: A small-scale reference from Statistics Canada, based on WSC basins, and adjusted by Doug Kirk (Wallace Engineering) and Rupert Brooks (Natural Resources Canada), 2000. (1:2,000,000)
USA: Digital data (2001) supplied by the U.S. Geological Survey. (1:2,000,000)
DIVN: Drainage area boundaries with this attribute were edited to improve accuracy by Doug Kirk, Wallace Engineering, in 2007, while delineating drainage diversions.
PA: Drainage area boundaries with this attribute were edited to improve accuracy by the Atlas, in 2007, while delineating Protected Areas.
VOR1: Early in the project, voronoi polygons were built around every river and lake in the network. These polygons' boundaries were used where no other reference set contained a suitable arc. Coastline arcs were part of this set of voronoi polygons, which is why they share this code. (The "1" in VOR1 is to distinguish it from the voronoi polygons generated much later in the project for the creation of the discontinued **catch** and **station basin** datasets).
LAKE: Where drainage area boundaries are defined by lake shores (see the list of "inland lakes" above), the boundaries were simply copied from the lake dataset.
NONE: Arcs with this code were manually digitized during the QC stage, replacing rejected arcs where no other reference set contained a suitable arc. Frequently this was done using the NTDB 1:250,000 data as a guide.

TYPE_NA: The boundary attribute of the "National Atlas" drainage basin scheme, included to permit the selection of boundary lines for symbolization.

-2: not a "National Atlas" boundary
-1: lake & river shorelines
0: outer boundary of dataset, including coastline
1: Sub-Sub-Component Basin boundary
2: Sub-Component Basin boundary
3: Component Basin boundary
4: Major River Basin boundary
5: Ocean Drainage Area boundary

TYPE_WSC: The boundary attribute of the "Water Survey of Canada" drainage area scheme, included to permit the selection of boundary lines for symbolization.

-2: not a "Water Survey of Canada" boundary
-1: lake & river shorelines
0: outer boundary of dataset, including coastline
1: Sub-Sub-Drainage Area boundary
2: Sub-Drainage Area boundary
3: Major Drainage Area boundary

TYPE_WSHED: The boundary attribute of the "Canadian Watersheds" drainage area scheme, included to permit the selection of boundary lines for symbolization.

-2: not a "Canadian Watersheds" boundary
-1: lake & river shorelines
0: outer boundary of dataset, including coastline
1: Canadian Watersheds boundary

DATE_E: The date the feature was last edited.

FDA drainage area attributes (polygons/regions)

DRAINAGE AREAS: area attributes

	NAME	WIDTH	OUTPUT	TYPE
FDA code	FDA	5	5	C
Internal drainage	INTERNAL	2	2	C
Diverted drainage	DIVERSION	2	2	C
WSC codes	WSCSSDA	4	4	C
	WSCSDA	3	3	C
	WSCMDA	2	2	C
WSC names (English)	WSCSSDA_EN	70	70	C
	WSCSDA_EN	60	60	C
	WSCMDA_EN	60	60	C
WSC names (French)	WSCSSDA_FR	70	70	C
	WSCSDA_FR	60	60	C
	WSCMDA_FR	60	60	C
	OCEAN_EN	20	20	C
	OCEAN_FR	20	20	C
NA names (English)	NASSCB_EN	25	25	C
	NASCB_EN	30	30	C
	NACB_EN	25	25	C
	NAMRB_EN	30	30	C
	NAODA_EN	20	20	C
NA names (French)	NASSCB_FR	25	25	C
	NASCB_FR	30	30	C
	NACB_FR	25	25	C
	NAMRB_FR	30	30	C
	NAODA_FR	20	20	C
WSHED code	WSHED	6	6	C
WSHED names	WSHED_EN	70	70	C
	WSHED_FR	85	85	C

Figure 25

Attributes of FDA datasets.
See figure 26 for a list of attributes for each specific drainage area dataset.

FDA: Fundamental Drainage Area code. There are three types of FDA code:

a. Most of the drainage area codes are **based on** the four-character WSC coding scheme. Either 4 or 5 characters long, the first two characters of the code are numeric, the balance alphabetic (e.g. 04CB, 05HBA).

b. Drainage areas lying well outside of Canadian jurisdiction were, for expediency, collapsed into a large drainage area called “USA”. This is not part of the WSC scheme, but it identified extended drainage areas reaching into the USA. Later, these

were further broken down (USB, USC, USD, etc) to support some NA drainage basins extending into the USA, such as the Great Lakes Component Basin and the Lake Erie Sub-Component Basin. Most begin with "US" but several, which have no connection to Canadian drainage, are coded "U**X**A," "U**X**S," etc. (X signifying "external").

c. Certain water bodies (22 altogether), each wholly contained within single FDAs, were defined as separate drainage areas in their own right (see section 3.1.4 **FDA treatment of large lakes**, above). Specifically,

01B1 - Restigouche River
0201 – 0211 - Great Lakes to the St. Lawrence River (11 bodies)
0501 - Lake Winnipeg
05K0 - South Moose Lake
05K1 - Cedar Lake
05L0 - Lake Winnipegosis
05L1 - Lake Manitoba
07B0 - Lesser Slave Lake
0710 - Lake Athabasca
0701 - Great Slave Lake
1001 - Lower Mackenzie River
10J1 - Great Bear Lake

Note: True WSC codes use alphabetic characters to specify the sub-levels and subsub-levels (the last two characters). Codes for these water body drainage areas differ in that each water body code contains at least one numeric character in the last two characters.

LAKE_FDA: (Note that this attribute appears in the polygon feature class of the ArcInfo coverage (e00 format) but not in the region feature class. Therefore it is not available in the shapefile format.)

In the WSC classification scheme, drainage area boundaries are extended into some of the major inland water bodies. This allows the assignment of islands and hydrometric stations to specific WSC drainage areas. For example, Lake Winnipeg, with FDA code 0501, is surrounded by WSC drainage areas 05RA, 05RB, 05SA, etc., which have been extended into the lake. These lake polygons all have FDA = 0501, but LAKE_FDA = 05RA, etc.

OCEAN_EN, OCEAN_FR: Name (English, French) of the Ocean Drainage Area. Although they are not part of the WSC classification hierarchy, and cannot be derived from the eleven Major Drainage areas, the five Ocean Drainage Areas are used by hydrologists working with the WSC scheme. Fortunately, this attribute does appear as part of the NA classification scheme (attribute NAODA). To ensure that it will be available in the derived WSC SSDA and SDA datasets, the NAODA attribute is duplicated here.

INTERNAL: Indicates whether or not a polygon is an area of "internal drainage:" an area occupied by a drainage system, or one that contributes water to a drainage system, with no outlet

to the ocean. (Values: Y or N). Source: printed map MCR 4055 *Canada–Drainage Basins* (National Atlas of Canada, 5th Edition, 1985.) Internal Drainage areas revised in 2003 by Atlas of Canada.)

DIVERSION: An FDA consisting of diverted drainage. The code (Y or N) indicates whether or not the unit is an area whose drainage has been artificially diverted from one drainage basin or sub-basin for use in another. Source: printed map MCR 4055 *Canada–Drainage Basins* (National Atlas of Canada, 5th Edition, 1985.)

WSCSSDA, WSCSDA, WSCMDA:

WSCSSDA. WSC Sub-sub-drainage area. This code consists of two numerals and then two letters. When given a WSCSSDA code, truncating one letter gives code of the WSCSDA (sub-drainage area) containing this sub-sub drainage area. Truncating both letters gives code of the WSCMDA (major drainage area) containing this sub-sub-drainage area.

WSCSDA. WSC Sub-drainage. This code consists of two numerals and a single letter. Truncating the letter gives code of the WSCMDA (major drainage area) containing this sub-drainage area.

WSCMDA. WSC Major Drainage Area. This code consists of two numerals (01, 02, 03 … 11).

WSCSSDA_EN, WSCSDA_EN, WSCMDA_EN: English proper names for the various Drainage Areas. In early 2003, the Government of Canada consulted with the provinces to formally name every WSC drainage area in Canada, thereby avoiding ambiguity and duplication. Version 5.0 of the National Scale Frameworks Hydrology Theme is the first public release of these proper names.

WSCSSDA_FR, WSCSDA_FR, WSCMDA_FR: French version of these proper names.

NASSCB_EN, NASCB_EN, NACB_EN, NAMRB_EN, NAODA_EN: English proper names for the five levels of the National Atlas classification scheme. This scheme contains no alpha-numeric code attribute corresponding to WSCSSDA, etc. – these five name attributes **are** the coding scheme for National Atlas drainage areas.

NASSCB_EN: Sub-Sub-Component Basin
NASCB_EN: Sub-Component Basin
NACB_EN: Component Basin
NAMRB_EN: Major River Basin
NAODA_EN: Ocean Drainage Area

In contrast to the WSC scheme, many polygons of the National Atlas scheme cannot be assigned a value for all five of its hierarchical levels. All polygons are assigned to the largest units - ocean drainage areas (NAODA). Most areas are assigned to the second largest, major river basins (NAMRB). Areas not assigned to a named NAMRB are assigned to a residual class for the particular ocean drainage area, usually with a name such as "Arctic Ocean Seaboard". For the smaller three units (NACB, NASCB, and NASSCB), many areas are not in a named unit of this type, and so are assigned a null value.

NASSCB_FR, NASCB_FR, NACB_FR, NAMRB_FR, NAODA_FR: French version of these proper names.

WSHED: Canadian Watershed

WSHED_EN: English proper names for the various Watersheds.

WSHED_FR: French version of these proper names.

Comparison of attributes of the nine Drainage Area datasets

Datasets	FDA	canad WSC SSDA	canad WSC SDA	canad WSC MDA	canad NA SSCB	canad NA SCB	canad NA CB	canad NA MRB	canad NA ODA	canad WSHED
Attributes										
FDA	√	-	-	-	-	-	-	-	-	-
LAKE_FDA [1]	(√)	-	-	-	-	-	-	-	-	-
OCEAN_EN [2]	√	√	√	-	-	-	-	-	-	√
OCEAN_FR [2]	√	√	√	-	-	-	-	-	-	√
INTERNAL	√	-	-	-	-	-	-	-	-	-
DIVERSION	√	-	-	-	-	-	-	-	-	-
WSCSSDA	√	√	-	-	-	-	-	-	-	-
WSCSDA	√	√	√	-	-	-	-	-	-	-
WSCMDA	√	√	√	√	-	-	-	-	-	-
WSCSSDA_EN	√	√	-	-	-	-	-	-	-	-
WSCSDA_EN	√	√	√	-	-	-	-	-	-	-
WSCMDA_EN	√	√	√	√	-	-	-	-	-	-
WSCSSDA_FR	√	√	-	-	-	-	-	-	-	-
WSCSDA_FR	√	√	√	-	-	-	-	-	-	-
WSCMDA_FR	√	√	√	√	-	-	-	-	-	-
NASSCB_EN	√	-	-	-	√	-	-	-	-	-
NASCB_EN	√	-	-	-	√	√	-	-	-	-
NACB_EN	√	-	-	-	√	√	√	-	-	-
NAMRB_EN	√	-	-	-	√	√	√	√	-	-
NAODA_EN	√	-	-	-	√	√	√	√	√	-
NASSCB_FR	√	-	-	-	√	-	-	-	-	-
NASCB_FR	√	-	-	-	√	√	-	-	-	-
NACB_FR	√	-	-	-	√	√	√	-	-	-
NAMRB_FR	√	-	-	-	√	√	√	√	-	-
NAODA_FR	√	-	-	-	√	√	√	√	√	-
WSHED	√	-	-	-	-	-	-	-	-	√
WSHED_EN	√	-	-	-	-	-	-	-	-	√
WSHED_FR	√	-	-	-	-	-	-	-	-	√

Figure 26

Attributes found in FDA, WSC, NA and WSHED Datasets. See attribute descriptions in previous section.

[1] LAKE_FDA is present only in the e00 format, in the polygon feature class; it does not appear in the region feature class in the e00 format. LAKE_FDA does not appear at all in the shapefile format.

[2] Ocean Drainage Areas cannot be derived from WSC Major Drainage Areas, so this attribute is not incuded in WSC MDA.

3.2.2 Water Survey of Canada drainage areas

Dataset: Water Survey of Canada drainage areas (3 levels)
Filename tag: **wsc** followed by abbreviation of hierarchical level: **mda, sda, ssda**)
(e.g. canad**wscssda**_v6.0_geog.shp.zip, canad**wscmda**_v6.0_geog.ee00.zip)
Extents available: Full country coverage only
Feature Classes: e00 format: arc, polygon, region shapefile format: line, polygon

These three datasets are derived from the FDA dataset. See figure 26 for a list of polygon attributes included in these datasets. Most of the line attributes found in FDA are also in the WSC datasets. For the definitions of the attributes, see the list of FDA attributes above.

3.2.3 National Atlas (Atlas of Canada) drainage areas

Dataset: National Atlas drainage areas (5 level)
Filename tag: **na** followed by abbreviation of hierarchical level: **oda, mrb, cb, scb, sscb**)
(e.g. canad**naoda**_v6.0_geog.shp.zip, canad**nasscb**.e00)
Extents available: Full country coverage only
Feature Classes: e00 format: arc, polygon, region
shapefile format: line, polygon

These five datasets are derived from the FDA dataset. See figure 26 for a list of attributes included in these datasets. For the definitions of the attributes, see the list of FDA attributes above. Most of the line attributes found in FDA are also in the NA datasets. For the definitions of the attributes, see the list of FDA attributes above.

3.2.4 Canadian Watersheds

Dataset: Canadian Watersheds (1 level)
Filename tag: **wshed** (e.g. canadwshed_v6-0_geog.shp.zip, canad**wshed**.e00)
Extents available: Full country coverage only
Feature Classes: e00 format: arc, polygon, region
shapefile format: line, polygon

This drainage area scheme did not exist in version 5. It was created through a partnership between Natural Resources Canada and Environment Canada known as "Know Your Watershed", a RésEau project (http://map.ns.ec.gc.ca/reseau)

"As watersheds become an increasingly important planning and monitoring unit, the demand is growing for on-line maps depicting watershed information. One challenge is to make the navigation tools to these watershed information systems intuitive for non-specialists. Although most Canadians may not know which watershed they live in, they do know the name of their city or village. Why not allow people to search for watersheds based on place name?" *(Know Your Watershed: by Peter Paul, Atlas of Canada Frameworks, Natural Resources Canada).*

The earlier release of the Atlas of Canada frameworks identified 2 drainage schemes (Water Survey of Canada and National Atlas), but neither of them can be considered systems of Classic

Watersheds (i.e. a land area that has all the surface drainage within its boundary converging at a single point). The National Atlas scheme has approximately 114 drainage basins identified, but they do not cover the entire area of Canada, so many watersheds are missing. The Water Survey of Canada has 978 Sub-Sub-Drainage Areas that covered all of Canada, but many of those areas are simply area sub-divisions which do not represent classic watersheds (i.e. a land area that has all the surface drainage within its boundary converging at a single point). Their 164 Sub-Drainage Areas also cover all of Canada, and are a closer approximation of watersheds, but for populated areas they often encompass too large an area (i.e. only 2 watersheds for all of New Brunswick or Nova Scotia).

The task was to create a network of meaningful watersheds. By selectively combining the existing 1090 FDAs, 595 Canadian Watersheds were defined. The definition process was very subjective because there were no rules regarding the size or the frequency of watersheds. In the populated areas of Canada, a single drainage unit was usually used as a watershed because this would be most meaningful to the local populace. In more remote areas, the watershed usually comprised of a number of drainage units (possibly at the Sub-Drainage Area level). There were 26 cases where water was being diverted from one of the watersheds into an adjacent watershed. In those cases, the diverted area was designated as a separate watershed, and identified as a diversion in the name.

The underlying objective was to select, as far as possible, true watersheds that would be recognized and meaningful to the public. These 600 Canadian Watersheds are being used for the demonstration project of identifying towns by watershed and creating Watershed Profiles. http://map.ns.ec.gc.ca/kyw/ Although the 600 Canadian Watersheds are an improvement to the previous drainage schemes, in many cases these watersheds still can not be considered true Classic Watersheds because the existing boundaries do not "converge at a single point." However, for this test project, the National Atlas has been limited to make use of the existing FDA boundaries only.

As with the other two drainage area schemes, names were assigned to each of these Canadian Watersheds. Where possible, existing Drainage Unit names were used but in many cases new names have been assigned.

Because this dataset was intended for use as a database for an on-line mapping application, a concise coding system was required. With the exception of two localities in Canada, Canadian Watersheds can be merged exactly into WSC Sub-Drainage Areas.[1] Taking advantage of this, a unique 5-character coding system is used to identify the Canadian Watersheds. The first three characters are the code of the coincident WSC Sub-Drainage Area, and the last 2 characters are the sequential number 01-99. By truncating a watershed code to the first 3 characters, one obtains the code for the corresponding WSC sub-drainage area.

[1] This doesn't work well at the Sub-Sub level because some WSC Sub-Sub-Drainage Areas have been further subdivided at the FDA level in order to delineate areas of diverted drainage. These diverted areas actually contribute drainage to a neighouring watershed, and the Canadian Watersheds scheme merges that diverted area into its neighbour.. For example, WSC Sub-Sub 01EC (Roseway) has been split at the FDA level into 01ECB, a small area whose drainage is diverted into the neighbouring watershed 01ED (Mersey), and 01ECA, the remainder of 01EC. In this example, the greatest part of 01EC is assigned to 01E01 and the diverted part to 01E02.

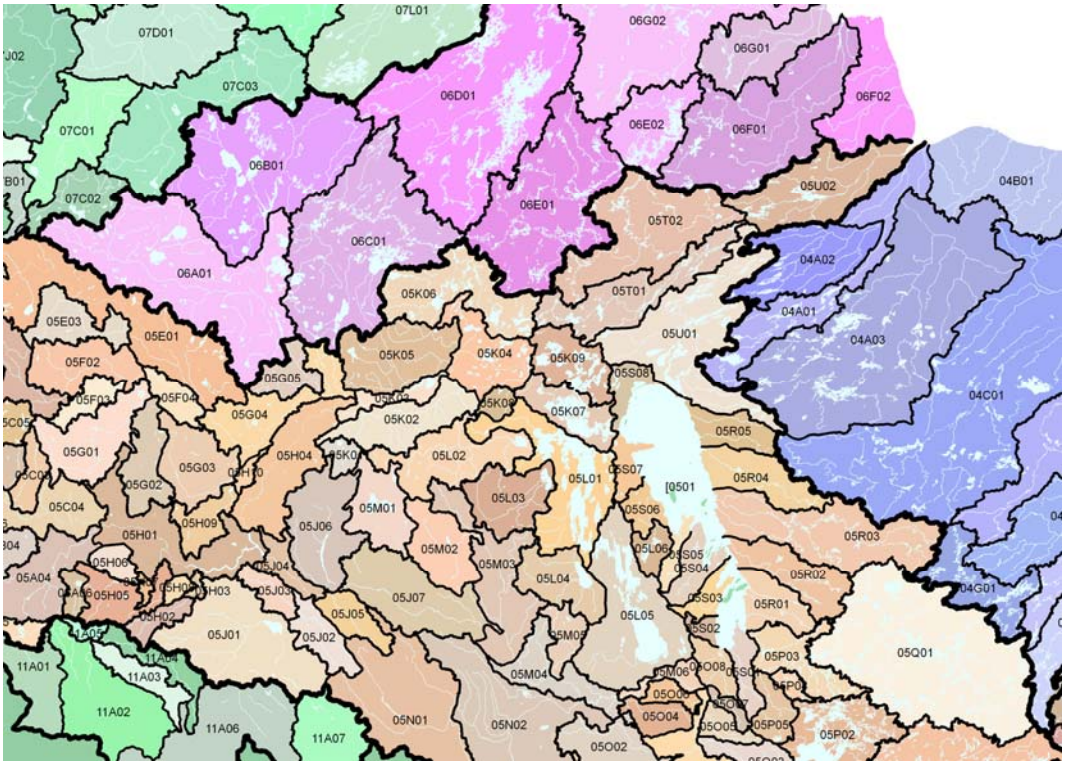

Figure 27: The "Canadian Watersheds" classification scheme.
Compare with figures 17 and 18 in section 3.1.1

Example of the link between the 3 systems:

WSC	WSC Name	Canadian Watershed	Watershed Name
01DM	Tidnish	01D08	North Shore
01DN	Philip	01D08	North Shore
01DO	John	01D08	North Shore
01DP	East and West River of Pictou	01D08	North Shore
01DQ	French (N.S.)	01D08	North Shore
01DR	South and West Antigonish	01D08	North Shore
01DS	Tracadie	01D08	North Shore
01EA	Tusket	01E01	South Shore - Clyde
01EB	Clyde	01E01	South Shore - Clyde
01ECA	**Roseway**	**01E01**	**South Shore - Clyde**
01ECB	**Roseway**	**01E02**	**Jordan Diversion**
01ED	Mersey	01E03	South Shore - Mersey
01EE	Medway	01E03	South Shore - Mersey
01EF	LaHave	01E04	South Shore - LaHave
01EG	Gold	01E05	South Shore - Mahone-St. Margarets

4. Supplemental Drainage Features

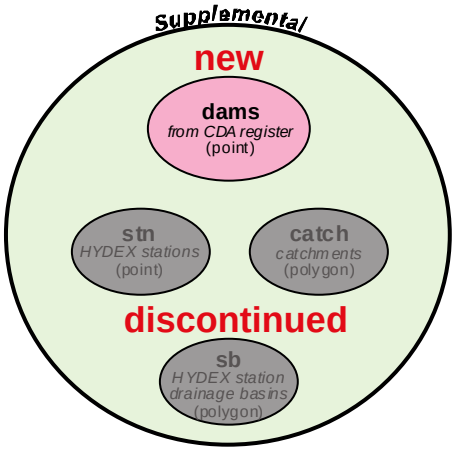

Figure 28

Supplemental Drainage datasets.

4.1 Overview

The only Supplemental Drainage features available at version 6.0 are Dams. Catchments, Hydrometric Stations, and Hydrometric Station drainage areas were features of version 5.0, and are no longer supported. See Section 4.2.2 below.

In this section

4.2 Supplemental datasets

4.2.1 Dams

The Dams dataset is based on the 2003 Canadian Dam Association (CDA) Register of Dams in Canada. The register lists 933 dams, including all those existing or under construction and meeting the criteria listed below. Tailings dams and the dams under construction listed in the register are not included in this dataset. (Tailings are the remains of ore once most of the valuable material has been removed.)

The 843 dams in this dataset are represented by points. Dams have been snapped to nodes (endpoints) in either the river network or on the boundaries of lakes; in most cases the streams or lake boundaries had to be split to create the node.

Criteria for dams to be included in the CDA Register of Dams:

- Dams less than 10 m in height are not to be included in the Register.
- All dams with a height of 15 m or more, measured from the lowest portion of the general foundation area to the crest, are to be included.
- Dams between 10 m and 15 m can be included if desired, provided they comply with at least one of the following conditions.
  - the length of crest not less than 500 m,
  - the capacity of the reservoir formed by the dam not less than one million cubic meters,
  - the maximum flood discharge dealt with by the dam not less than 2,000 m3/s,
  - if the dam had specially difficult foundation problems, or
  - if the dam is of unusual design.

DAMS: point attributes

	NAME	WIDTH	OUTPUT	TYPE	N.DEC
Unique Identifier ←	UID_V6	4	12	B	-
CDA Identifier ←	CDA_NUMBER	4	5	B	-
Attributes of dams {	NAME	80	80	C	-
	YEAR	5	5	C	-
	RIVER	40	40	C	-
	HEIGHT	4	8	F	2
	RES_VOL	10	10	C	-
	PURPOSE	15	15	C	-
	PROV_EN	30	30	C	-
	PROV_FR	30	30	C	-
Edit date ←	DATE_E	8	8	C	-

Figure 29

Point attributes for the **dams**.dataset

UID_V6: Unique feature ID.

CDA_NUMBER: Dam number as assigned by Canadian Dam Association

NAME: The official name of the dam.

YEAR: The year when the main dam structure is completed and ready to use.

RIVER: The name of the river or stream upon which the dam is built.

HEIGHT: The height from the lowest portion of the general foundation area of the dam to the top of the dam.

RES_VOL: Storage capacity of reservoir, including dead storage and surface area, up to the normal top or retention water level (not flood level).

PURPOSE: The purpose for which reservoir is used.

- **I**: Irrigation
- **H**: Hydroelectric
- **C**: Flood Control
- **N**: Navigation
- **S**: Water Supply
- **R**: Recreational Purposes

PROV_EN, PROV_FR: English and French name of province where the dam is located.

DATE_E: The date the feature was last edited.

4.2.2 Hydrometric Stations DISCONTINUED

The previous release of 1:1-million Frameworks layers included a selection of Water Survey of Canada (WSC) hydrometric stations. This dataset has been retired, but access to the full set of hydrometric stations is now available from Environment Canada at http://www.wsc.ec.gc.ca/products/main_e.cfm?cname=products_e.cfm

There are various ways to view the data. For example, there are two different map viewers.

The link "Station metadata download" gives access to a comma-delimited table of stations, listing such attributes as Station Number, Station Name, Province, Status, Latitude, Longitude, etc. This table is easily imported into spreadsheet software. URL: http://www.wsc.ec.gc.ca/hydex/main_e.cfm?cname=StationList_e.cfm

Note that historical and real-time water level data for individual stations (eg: 05KD006) can be accessed online at http://scitech.pyr.ec.gc.ca/waterweb/fullgraph.asp?lang=0&stnID=05JL005

All URLs accessed in April 2009.

Appendix 1: Data formats: e00 versus shapefile

The e00 format is an ASCII version of an ArcInfo coverage, and as such a single e00 file may contain point, line, polygon and region features. (A region is a single area feature consisting of one or more polygons – see the explanation below.) The coordinates of the lines' vertices are recorded once, and the lines in turn define the polygons.

In contrast, the shapefile format requires a separate set of files for each feature class. So if a dataset consists of both polygons and lines, two shapefiles are required. The coordinates of the vertices are stored in the line shapefile and again in the polygon shapefile. The shapefile "polygon" feature class can be the equivalent of either the polygon or region feature class in the coverage format.

Any of the Drainage Area datasets provides a good example. The data is maintained in ArcInfo coverage format. A single Drainage Area coverage contains arcs, polygons, and regions. The arcs are attributed with their source -- ie: which source agency does this arc come from? The polygons define the drainage areas and have a number of drainage area attributes attached to their respective label points. But a single drainage area may consist of more than one simple polygon (i.e. offshore islands), and for our purposes it is more appropriate to treat each drainage area as a unit rather than as multiple polygons. For instance, Statistics Canada has provided population figures for each drainage area. This data should be applied once for each drainage area, not to every polygon.

In the coverage format, the region feature class provides the solution. All the polygons making up a given drainage area are "grouped" into a single "region." Each drainage area is a single region which may be selected by clicking on any of its constituent polygons. In the Region Attribute Table there is only one record (and one population figure) for each drainage area. (All the polygons making up a given drainage area remain as distinct polygons, as they are required to support the higher-level region feature class.) Regions are named (e.g. **fda**) and are accessed in ArcInfo/ArcEdit as **region.fda**.

In contrast, a shapefile polygon can consist of one or many parts. Drainage area shapefiles are created by "exporting" from each drainage area coverage. A line shapefile is created from the coverage's line feature class, and a polygon shapefile from the coverage's region feature class.

This is how polygons are treated for the various Drainage Area datasets. For the other datasets, shapefile polygons are exported from the coverage polygon feature class.