Standards and Specifications of the National Topographic Data Base

Edition 3.1

Geomatics Canada

Canada

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1. Introduction

In 1990, Geomatics Canada began developing the National Topographic Data Base (NTDB) with the basic objectives of:

1- responding to the Government of Canada's cartographic needs;

2- providing topographic data (computerized) to users of sophisticated technologies such as Geographic Information Systems (GIS).

In an effort to better respond to the requirements of users of digital topographic data, Geomatics Canada carried out an exhaustive study of user needs in 1994. As a result of the study, modifications were implemented to the design, standards, and specifications of the NTDB and its data enhanced.

This document presents version 3.1 of the *National Topographic Data Base Standards and Specifications*. The conceptual model and the data dictionary were revised in order to better respond to the requirements of users of digital topographic data and to facilitate the acquisition, management, and distribution of NTDB data.

This version of the *National Topographic Data Base Standards and Specifications* focuses on NTDB organization and the concepts of data set, theme, entity, entity occurrence, and spatial relation. The data dictionary itself is a separate document.

2. NTDB Organization

2.1 General Description

The contents of the NTDB largely corresponds to that of the topographic maps in the National Topographic System (NTS). The NTDB contains information relating to 112 entities in 14 themes.

To manage the NTDB, the country is divided into territories corresponding to the National Topographic System at the 1:50 000 scale[1], based on North American Datum of 1983 (NAD83). Figure 1 depicts the overall model of the NTDB; Figure 2 shows its division into territories.

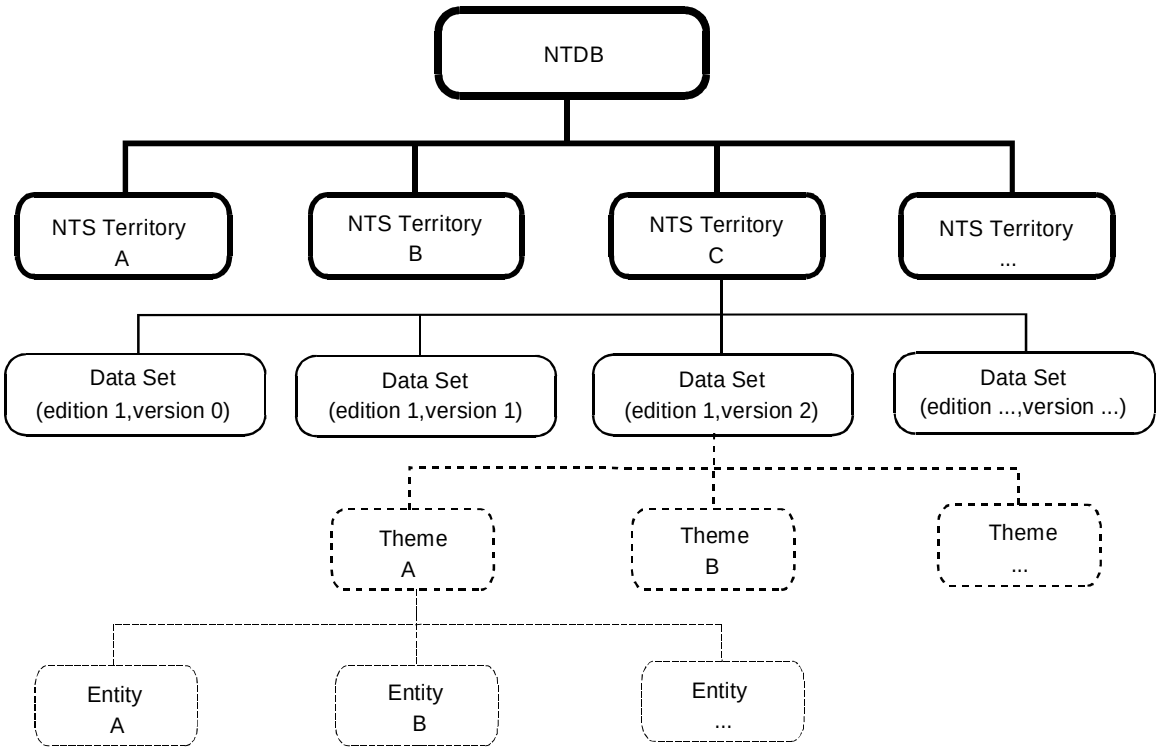

Figure 1 : Overall Model of the NTDB

[1] Since digital coverage at the 1:50 000 scale is not complete, the NTDB product at the 1:250 000 scale substitutes for areas for which data at the 1:50 000 do not exist.

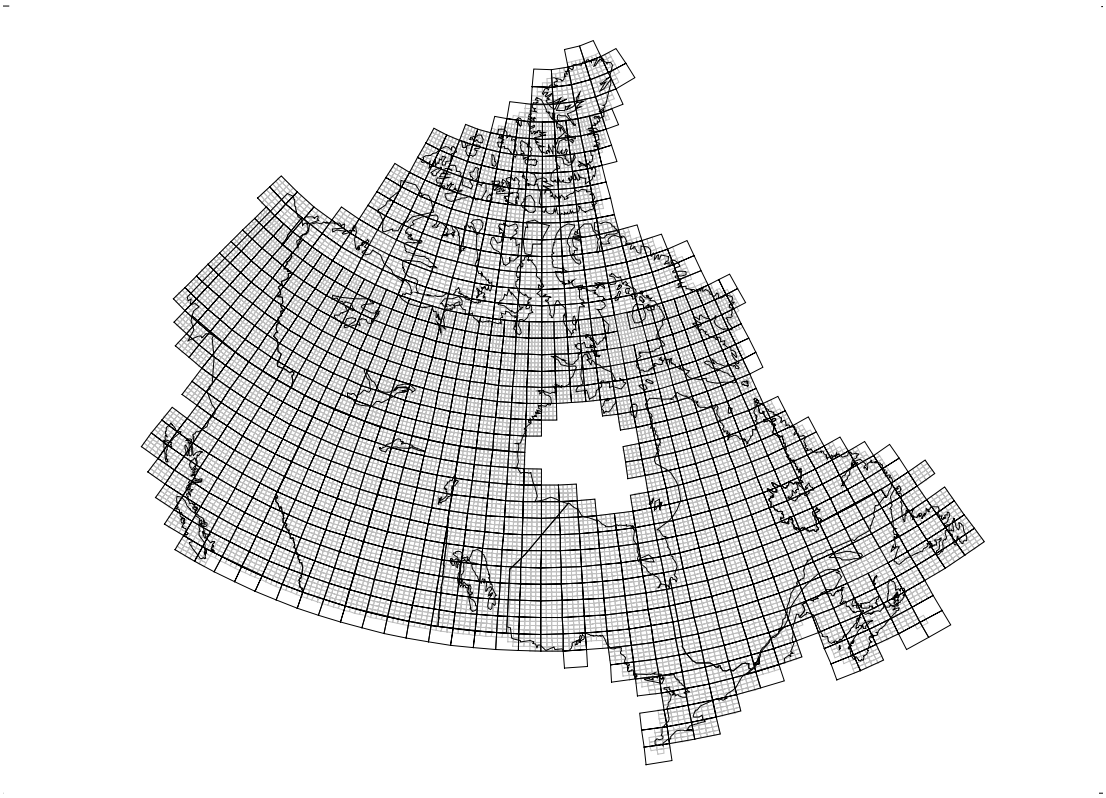

Figure 2 : NTS Divisions

Under the NTS, Canada is divided into primary quadrants, each 4° in latitude by 8° in longitude south of the 80th parallel of latitude and 4° in latitude by 16° in longitude north of the 80th parallel of latitude. The territories—whose extents are shown below—are based on the subdivision of these primary quadrants.

Latitude	Latitude by Longitude
North of 80°	15’ by 2°
From 68° to 80°	15’ by 1°
South of 68°	15’ by 30’

The limits of these territories are as follows:

EASTERN limit: Straight segment joining points of equal longitude for each 15 minutes of latitude, between northeast and southeast corners.

SOUTHERN limit: Straight segment joining points of equal latitude for each 15 minutes of longitude, between southwest and southeast corners.

WESTERN limit: Straight segment joining points of equal longitude for each 15 minutes of latitude, between northwest and southwest corners.

NORTHERN limit: Straight segment joining points of equal latitude for each 15 minutes of longitude, between northwest and northeast corners.

Generally speaking, data sets covering maps that exceed the theoretical NTS limits at the 1:50 000 scale are separated and placed into their own data set. The international boundary automatically becomes the data set limit. The NTDB contains only data that lies within Canadian borders, even when the boundary coincides with the centre of a river. Data from maps with border breaks along the international boundary, those from a new territory resulting from a change in the reference surface, and a few special cases can deviate from regular NTS limits and be included in a special territory with irregular limits.

The NTDB covers the entire Canadian landmass. Version 2 of the NTDB comprised data at the 1:50 000 and 1:250 000 scales, while Version 3 contains only data that is of higher accuracy and more recent (based on the validation date) than that in Version 2.

2.2 Data Characteristics

2.2.1 Measuring Unit

The measuring unit for registering spatial data is the meter (integer value) for the X- and Y-axes.

2.2.2 Geometric Accuracy

The accuracy of geometric representation data is given by the difference between the position of the geometric representation associated with an entity and the real ground position of the corresponding topographic feature, as measured with respect to the geodetic network.

Accuracy, which can vary from one occurrence of an entity to the next, is provided in the entity metadata.

The NTDB aims at attaining the following classes of accuracy:

Urban area: Inhabited part of the Canadian landmass with a high population density whose extent is generally corresponding to that of urban built-up areas (including suburbs) and industrial parks. Only those cities and towns with more than 5 000 inhabitants[(2)] and a built-up area of at least 2.25 km^2. A circular map accuracy standard (CMAS[(3)]) of 10 meters is the accuracy for data in urban areas.

(2) The most recent census carried out by Statistics Canada is used to identify towns and cities with 5 000 inhabitants or more.

(3) The circular map accuracy standard is the maximum difference established between the planimetric positions of well-defined, identifiable NTDB topographic features and their real positions established with respect to geodetic control network. Section 5.1.1.6 provides a detailed explanation of how to determine the CMAS.

Rural area: Inhabited part of the Canadian landmass with a low population density and in which there are human or economic activities such as agriculture, mining, or fishing. A CMAS of 25 meters is established as the accuracy for data in rural areas.

Isolated area: Uninhabited area of the Canadian landmass that corresponds to the parts uncovered by the two preceding classes (urban and rural areas). A CMAS of 125 meters is established as the accuracy for data in isolated areas.

2.2.3 Resolution

Resolution deals with the size of topographic features in the NTDB. It is defined using a set of values referred to as "guaranteed sizes", which set the minimum sizes for topographic features to be included in the NTDB. The NTDB may contain topographic features that are smaller than the guaranteed sizes as long as:

1. the authorized geometric representations of each entity are respected;
2. the data in the NTDB remain homogeneous (that is, the resolution of data is not significatively altered in including these entities).

The NTDB is currently divided into two resolution classes. Territories located in urban or rural areas are generally available at a resolution close to that of topographic maps at the 1:50 000 scale, while territories located in isolated areas are available at a resolution of maps at the 1:250 000 scale.

2.2.4 Spatial Structure

The data are free from any spatial inconsistencies such as overshoots, undershoots, and area misclosures. To obtain this result, two relations are defined: connection and sharing; both are described in detail in Section 6.

2.2.5 Data Quality

CTI ensures that the topographic data in the NTDB respect the topographic contents of the source material used according to *National Topographic Data Base Standards and Specifications*. Improper attribution of values to any of the descriptive data will result in a **classification error**. An object in the source data but not in the data set is an **error of omission**. An object in the data set but not in the source data set is an **error of commission**. The maximum acceptable proportion of errors of classification, omission, and commission is all together 5% for a representative sample.

CIT ensures that the spatial structure of data adheres to *National Topographic Data Base Standards and Specifications*. NTDB data contains not more than 1% connection errors and 2% sharing errors[(4)].

[(4)] More complete descriptions of connection and sharing relations are given in Section 6 herein.

2.3 Territory Metadata

The NTDB keeps the following information for each territory:

NTS number : Territory number corresponding to the divisions of the NTS at the 1:50 000 scale.

Name of the Territory : Name corresponding to the NTS mapsheet at the 1:50 000 scale. The geographic location of a territory resulting from a border break corresponds to the NTS number of the original map.

Provinces : List of provinces (maximum of four) in descending order of the percentage of the territory occupied by each in the data set.

UTM Zone : Value in the interval $7 \leq Z \leq 23$, corresponding to the Universal Transverse Mercator (UTM) cartographic projection zone in which the territory is located as defined by the formula :

$$\text{UTM Zone} = \text{Integer}^{(5)} ((180^\circ - \lambda) / 6^\circ + 1)$$

where λ is the mean longitude of the data territory, which must fall between 48° and 144°.

Percentage of Land : Value from 1 to 100 that indicates the percentage of the area of the territory covered by land (that is, excluding waterbodies in coastal regions, in the Great Lakes region, and other major waterbodies). The degree of confidence in this value is within $\pm 5\%$.

(5) The function “Integer” means “truncated value” or “nearest integer less than”.

3. Data Set

3.1 General Description

The territory is the base unit to manage the NTDB. Each territory corresponds to at least one data set that contains the topographic information relating to 112 entities grouped into 14 themes. Each update to a data set results in a new edition/version.

3.2 Data Set Characteristics

3.2.1 Horizontal and Vertical Reference Systems

The North American Datum of 1983 (NAD83) is used as the reference system for planimetric coordinates. Elevations (h) are orthometric and expressed in reference to the Mean Sea Level (Canadian (Vertical) Geodetic Datum).

3.2.2 Cartographic Projection and Horizontal Coordinate System

The planimetric coordinates X and Y for geometric representations are expressed according to the UTM projection.

3.3 Data Set Metadata

Data set metadata contain the information that is common the entire data set. Each data set—identified by its NTS number and edition/version—contains the following metadata.

NTS Number : Territory number corresponding to the divisions of the NTS at the 1:50 000 scale.

Edition/Version : Number of the edition and version of the data set. The edition number is increased by one for every update (e.g., partial or complete updating of topographic contents or enhancement of geometric accuracy) of the data set. The version number is increased by 1 for every modification to a data set other than an update (e.g., horizontal integration, error correction). When a new edition is issued, the version is reset to 0.

Measuring Unit for Contours : This indicates the measuring unit used for contours and spot heights. Possible units are:

feet;
meters.

Contour Intervals : The contour interval is the difference in elevation between two consecutive intermediate contours. The relief of certain NTS territories is represented by two intervals : one for the flat areas of the territory and the other for the mountainous areas of the territory. Each NTS territory may therefore have two associated contour intervals.

NTDB Standards Version : Number of the version of *National Topographic Data Base Standards and Specifications* to which the data conforms.

Dimension : Data value indicating whether the data set is in two (X,Y) or three (X,Y,h) dimensions.

Map Edition : Map edition number corresponding to the data set if produced by reprographic material digitization.

Date of Availability : Date at which the data set is added into the NTDB, formatted YYYY/MM/DD.

North, South, East, West Horizontal Integration : Data that indicates the status to the horizontal integration of the data set with the adjacent territories. The possible values are:

Yes:	Applicable on the north, east, south, or west limit; indicates that integration was carried out;
No:	Applicable on the north, east, south, or west limit; indicates that integration has not been carried out;
Not required:	Applicable on the north, east, south, or west limit; indicates that integration is not required;
Left:	Applicable on the south limit of data territories located immediately above the 68th and 80th parallels of latitude; indicates that integration was carried out only with the data set to the south-west;
Right:	Applicable on the south limit of data territories located immediately above the 68th and 80th parallels of latitude; indicates that integration was carried out only with the data set to the south-east.

Note : «Left» or «Right» is replaced by «Yes» when the integration was carried out for the whole south limit.

4. Theme

4.1 General Description

Entities are grouped according to themes within in a data set. These themes are: designated areas, roads, manmade features, relief and landform, general, hydrography, hypsography, administrative boundaries, power network, rail network, road network, water saturated soils, toponymy, and vegetation.

4.2 Metadata Associated with the Theme

The metadata associated with the theme aim at providing a synthetic view of the data comprising the theme. There are as many metadata occurrences associated to the theme as there are themes in the data set. The metadata are :

NTS number : Territory number corresponding to the tiles of the NTS at the 1:50 000 scale.

Edition/Version : Number of the edition and number of the version of the data set.

Theme : This field indicates the theme identification code. The valid codes are :

AD : Designated Area
CH : Roads
CO : Manmade Features
FO : Relief and Landform
GE : General
HD : Hydrography
HP : Hypsography
LA : Administrative Boundaries
TO : Toponymy
RE : Power Network
RF : Rail Network
RR : Road Network
SS : Water Saturated Soils
VE : Vegetation

Resolution : Resolution can vary from one theme to the next within a data set. This field indicates the resolution of the theme data for the data set. It is expressed as the scale number best corresponding to the various sources used in capturing the data. The possible values are:

50 000
250 000

Number of kilometers : The number of kilometers corresponding to the total length of occurrences of linear entities, plus the total perimeter of occurrences of area entities in the theme.

Number of points : The total number of occurrences of point entities in the theme.

5. Entity and Entity Occurrence

An entity is a thing (object, person, concept, event, etc.), distinguishable from its surroundings, about which information is required.

For NTDB purposes, an entity is the digital representation of all or part of a topographic feature. It is associated with a name in order to be distinguished from other entities (e.g., road, dam, transmission line, or contour).

Figure 3 depicts the complete scheme of a generic entity; Section 5.1 provides a detailed description of each of the components of an entity.

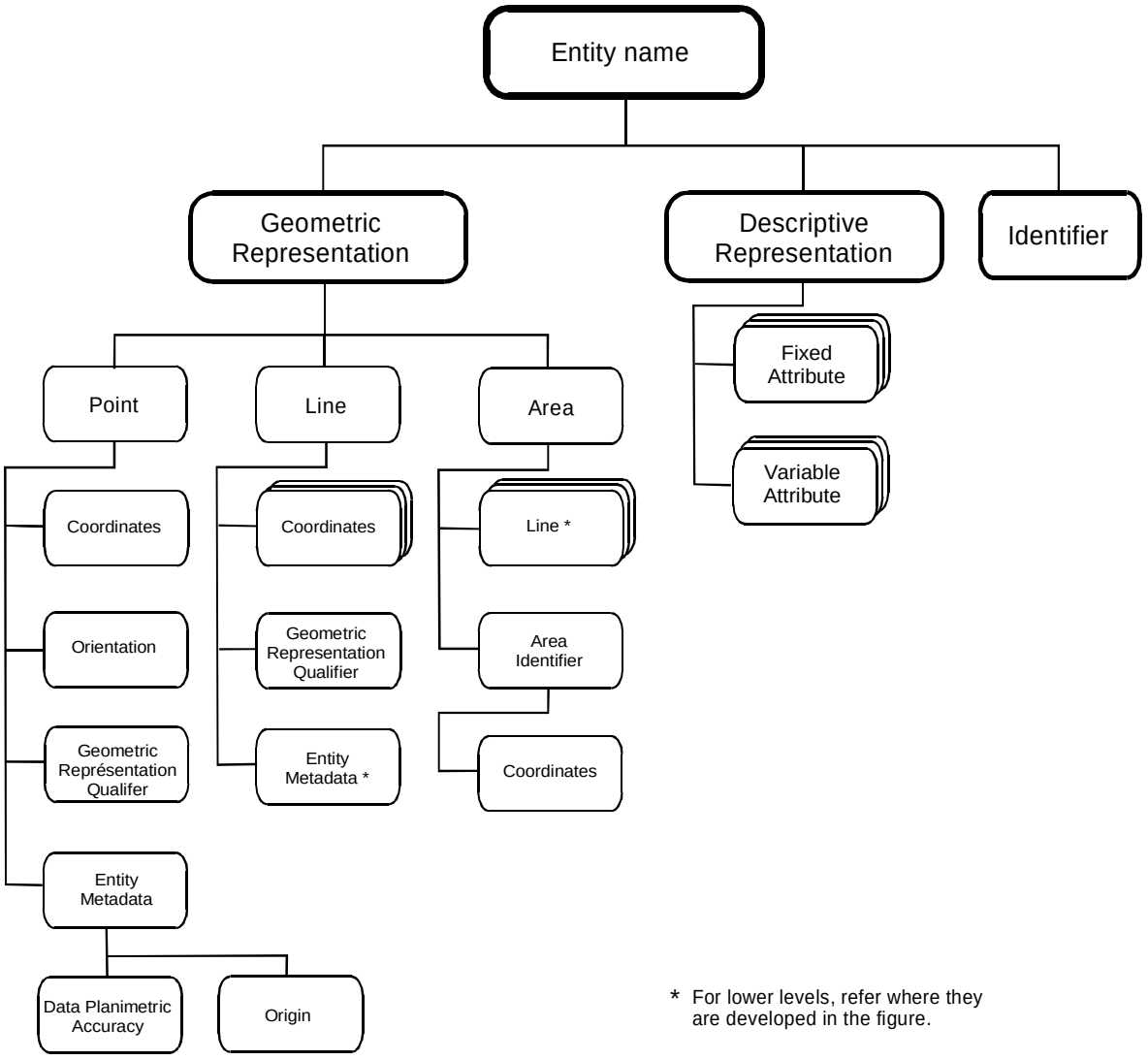

Figure 3 : Generic Entity

5.1 Detailed Description of an Entity

An entity has a tree structure. This section describes each of its components in detail. Only the leaves (extremities) of an entity's tree structure contains data. The intermediate levels serve only for abstraction or generalization. The NTDB data dictionary defines and limits the values, for each entity, that the components can have.

On the most basic level, an entity always comprises three parts: a geometric representation, a descriptive representation, and an identifier.

5.1.1 Geometric Representation

The geometric representation is the digital description of the spatial component of an entity. The NTDB supports three types of geometric representation: point, line, and area. Each entity may be associated with one, two, or three types of geometric representation.

5.1.1.1 Point

A point is a geometric representation comprised of:

a) a single pair of coordinates;
b) an orientation (facultative);
c) a geometric representation qualifier; and
d) metadata.

Figure 4 : Point

The orientation gives the direction of an occurrence of a point entity. It is expressed in degrees from 0 to 359, **rounded** to the nearest unit. When the orientation is unknown, its value is "-1". The orientation is measured counterclockwise from the X-axis (Figure 5).

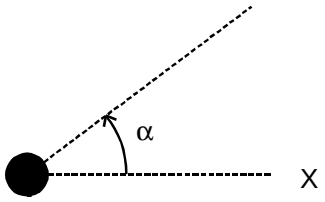

Figure 5 : Orientation

5.1.1.2 Line

A line is a geometric representation comprised of:

a) a series of two (2) or more distinct pairs of coordinates (C1, C2, ..., Cn) sequentially linked;
b) a geometric representation qualifier;
c) metadata.

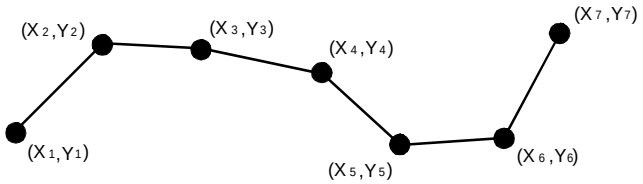

Figure 6 : Line

5.1.1.3 Area

An area is a geometric representation comprised of :

a) a line or series of lines delimiting the extent of the area;
b) an area identifier lying within the limits of the area (often referred to as a centroid).

An area may be simple or complex (see Figure 7). A complex surface is made up of inclusive and exclusive lines.

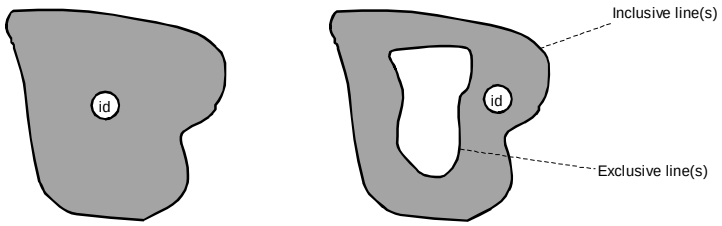

Figure 7 : Area Types

5.1.1.4 Coordinates

A coordinate pair comprises two values (X,Y) that determine a planimetric position. An elevation (h) may be supported to describe a position in three dimensions. Coordinates are expressed in integer values **rounded** to the nearest unit. Coordinates are used in defining the point, line, and area (as an area identifier).

5.1.1.5 Geometric Representation Qualifier

A geometric representation qualifier identifies the nature of the geometric representation of an entity. The qualifier always has one of the following values :

Position definite : Qualifies the planimetric position of all or part of the geometric representation of an entity occurrence when it is visible[6] and discernable[7].

Position Approximate : Qualifies the planimetric position of all or part of the geometric representation of an entity occurrence when it is not visible or not clearly discernable on the data source.

Position Virtual/Continuity : This value is used to characterize a line along the theoretical neatlines of territories that subdivides a surficial topographic feature extending over more than one territory.

It indicates that :

- the line coincides with the theoretical neatline to within one resolution unit;
- the continuity of the topographic feature (surficial) is present in one or more adjacent data sets.

The vertices making up such a line cannot support an elevation (h).

Position Virtual/Discontinuity : This value is used to characterize a line along the theoretical neatlines of territories that subdivides a surficial topographic feature extending over more than one territory.

It indicates that:

- the line coincides with the theoretical neatline to within one resolution unit;
- the continuity of the topographic feature (surficial) is not present in one or more adjacent data sets.

The vertices making up such a line cannot support an elevation (h).

The geometric representation qualifier is used in defining the point and the line but not the area. An area is made up of “line” geometric representations that support the geometric representation qualifier. Consequently, a waterbody can be composed of lines with the qualifiers “position definite” and “position approximate.” The geometric representation qualifiers “virtual/continuity” and “virtual/discontinuity”are used to qualify lines delimiting areas.

5.1.1.6 Entity Metadata

Entity metadata qualify the accuracy and source of the entity data for each entity occurrence. They are directly linked to the entity occurrences by geometric representation (see Section 5.2: Entity Occurrence) or attached to a polygon.

---

(6) “Visible” means that a topographic feature can be perceived on the data source.

(7) “Discernable” means that a topographic feature can be clearly perceived, well defined, identifiable without doubt from the data source.

The metadata directly linked to entity occurrences are :

Planimetric Data Accuracy : Planimetric data accuracy is expressed as the circular map accuracy standard (CMAS) of a topographic feature derived from the equation below :

Standard circular error: $\sigma_C = 0.7071 (\sigma_X^2 + \sigma_Y^2)^{1/2}$

σ_X : standard deviation in the X-axis
σ_Y : standard deviation in the Y-axis

Circular map accuracy standard: $CMAS = 2.1460\ \sigma_C$

The metadata attached to a polygon provide information relevant to **all occurrences or partial occurrences of entities** located exclusively within the area delimited by the polygon. They are maintained as a temporal stack : each time a data set is updated, the occurrences that indicate the changes made are added to the metadata polygon. A correction to a data set that affects the spatial integration of adjacent data sets, for example, would not result in the addition of occurrences to the metadata polygon. Figure 8 shows the portions of a data set affected, at various times (T0, T1, T2), by the capture of metadata occurrences and the resulting metadata affecting each edition/version of the data set.

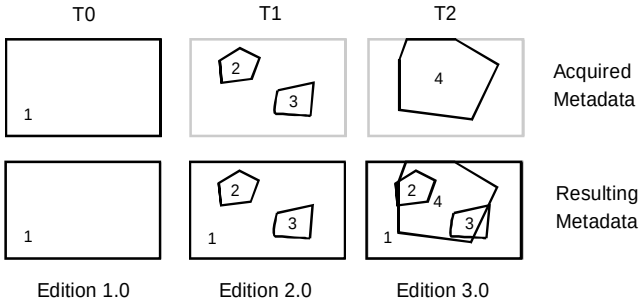

Figure 8 : Metadata Attached to a Polygon

The metadata attached to a polygon are :

Polygon Identification Number : Unique sequential number identifying each metadata polygon.

Names of Affected Entities : List of entities that have been modified, updated, or otherwise changed in the data set.

Type of Data Source : The source of digital or analog data used to acquire data for the NTDB. Possible sources are :

Aerial Photography (including orthophotos)
Reproduction Material
MSS Landsat Image
TM Landsat Image
Spot XS Image
Spot PAN Image
GPS Data
Digital Vector Data from another data base

Name of the Data Source : Name and/or number that identifies the source material used.

Planimetric Accuracy of the Data Source : The planimetric accuracy of the source material is qualified as the source's CMAS, as described in Section 5.1.1.6.

Altimetric Accuracy of the Data Source : The altimetric accuracy of the source material is expressed as the Linear Map Accuracy Standard (LMAS), obtained according to the equation below :

Linear Map Accuracy Standard: $LMAS = 1.6449\ \sigma_z$

σ_z : standard deviation of the elevation

Planimetric and Altimetric Accuracy Qualifiers : Planimetric and altimetric accuracy qualifiers provide information about the method used to determine the accuracy of the source material. The possible values are :

Calculated : Based on rigorous aerial triangulation methods and photogrammetric control. This qualifier applies only to revised data.

Estimated : Based on the specified map accuracy to which scanning and other related errors are added. This qualifier applies only to stereodigitized and scanned data.

Unknown : Given to source material for which no positioning accuracy is known.

Data Validation Date : Date relating to data capture or revision. It corresponds to the date of the source used to identify[8] the data, such as the date of the latest field completion or the date of images taken of the earth's surface (aerial photography, satellite imagery, or other used to identify the data). The date is given as year and month (YYYY/MM).

Action : Data that indicates the nature of the modifications to the polygon, such as an update of the road network or an accuracy enhancement.

[8] "Identify" implies being able to see and recognize an new entity occurrence or a modification to an existing one.

Impact of Action on Content : Data that indicates if the action was systematically applied to the entire contents of the polygon. The possible values are :

Systematic;
Sporadic.

Impact of Action on Geometric Representation : Data that indicates if the action has affected the geometric representation of occurrences. Any action that affects geometric representation is always systematically applied within the polygon. The possible values are:

yes;
no.

Polygon Coordinates : List of ordered, closed coordinates[(1)] (X,Y) that delimits the polygon.

Polygon Area : Area of the NTS territory covered by the polygon, expressed in % of the "Percentage of land"[(1)] of the NTS territory.

NTS Number : Territory number corresponding to the divisions of the NTS at the 1:50 000 scale in which the polygon is located.

Edition/Version : Edition and version numbers for the data set linked to the polygon.

5.1.2 Descriptive Representation

The descriptive representation brings together the set of attributes that describe an entity. Attributes are either fixed domain or variable domain.

5.1.2.1 Fixed Domain Attribute

An attribute is of fixed domain when its values are known, limited, and set. An entity may not have fixed domain attributes.

5.1.2.2 Variable Domain Attribute

An attribute is of variable domain when the multiplicity of values that the attribute may take does not allow one to explicitly state their domain. An entity may not have variable domain attributes.

5.1.3 Identifier

An identifier is an attribute used to distinguish between distinct occurrences of entities in a given data set. The identifier, territory number, and edition/version of the data set together uniquely identify each occurrence in the entire NTDB.

---

(9) See Section 5.1.1.4 for the definition of "coordinates".

(10) See territory metadata : Percentage of land.

5.2 Entity Occurrence

To partly or wholly represent a particular topographic feature, a value is given to each of the attributes of an entity. This set of values constitutes an occurrence of an entity. The example below illustrates an occurrence of the entity “BUILDING.”

Entity : ..... **BUILDING**

Geometric Representation :

Point :

Coordinates : **230452, 5603412**
Orientation : **45**
Geometric Representation Qualifier : ..... **Position Definite**
Metadata :

Planimetric Accuracy : **10**

Descriptive Representation :

Fixed Attribute :

Building Function : ..... **Courthouse**

Variable Attribute :

None

Identifier : ..... **(31G01-3.1) 7345274**

In order to describe a linear and/or surficial topographic feature that has different characteristics, as many entity occurrences as there are parts of the topographic feature with different characteristics are created. The attributes (fixed attributes, variable attributes, accuracy, origin, and so on) are assigned specific values for each occurrence. For example, a road with various kinds of surface would be represented in NTDB by as many occurrences of the entity “Road” as it has sections that are surfaced differently.

5.3 Guaranteed Size

Each topographic feature (river, lake, road, and so on) has a predetermined guaranteed size (area, width, length, and height) that ensures its presence in the NTDB if the size is met or exceeded.

Since the NTDB registers topographic features as entity occurrences, guaranteed sizes are evaluated based on them. An entity occurrence that does not meet the guaranteed size value is not eliminated if :

- the linear entity occurrence has one or more connection relations at both of its extremities (Figure 9);

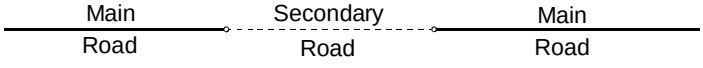

Figure 9 : Connection at each End Point

- the linear entity occurrence has a connection relation at one of its ends (Figure 10) with another linear occurrence of the same entity and also with one or more occurrences of other entities (point, line, or area).

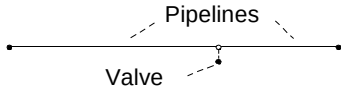

Figure 10 : Connection at one End Point

For the generalization and filtering of entities smaller than the guaranteed sizes in the NTDB, refer to the *Technical Specifications for NTDB Data Acquisition*.

6. Spatial Relations

NTDB data are free from any spatial inconsistencies such as overshoots, undershoots, or area misclosures. To obtain this result, four relations are defined: connection, sharing, adjacency, and superimposition.

6.1 The Connection Relation

Entity occurrences are connected when the following two conditions are satisfied :

- there is a geometric intersection of the entity occurrences involved;
- the NTDB supports the relation between the entities involved (see *NTDB Data Dictionary*).

In general, connection relations are applied differently depending on whether the entities involved are from the same or different themes.

6.1.1 Connection between Entities from the Same Theme

A connection relation between entities from the same theme requires that :

- the planimetric coordinates (X,Y) at the point of connection be duplicated in the geometric representation of each entity occurrence;
- the entity occurrences are segmented at the point of connection.

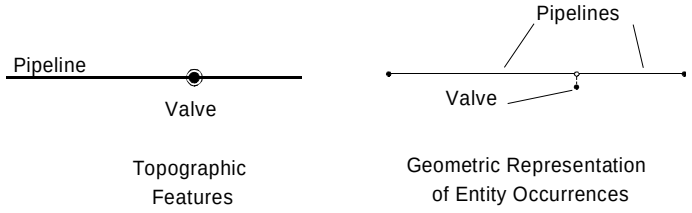

Figure 11 : Connection Relation between Entities from the Same Theme

6.1.2 Connection between Entities from Different Themes

A connection relation between entities from different themes requires that :

- the planimetric coordinates (X,Y) at the point of connection be duplicated in the geometric representation of each entity occurrence;
- the entity occurrences are not segmented at the point of connection.

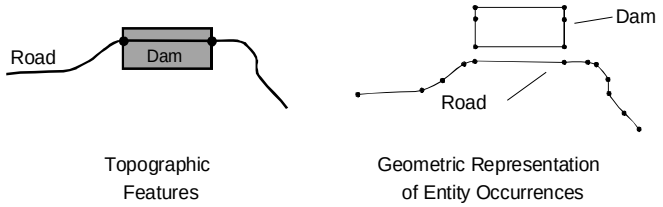

Figure 12 : Connection Relation between Entities from Different Themes

6.2 The Sharing Relation

Sharing exists between occurrences of entities when the following conditions are satisfied :

- the occurrences of linear or surficial entities are partially or totally contiguous or coincident;
- the NTDB supports this relation between the entities involved (see *NTDB Data Dictionary*).

In general, sharing relations are applied differently depending on whether the entities involved are from the same or different themes.

6.2.1 Sharing between Entities from the Same Theme

A sharing relation between two entity occurrences from the same theme requires that :

- the planimetric coordinates (X,Y) of the line of coincidence be duplicated in the geometric representation of each entity occurrence;
- the entity occurrences be segmented at the ends of the coincident part.

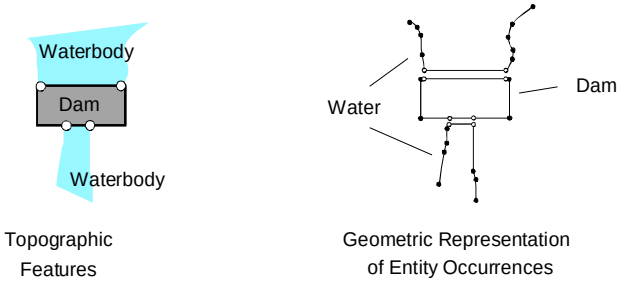

Figure 13 : Sharing Relation between Entities from the Same Theme

6.2.2 Sharing between Entities from Different Themes

A sharing relation between entity occurrences from different themes requires that :

- the planimetric coordinates (X,Y) of the line of coincidence be duplicated in the geometric representation of each entity occurrence;
- the entity occurrences are not segmented at the ends of the coincident part.

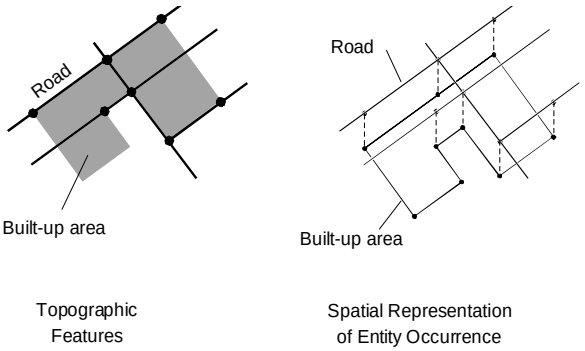

Figure 14 : Sharing Relation between Entities from Different Themes

6.3 Connection and Sharing Tolerances

Two entity occurrences that meet at one point (connection) or along a line (sharing) within a predetermined tolerance must have exactly the same coordinates at the meeting point as described in Sections 6.1 and 6.2. The tolerance is dependent on the resolution or scale of the source material. It corresponds to the distance between two topographic features at which two distinct geometric representations can be identified.

6.4 Integration of Data with no Explicit Spatial Relation

Entities that have no explicit relation of connection or sharing can nevertheless be spatially integrated if they are within 0.7071[(11)] meter of each other. This type of integration is to minimize unwanted segmentation between occurrences of NTDB entities. It requires only that the number of pairs that spatially define the occurrences of entities be identical. The overall geometry must fall within a tolerance of 0.7071 meter of the occurrence of the NTDB entity into which it is to be integrated. This is the case when administrative boundaries are to be integrated with other NTDB entities.

6.5 Altimetric Exclusion Areas

An altimetric exclusion area is a surficial entity whose relief is distinct or inconsistent with that of the surrounding objects. The distinction derives from the nature of the objects in proximity (e.g., land versus a river) or a manmade alteration in the natural shape of the surface of the earth. Such areas must be void of all occurrences of the entity “elevation point”. Contours—represented for spatial continuity—are attributed the geometric representation qualifier “Position Approximate”. The ***NTDB Data Dictionary*** identifies the entities that are altimetric exclusion areas.

(11) The value 0.7071 is derived by considering the maximum deviation of 0.5 meter in the x- and y- axis between the real coordinates of a vertex and its coordinates in the NTDB ($0.7071 = (0.5^2 + 0.5^2)^{1/2}$).

6.6 Spatial Continuity between NTDB Data Sets

The spatial continuity of topographic features must be ensured between adjacent data sets.

6.6.1 Linear Topographic Feature

A linear topographic feature extending through more than one territory is segmented into distinct portions at the limit between the territories. Each portion is kept in its respective data set.

6.6.2 Surficial Topographic Feature

A surficial topographic feature extending across more than one territory is separated into distinct portions at the limit between the territories. Each portion creates an entity occurrence that is closed off at the limit of the NTS territory with a line that has the “virtual” geometric representation qualifier. The qualifier “virtual/continuity” is used between occurrences in their respective data sets (see Figure 15). The qualifier “virtual/discontinuity” is used when a portion of the topographic feature exists in one data set but the other portion is not in the adjacent data set.

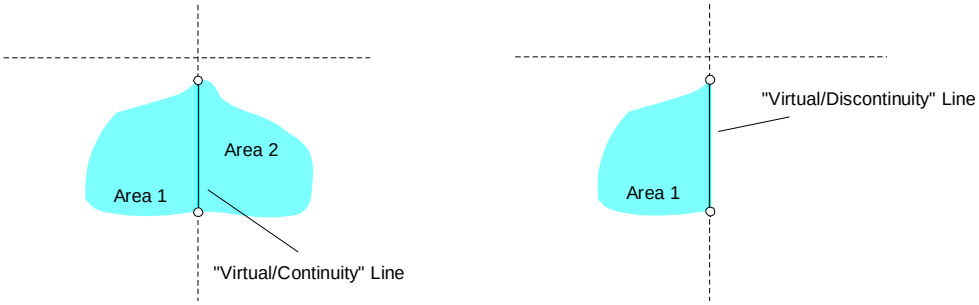

Figure 15 : Continuity of Topographic Features that Extend across more than one Territory

When an occurrence of a surficial area ends at the limit of a territory, within a predetermined tolerance, the line delimiting the area at the limit of the territory has the geometric representation qualifier “virtual/discontinuity”.

A virtual geometric representation can never support a relation of connection or sharing. Then, two entity occurences are never segmented at the territory limit if :

- a sharing relation exists between the entities,
- they are superimposed, and
- they have together a vitual geometric representation qualifier, totally or partially coincident (see Figure 16).

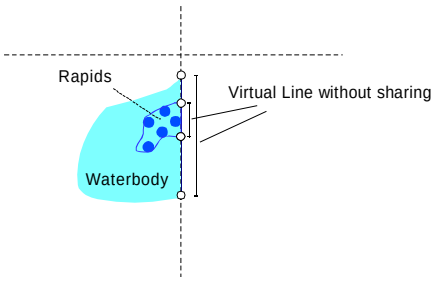

Figure 16 : Coincidence of Areas at the Limit of a Territory

Entities that support connection relations can never connect to a virtual line in a surficial entity.

6.6.3 Spatial Definition of the Limits of NTS Territories

In order to integrate data sets, the coordinates for the limits of NTS territories are in real values so as to attain spatial definition of the highest accuracy. This is to maximize the quality of the geometric representation of occurrences of entities along the neatline of the data sets being integrated, even when the geometric representation of the data is given in whole values. Nonetheless, adjacent data sets from different UTM zones may evidence data discontinuities of one meter as a result of the transformation of coordinates from one zone to the next and the rounding off of coordinates to whole values.

The geometric representation of the entity “NTS territory limit” is, as are all other NTDB entities, maintained and distributed in whole values.

References

Géomatics Canada, *National Topographic Data Base*, *Normes et spécifications*, Edition 2.4, 1994, 18 p.

Géomatics Canada, *National Topographic Data Base, Data Dictionary*, 1994, 225 p.

NATO (Military Agency for Standardization), *Standardization Agreement ,Evaluation of Land Maps*, STANAG 2215, Édition 4, 1983.

Egenhofer, Max J. and Jayant Sharma, “Topological Consistency”. *Proceedings of 5th International Symposium on Spatial Data Handling*, 1992, pp.261-273.

Egenhofer, Max J., “A Model for Detailed Binary Topological Relationships.” *GEOMATICA, Vol. 47, No 3 & 4*, Canada, 1993, pp.261-273.

Egenhofer, Max J., E. Clementi and P. Di Felice, “Topological relations Between Regions vith Holes.” *International Journal of Geographical Information Systems*, 1994, pp.129-142.

Appendix : NTDB Metadata