Natural Resources Canada
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Canadian Digital Elevation Data

Standards and Specifications

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Canada

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1- Introduction

The Canadian Digital Elevation Data (CDED) consists of an ordered array of ground elevations at regularly spaced intervals. These CDED are based on National Topographic Data Base (NTDB) digital files at the scale of 1:50,000 and 1:250,000, according to the National Topographic System (NTS).

The coverage of every file corresponds to half an NTS map sheet, which means that there are western and eastern parts to the CDED for every NTS map when necessary. CDED files are available at scales of 1:50,000 and 1:250,000. The grid spacing of the 1:50,000 CDED is based on geographic coordinates at a maximum resolution of 0.75 arc second and a minimum resolution of 3 arc seconds depending on latitude. The grid spacing maximum and minimum resolutions for the 1:250,000 CDED are respectively 3 and 12 arc seconds depending on latitude. A CDED file consists of elevation data recorded in metres relative to Mean Sea Level (MSL) based on the NAD83 horizontal reference datum. Quality control is implemented throughout the production process. These CDED are produced jointly by the Centre for Topographical Information (CTI) and the Canadian Forest Service, Ontario Region (CFS). All CDED files are produced using ANUDEM (Australian National University Digital Elevation Models) software.

CDED have assumed a major role in digital mapping. They are used in geographic information systems (GIS) for land-management applications. CDED play the same roles that contours and relief shading do on conventional paper maps, but are more powerful analytically. In addition to providing estimated values of elevation points, CDED can be used to determine orientation and the slope of each point when used in GIS applications. CDED can also be used for terrain modeling, for calculating the influence of the terrain on line-of-sight, for radar imaging, for simulating flooding, and similar applications.

2- Product Specifications

2.1- CDED Directory and File Names Conventions

Two distinct and possible cases can be encountered with CDED directories and files. The first case is encountered when a client places a purchase order through the Customer Support Group of the Centre for Topographic Information in Sherbrooke (CTIS). The second case happens when a client places a request to process data, directly on line, through the CTIS web site, like in the case of a subscriber for instance. In both cases, a physical volume may contain many data sets.

FIRST CASE (examples)

Name of the directory associated to a data set: **031k01_d**
Name of a CDED file associated to a data set: **031k01_w.dem**

In the first case, a directory identified by the NTS number, followed by the characters "_d" is created for each data set contained in the physical volume (eg 031k01_d). All CDED files relating to this specific data set are then stored into this directory. Since a NTS sheet normally covers two CDED cells, namely eastern and western cells, therefore the directory generally includes the two corresponding CDED files. CDED file names correspond to the NTS sheet number, followed by two characters indicating in which part of the

NTS (east or west) the file is located, followed and completed by the file extention ".dem". For example, cells 031k01_e.dem and 031k01_w.dem respectively cover eastern and western parts of the NTS sheet 031k01 at the scale of 1:50 000. CDED files at the 1:250 000 scale are named similarly. For example, cells 031k_e.dem and 031k_w.dem respectively cover eastern and western parts of the NTS sheet 031k at the scale of 1:250 000.

SECOND CASE (examples)

Name of the directory associated to the CDED product:	**DNEC_CDED**
Name of the "container" type file associated to a data set:	**031k01_000000000001.zip**
Name of a CDED file associated to a data set:	**031k01_0100_demw**

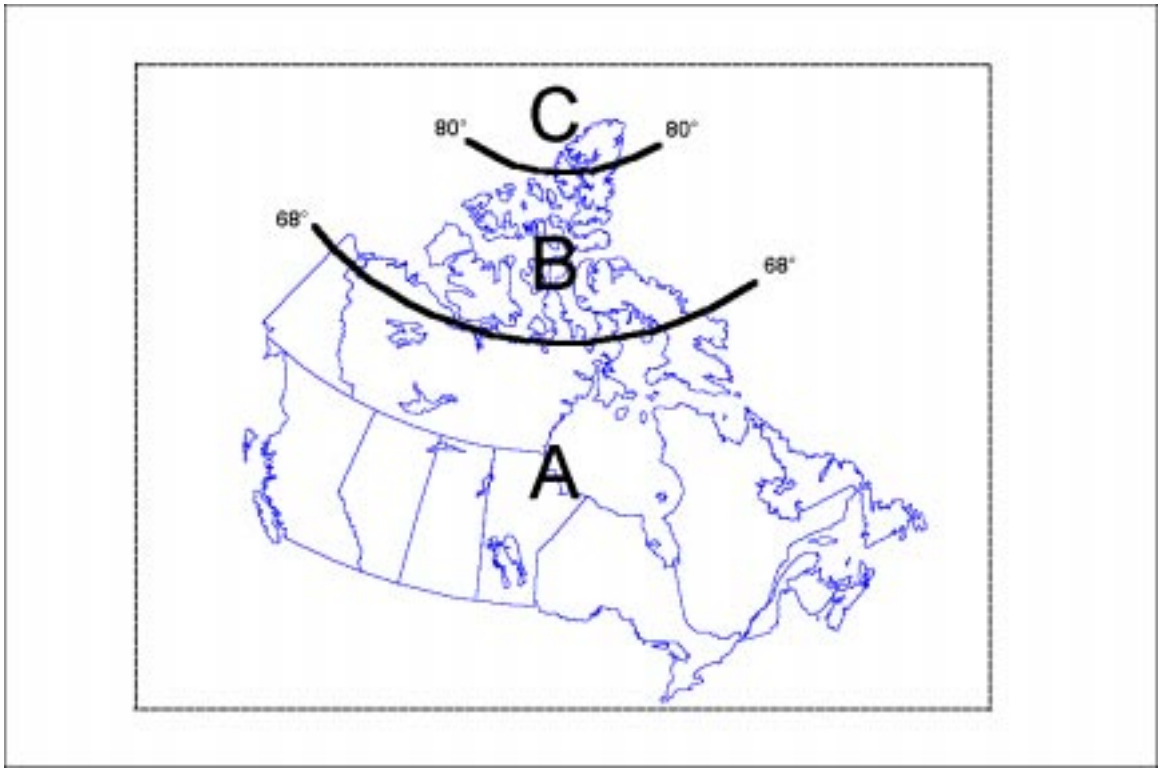
In the second case, a directory identified by the product name allows for the grouping of data that belong to the same product. For CDED product, this directory's name is "DNEC_CDED". All CDED files relating to the same data set are then compressed (using PKZIP compression software) together in one file, which name corresponds to the NTS sheet number, followed by a underscore "_" character, itself followed by a unique twelve-character identifier (automatically generated), and completed by the file extention ".zip" (eg 031k01_000000000001.zip). All CDED files relating to this data set are stored into this file. The name of the CDED files included in this ".zip" file refers to the NTS sheet number, followed by a underscore "_" character, itself followed by two characters specifying the CDED data set edition, followed by two characters specifying the CDED data set version, followed by the four-character string "_dem", and completed by one character indicating which of the eastern and western part of the NTS sheet the file is in. For example, cells 031k01_0100_deme and 031k01_0100_demw respectively cover eastern and western parts of the NTS sheet 031k01 at the scale of 1:50 000. CDED files at the 1:250 000 scale are named similarly. For example, cells 031k_0101_deme and 031k_0101_demw respectively cover eastern and western parts of the NTS sheet 031k at the scale of 1:250 000.

NOTE **Previously described CDED file names are different from the name found in the Data Element number 1 in the Type A Logical Record described under section 3.2.**

2.2- Coverage of CDED Files

Cell coverage varies according to three geographic areas. All cells contain the same number of nodes (elevation). All profiles are oriented north-south and contain 1201 elevation points. Each cell holds 1201 profiles, for a total of 1 442 401 elevation points.

Coverage of the Three Geographic Areas



1:50,000 CDED cell coverage according to the Three Geographic Areas

GEOGRAPHIC AREA	LATITUDE		SPACING (latitude and longitude in arc seconds)	SPACING (in metres, approximate)	CELL COVERAGE (latitude - longitude)
	from	to	lat. long.	N.-S. E.-O.	
A	—	68°	0.75" x 0.75"	23 m x 16-11 m	15' x 15'
B	68°	80°	0.75" x 1.5"	23 m x 17-8 m	15' x 30'
C	80°	90°	0.75" x 3"	23 m x 17-8 m	15' x 1°

1:250,000 CDED cell coverage according to the Three Geographic Areas

GEOGRAPHIC AREA	LATITUDE		SPACING (latitude and longitude in arc seconds)		SPACING (in metres, approximate)		CELL COVERAGE (latitude - longitude)		
	from	to	lat.	long.	N.-S.	E.-W.			
A	—	68°	3"	3"	93 m	65-35 m	1°	x	1°
B	68°	80°	3"	6"	93 m	69-32 m	1°	x	2°
C	80°	90°	3"	12"	93 m	65-32 m	1°	x	4°

2.3- Vertical and Horizontal Datums

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

2.4- Comparison of CDED to Existing DTED (Digital Terrain Elevation Data)

ITEMS	DTED Level 1	1:50K CDED	1:250K CDED
Vertical and horizontal datums	WGS84 and NAD27 Mean Sea Level (MSL)	NAD83 Mean Sea Level (MSL)	NAD83 Mean Sea Level (MSL)
File format	USDMA's DTED (United States Defence Mapping Agency) 1 cell/file	Modified version of USGS's DTED (United States Geological Survey) 1 cell/file	Modified version of USGS's DTED (United States Geological Survey) 1 cell/file
File or Cell coverage	1° x 1°	15' x 15', 15' x 30', 15' x 1°	1° x 1°, 1° x 2°, 1° x 4°
Number of profiles	1201, 601, 401, 301 or 201	1201	1201
Number of elevation points per profile	1201	1201	1201
Number of geographic areas	5	3	3
Spacings between elevation points	3" x 3", 3" x 6", 3" x 9", 3"x 12", 3" x 18"	0.75" x 0.75", 0.75" x 1.5", 0.75" x 3"	3" x 3", 3" x 6", 3" x 12"

ITEMS	DTED Level 1	1:50K CDED	1:250K CDED
File naming convention	Latitude and longitude of SW corner (ex.: /w0770000/n430000.dtn)	For explanations, refer to section 2.1.	For explanations, refer to section 2.1.
Write formats	ASCII and binary	ASCII only	ASCII only
Logical records	A, B et C	A (modified) and B	A (modified) and B

2.5- File Overlap

To provide overlap between adjacent data files, CDED cell coverage includes the limits of a half NTS map sheet. Each profile has one point of overlap with the cell above it (to the North) and one with the cell below it (to the South), while the first and last profile of the CDED cells respectively coincide with the last and first profile of the adjacent CDED cells (West and East).

2.6- Density

The number of points per profile and the number of profiles per cell are constant for all the files (1201 x 1201). Elevation values are contained on a grid, spaced according to latitude. For the 1:50,000 scale, the spacing is always 0.75 arc second along a profile in the north-south direction and varies from 0.75 to 3 arc seconds in the east-west direction, depending upon the appropriate elevation grid spacing for the latitude zone. The spacing in metres is about 23 metres in the north-south direction and varies from approximately 8 to 17 metres between profiles (east-west direction), depending upon the latitude.

The elevation grid spacing for the 1:250,000 scale is always 3 arc seconds in the north-south direction along a profile and varies from 3 to 12 arc seconds in the east-west direction, depending upon the appropriate elevation grid spacing for the latitude zone. The spacing in metres is about 93 metres in the north-south direction and varies from approximately 30 to 70 metres between profiles (east-west direction), depending upon the latitude.

2.7- Accuracy

The only measurable or perceivable errors in the CDED are vertical errors that may be partially attributable to horizontal errors inherent in the source data. Since all the data come from scanning NTS map sheets at the 1:50,000 and 1:250,000 scales and since conversion errors are cumulative, sometimes the data quality might be somewhat lower than that of the source product.

Special care was taken with regard to watercourse direction of flow and the flatness of the water surface and surrounding area. The CDED was compiled from all the hypsographic and hydrographic elements on the original 1:50,000 and 1:250,000, respectively, according to the CDED scale.

Accuracy depends on the original map from which the data is scanned. The current system used to classify the NTS map is based on the STANAG 2215 Agreement, Edition 5.

2.8- Accuracy relative to Density

In some NTDB data sets, horizontal inaccuracy goes up to 100 metres for the 1:50,000 scale and 500 metres for the 1:250,000 scale. This should not give rise to any confusion about data accuracy. The close spacing does not mean, for example, that the horizontal accuracy is equivalent to about half of the distance between two elevation points. The reason for this density is to better describe the terrain and to enhance data consistency. Data accuracy also depends on the level of detail or grid refinement that can be attained with the source materials. In forming a grid, precise points must be transferred, which may alter the apparent position upon display of the point or original vector-data source. This reduces the ability to recover the positions of specific features whose dimensions are less than the internal grid cell spacing.

2.9- Regeneration of Contours from CDED Data

Although contours can be regenerated from the CDED, the original NTDB contours should be used for higher accuracy and to preserve as much detail as possible.

2.10- CDED Consistency

Waterbodies are naturally occurring areas of constant elevation (lakes) or having a small slope (rivers). Oceans and estuaries at Mean Sea Level are assigned an elevation value of zero metre. All other waterbodies are assigned their known elevations or estimated values. In the case of large bodies of water, the file is not empty but contains an estimated elevation. A body of water of unknown elevation is assigned an interpolated elevation that should be roughly equal to that of its shores. Waterbodies are represented flatter and lower than the surrounding terrain. The shore must be clearly discernible.

The purpose of CDED production is to produce DEM data sets that accurately represent slope and elevation. Slope data are more critical to certain scientific applications than elevation data. Consequently, quality control must assure that the CDED is smooth within the grid and continuous from node to node, except at natural break points such as streams, cliffs, and craters.

The CDED production process provides for drainage patterns. The methodology used to create these CDED are based on ANUDEM software, which pays close attention to watercourse direction of flow. In addition, quality control is carried out to eliminate nonsense drainage activity especially along file edges.

2.11- Edge matching

Edge matching is a process of matching elevation values along quadrangle edges or at the CDED file limits. The objective of edge matching is to improve the alignment of ridges and drains, and overall topography shaping and representation. Edge matching is not required for areas outside Canada’s borders.

2.12- Seamless Aspect of the Data

The 1:250,000 CDED provide complete seamless coverage of the entire country, including edge matching and matching with NTDB elements at the 1:250,000 scale. The 1:50,000 CDED provides a partial coverage of the country, mainly in inhabited areas and where an economic activity is significant.

3- File Format

The format is very similar to the ASCII version of the DTED of USGS (United States Geological Survey). All the information relative to the data is given in the Type A logical record. The data is written in the same manner as in the USGS version of the DTED. The data should be compatible with all translators designed for USGS DTED.

3.1- Physical Structure of the CDED File

Data are written as ANSI Standard ASCII characters and are recorded in IBM Standards fixed-block format.

Physical record size is 1024 bytes. No more than one logical record type (A or B) can be recorded in any 1024 byte record. However, more than one 1024 byte record is usually required to store a single record type B. Logical records are padded with blanks if necessary to fill to the end of the 1024 bytes of the physical record.

There is only one type A record for each CDED file, and it appears as the first record in the data file. The type B record contains elevation data and associated header information. All type B records of the CDED files are made up of data from one-dimensional bands called profiles. Therefore, the number of profiles covering the CDED area is the same as the number of type B records in the CDED.

The following special conventions shall be observed for the population of data fields in the A and B logical record elements :

- All character fields must be in upper case. Character field of no data value must be blank, ASCII space (binary 0010 0000);
- All integer or character flagged fields of no data value but which default to zero must be ASCII zero (binary 0011 0000);
- All real (non-integer) numeric fields shall be populated. Default zero fill shall follow the following convention ;

1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	**Byte position, left justified**
				.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	D	+	0	0	Standard format specified is D24.15. Zero values listed are common machine dependant numeric default for real zeros.
			0	.	0																			
			0	.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	D	+	0	0	
				.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0				

3.2- TYPE A LOGICAL RECORD

Note: For the majority of information fields the value is right justified.

Data Element	Contents	Format Type (Fortran)	ASCII (Fortran)	Comments
1	File name	ALPHA	A40	Ex: 31a01DEMw
1	Producer of data, Free format text (e.g.: CFS-SSM)	ALPHA	A60	Free format descriptor, containing information about the data producer.
1	Filler		9 bytes	Blank fill
1	SW geographic corner	INTEGER*2 REAL*8	2(I4,I2,F7.4)	SW geographic quadrangle corner ordered as: Long. = SDDDMMSS.SSSS Lat. = SDDDMMSS.SSSS
1	Process Code	ALPHA	A1	8 = ANUDEM using NTDB files.
1	Filler		1 byte	Blank fill
1	Sectional indicator	ALPHA	A3	Not used in this case.
2	Origin code	ALPHA	A4	Free format mapping origin set to "NTDB".
3	DEM level code	INTEGER*2	I6	Code 1 = DEM-1 2 = DEM-2 3 = DEM-3 Set to Code 1 for 1:50,000 and 1:250,000 CDED.
4	Code defining the elevation pattern (regular or random).	INTEGER*2	I6	Code 1 = regular 2 = random Set to Code 1.
5	Code defining the ground horizontal reference system.	INTEGER*2	I6	Code 0 = Geographic 1 = UTM 2 = state plane Normally set to the code representing the geographic (lat/long) system for 1:50,000 CDED. Set to code 0.
6	Code defining the zone in the ground horizontal reference system.	INTEGER*2	I6	Code is set to 0 for 1:50,000 and 1:250,000 CDED.

Data Element	Contents	Format Type (Fortran)	ASCII (Fortran)	Comments
7	Map projection parameters	REAL*8	15D24.15	All 15 fields of this element are set to zero and should be ignored when geographic.
8	Code defining the unit of measure for the ground horizontal coordinates throughout the file.	INTEGER*2	I6	Code 0 = radians 1 = feet 2 = metres 3 = arc-seconds Set to Code 3.
9	Code defining the unit of measure for the (vertical) elevation coordinates throughout the file.	INTEGER*2	I6	Code 1 = feet 2 = metres Set to Code 2.
10	Number of sides in the polygon that defines the coverage of the CDED file.	INTEGER*2	I6	Usually n = 4
11	A 4,2 array containing the ground geographic coordinates of the four corners of the CDED.	REAL*8	4(2D24.15)	The coordinates of the quadrangle corners are ordered clockwise beginning with the southwest corner. The array is stored row-wise as pairs of decimal longitude and latitude.
12	A two-element array containing minimum and maximum elevations for the CDED.	REAL*8	2D24.15	The values are in the unit of measure given by data element 9 in this record (min., max.).
13	Counterclockwise angle (in radians) from the primary axis of the ground horizontal reference to the primary axis of the CDED horizontal local reference system.	REAL*8	D24.15	Normally set to zero to align with the coordinate system specified in element 5. Expressed in radians.
14	Accuracy code for elevations	INTEGER*2	I6	When set to 0, this indicates that a record does not exist and that no Type C record will follow. Always “0” because there is no “C” record for this product (CDED).

Data Element	Contents	Format Type (Fortran)	ASCII (Fortran)	Comments
15	A three-element array containing CDED spatial resolution (x,y,z). Units of measure for these resolution elements are consistent with those indicated by data elements 8 and 9 in this record.	REAL*4	3E12.6	These elements are usually set to 0.75,0.75,1; 0.75,1.5,1; or 0.75,3,1 (depending on latitude) for 1:50K CDED, and 3,3,1; 3,6,1; or 3,12,1 for 1:250K CDED. These units should not be confused with data accuracy.
16	A two-element array containing the number of rows and columns (m,n) of profiles in the CDED.	INTEGER*2	2I6	Normally, the row value m is set to 1. Thus, the n value normally describes the number of columns in the CDED file (1201).
17	Largest primary contour interval.	INTEGER*2	I5	Present only if two or more primary intervals exist. *This field is left empty*.
18	Largest source contour interval unit.	INTEGER*1	I1	Correspond to the unit of the NTDB largest primary contour interval 0 = NA, 1 = Feet, 2= Metres. *This field is left empty.*
19	Smallest primary contour interval.	INTEGER*2	I5	Smallest or only primary contour interval. *This field is left empty.*
20	Smallest source contour interval unit.	INTEGER*1	I1	Corresponds to the unit of the NTDB smallest primary contour interval 1 = feet, 2 = metres. *This field is left empty.*
21	Data source date.	INTEGER*2	I4	YYMM: two-digit year and two-digit month. MM = 00 for source having year only. *This field is left empty.*

Data Element	Contents	Format Type (Fortran)	ASCII (Fortran)	Comments
22	Data inspection/revision date	INTEGER*2	I4	YYMM: two-digit year and two-digit month. *This field is left empty.*
23	Inspection/revision flag	ALPHA*1	A1	"I" or "R". *This field is left empty.*
24	Data validation flag	INTEGER*1	I1	0 = No validation performed 1 = RMSE computed from test points, no quantitative test, no interactive CDED editing or review. 2 = Batch process waterbody edit and RMSE computed from test points. 3 = Review and edit, including water edit; no RMSE computed from test points. 4 = Level 1 CDED reviewed and edited. Includes waterbody editing RMSE computed from test points. *This field is left empty.*
25	Suspect and void area flag	INTEGER*1	I2	0 = none 1 = suspect areas 2 = void areas 3 = suspect and void areas *This field is left empty.*
26	Vertical datum	INTEGER*1	I2	1 = local Mean Sea Level (MSL) 2 = National Geodetic Vertical Datum 1929 (NGVD 29) 3 = North American Vertical Datum 1988 (NAVD 88) *This field is set to "1".*
27	Horizontal datum	INTEGER*1	I2	1 = NAD27 2 = WGS72 3 = WGS84 4 = NAD83 *This field is set to "4".*
28	Data edition	INTEGER*2	I4	Normally set to 1. *This field is left empty.*

Data Element	Contents	Format Type (Fortran)	ASCII (Fortran)	Comments
29	Percent void	INTEGER*2	I4	If element 25 indicates a void, this field (right justified) contains the percentage of nodes in the files set to void. *This field is left empty.*
30	Edge-match flag	INTEGER*1	4I2	Edge-match status flag. Ordered West, North, East, and South. Explanation of codes: 1 = Edge-Matched 3 = Edge is external, no match required *This field is left empty.*
31	Vertical datum shift	Real*8	F7.2	Vertical datum shift; normally set to 0. *This field is left empty.*

3.3- TYPE B LOGICAL RECORD

Note: For the majority of information fields the value is right justified.

Data Element	Contents	Format Type (Fortran)	ASCII (Fortran)	Comments
1	A two-element array containing the row and column identification number of the CDED profile contained in this record.	INTEGER*2	2I6	The identification number ranges from 1 to m (rows) and from 1 to n (columns or profiles). Rows are normally set to 1 and should be disregarded. The column identification is the profile sequence number.
2	A two-element array containing the number of rows and columns (m,n) of elevations in the CDED profile.	INTEGER*2	2I6	This first element in the field corresponds to the number of rows or nodes in the profile (1201). The second element in this field is normally set to 1, specifying 1 column per profile.
3	A two-element array containing the ground horizontal coordinates of the first elevation in the profil.	REAL*8	2D24.15	Ground horizontal coordinates (latitude and longitude) in arc seconds according to element 8 in Logical Record Type A.
4	Elevation of local vertical datum for the profile.	REAL*8	D24.15	The values are in the units of measure given by data element 9 in Logical Record Type A. Always 0 for 1 degree CDED (reference is MSL).
5	A two-element array of minimum and maximum elevations for the profile.	REAL*8	2D24.15	The values are in the units of measure given by data element 9 in Logical Record Type A.
6	The array of m x n elevations for the profile. Elevations are expressed in units of resolution elements (metres).	INTEGER*2	mn (I6)	A value in this array would be multiplied by the spatial resolution value and added to the elevation of the local elevation datum for the profile to obtain the elevation for the point.