

# Height Modernization 2013 A New Canadian Vertical Datum



Natural Resources Ressources naturelles Canada Canada



# What is Height Modernization?

- The Height Reference System Modernization is a project at the Geodetic Survey Division (GSD) of Natural Resources Canada (NRCan)
- The project will establish the geoid-based Canadian Geodetic Vertical Datum of 2013 (CGVD2013), superseding CGVD28 which is almost 100 years old
- The new vertical reference system will be officially released in November 2013 (CGVD2013)
- CGVD28 will continue to co-exist with CGVD2013
- USA are also in moving to a geoid-based datum (2022)



Orthometric height determination by two techniques: levelling and combination of GPS measurements and a geoid model.

# Why Height Modernization in Canada?

- CGVD2013 is compatible with Global Navigation Satellite Systems (GNSS) such as GPS.
- GNSS positioning is now mature and has gained widespread adoption by users.
- Reduction of dependency on monumented network
- It is a cost efficient technique in determining precise heights everywhere in Canada
- A geoid model realizes an accurate and homogeneous vertical reference surface all across Canada



Traditional Levelling Networks



Modern Geoid Model

# Why Height Modernisation in Canada?

- Modern technology in positioning
  - GNSS positioning is now mature and has gained widespread adoption by users.
  - It is a cost efficient technique in determining precise heights everywhere in Canada.
  - Satellite gravity missions offer unprecedented precision in the determination of the long and middle wavelength components of the geoid.
  - A geoid model realizes an accurate and homogeneous vertical reference surface all across Canada (land, lakes, oceans).









#### What is the geoid?

- Equipotential surface representing best, in a leastsquares sense, the global mean sea level (MSL)
  - The geoid is the actual shape of the Earth
  - ✓ The geoid is the global reference surface for heights
  - ✓ Satellite gravity data (Grace, GOCE)
  - Characteristics:
    - Gravity is perpendicular (vertical) to the geoid
    - The geoid is a level surface (water is at rest on the geoid)





#### **Canadian Geodetic Vertical Datum of 2013 (CGVD2013)**



#### Heights: Orthometric (H), geodetic (h), geoid (N)

Name:	Canadian Geodetic Vertical Datum of 2013
Abbreviation:	CGVD2013
Type of datum:	Gravimetric (geoid)
Vertical datum:	$W_0 = 62,636,856.0 \text{ m}^2\text{s}^{-2}$
Realisation:	Geoid model CGG2013 (NAD83(CSRS) and ITRF2005)
Type of height :	Orthometric

#### CGVD2013: What is the difference with CGVD28?

CGVD28(HTv2.0) – CGVD2013(CGG2010)



Preliminary values			
$H_{CGVD2013} - H_{CGVD28}$			
St John's	-37 cm		
Halifax	-64 cm		
Charlottetown	-32 cm		
Fredericton	-54 cm		
Montréal	-36 cm		
Toronto	-42 cm		
Winnipeg	-37 cm		
Regina	-38 cm		
Edmonton	-04 cm		
Banff	+55 cm		
Vancouver	+15 cm		
Whitehorse	+34 cm		
Yellowknife	-26 cm		
Tuktoyaktuk	-32 cm		



# What is the impact of the new datum?

- In New Brunswick all provincial HPN Monuments and ACS Stations will have a new elevation.
- NRCan has already stopped levelling surveys for the maintenance of the vertical datum
- NRCan is not maintaining the benchmarks by either levelling or GNSS technique
  - However, the levelling networks will be readjusted to conform with CGVD2013 using existing data.
  - NRCan will publish CGVD28 and CGVD2013 heights at benchmarks.
  - NRCan cannot confirm the actual height of the benchmarks from the adjustment as the adjustment is from legacy data.
- The Canadian Active Control Stations (CACS) and Stations of the Canadian Base Network (CBN) are forming the federal infrastructure for positioning
- Levelling will remain the most efficient technique for most short distance work.



#### **CGVD2013: Impact on data**

- My CGVD28 heights have a few metres accuracy and are rounded to the closest metre (e.g., CDED)
  - ✓ The difference between CGVD28 and CGVD2013 can be ignored.
- My CGVD28 heights are precise (< 10 cm) and cover a large region (e.g., LiDAR survey)
  - The difference between CGVD28 and CGVD2013 must be considered.
- My CGVD28 heights are precise (< 2 cm) and cover a small region (e.g., municipal dataset)
  - The difference between CGVD28 and CGVD2013 must be considered, but generally the same difference is sufficient for the region.

# **Labelling Heights**

- Type of height: Orthometric (H), dynamic (H<sup>d</sup>), normal (H<sup>n</sup>), geodetic (h), geoid (N)
- Height Reference System: NAD83, CGVD2013, ITRF
- Height Reference Frame: CSRS v., geoid model
- > Precision (e.g.,  $\pm$  0.05 m)
- Epoch (e.g., 2012.75)



Geoid Height: -10.354 m Precision: ± 0.015 m Epoch: Static Model: CGG2013 Frame: NAD83(CSRS)

N = -10.354 ± 0.015m CGG2013, NAD83(CSRS) Height: 101.61 m Precision: ± 0.01 m Epoch: 2013.2 Type of height: Orthometric Height system: CGVD2013 Height frame: CGG2013

H = 23.126 ± 0.01m CGVD2013(CGG2013) Epoch 2013.2

Height: 91.256 m Precision: ± 0.007 m Epoch: 2013.2 Type of height: Ellipsoidal (geodetic) Height system: NAD83 Height frame: CSRS (version if available)

h = 91.256 ± 0.007m NAD83(CSRS) Epoch 2013.2

#### Software available at NRCan



**GPS-H**: Convert ellipsoidal heights to orthometric heights. GPS-H makes use of any geoid models, works with different types of coordinate systems (geographic, UTM, MTM and Cartesian), and different geometric reference frames (NAD83(CSRS) and ITRF) http://webapp.geod.nrcan.gc.ca/geod/?file=apps/gpsh/gpsh&apps=GPSH&info=gpsh



**Precise Point Positioning (PPP)**: Process GPS RINEX files to provide coordinates (latitude, longitude, ellipsoidal height and orthometric height)



**TRX**: Transform coordinates between different geometric reference frames, epochs and coordinate systems.

#### Summary

#### > NRCan will release a new vertical datum in November 2013

- Canadian Geodetic Vertical Datum of 2013 (CGVD2013)
- ✓ Realised by geoid model CGG2013 ( $W_0 = 62,636,856.0 \text{ m}^2/\text{s}^2$ )
- Compatible with GNSS positioning technique
- Levelling networks will be readjusted using existing data to conform with CGVD2013

#### Why a new national vertical datum?

- Cost of conducting levelling surveys at the national scale
- To provide access to the vertical datum all across Canada

#### Canadian Geodetic Vertical Datum of 1928 (CGVD28) will continue to co-exist during the transition period

- NRCan is not conducting levelling surveys and maintaining benchmarks
- Other government agencies and industry can certainly resume their local activities with levelling technique

#### The difference between CGVD2013 and CGVD28

Separation ranging from -65 cm and 55 cm at the national scale.

#### **New Brunswick Tentative Plan**

- September 2013 Communiqué to User Community (ANBLS, APEGNB, Architects, Municipalities, Road Builders Association, Foresters and GNB Technical Group)
- September 2013 Web Page Addition on snb.ca Information Document
- September 2013 Presentation by SNB at ANBLS ASM
- September 2013 Presentation by UNB/NRCan at Geomatics Atlantic
- December 2013 NB Adjusted Values for HPNs + Evaluate DTMs
- Spring 2014 Information Sessions

#### Important Note on User Responsibility:

Private distribution networks like LEICA, CANSEL and TOPCON will adopt the new vertical datum and have committed to integrate their GPS base stations and elevation data distribution to CGVD2013, users should contact their service providers on when this will occur and what format/tools will be provided for support during and post the transition.

# **QUESTIONS?**

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#### **Height Modernization**

**Did you know** you can now determine heights relative to mean sea level anywhere in Canada using GPS and a geoid model?

# Modernisation des altitudes

Saviez-vous que vous pouvez maintenant déterminer l'altitude par rapport au niveau moyen de la mer n'importe-où au Canada à l'aide du GPS et d'un modèle du géoïde?



