Toitu te Land whenua Information New Zealand

New Zealand Vertical Datum 2009

LINZG25705

This fact sheet describes the New Zealand Vertical Datum 2009 (NZVD2009) and explains how heights from other datums can be transformed to be in terms of it.

NZVD2009 is the official vertical datum for New Zealand. It provides an accurate and consistent system for referencing the heights of points and objects across New Zealand, its offshore islands, and the continental shelf. It complements the 13 local levelling datums that have been used around New Zealand by enabling them to be linked and used with GNSS systems.

The NZVD2009 is formally defined in *LINZS25004: Standard for New Zealand Vertical Datum 2009*. It provides a nationally consistent height reference system for the first time in New Zealand.

Heights and datums

The two main types of height used in New Zealand are normal-orthometric and ellipsoidal. Normal-orthometric heights are what are commonly referred to as heights. They generally refer to the mean level of the sea.

Ellipsoidal heights are the type of heights that are measured by GNSS receivers. They do not relate to the Earth's gravity field or sea level; rather, they refer to a geometric approximation of the Earth called an ellipsoid. Ellipsoidal heights over New Zealand can differ from sea level and normal-orthometric heights by over 35 metres.

Heights are measured above (or below) a reference surface called a datum. Ellipsoidal heights are measured above an ellipsoid. Normal-orthometric heights are measured above a geoid (a surface of equal gravity strength that approximates mean sea level). The ellipsoid is a smooth oval-like shape, whereas the geoid is irregular and bumpy, much like a potato.

In New Zealand there are a number of vertical datums that are commonly used: New Zealand Vertical Datum 2009 (NZVD2009), local levelling datums, and New Zealand Geodetic Datum 2000 (ellipsoidal heights).

New Zealand Vertical Datum 2009

Unlike most vertical datums around the world which are based on mean sea level, NZVD2009 is based on the New Zealand Quasigeoid 2009 (NZGeoid2009). This means that NZVD2009 normal-orthometric heights will not be in terms of mean sea level; however, they will normally be within 40 cm of it.

NZVD2009 is consistent with the NZGD2000 and the GNSS/GPS datum WGS84. This means that NZVD2009 heights can be easily transformed to NZGD2000/WGS84 ellipsoidal heights and vice versa.

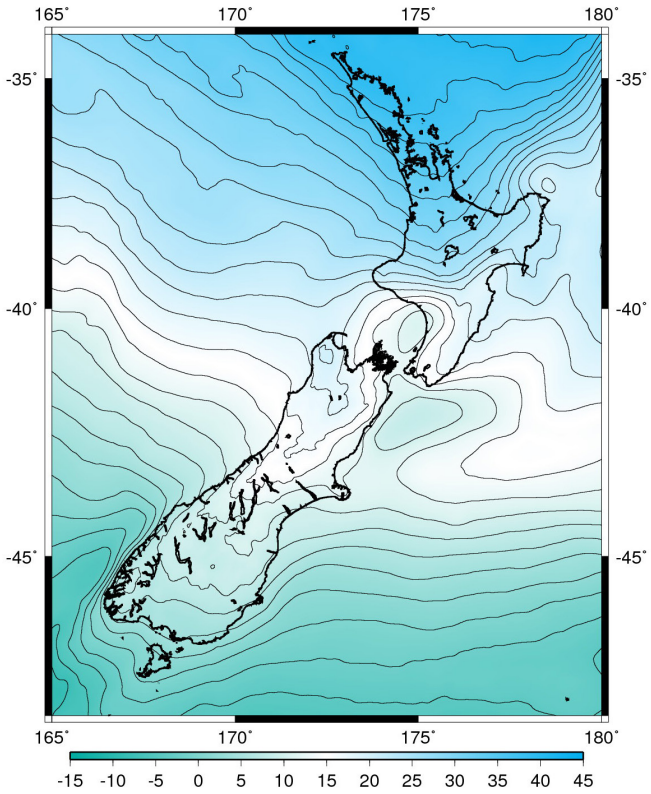
The NZVD2009 covers the New Zealand continental shelf area, 160° E – 170° W and 25° S – 60° S. The key parameters defining NZVD2009 are:

Name	New Zealand Vertical Datum 2009
Abbreviation	NZVD2009
Reference surface	NZGeoid2009
Height system	Normal-orthometric
Normal gravity field	GRS80

New Zealand Quasigeoid 2009

NZGeoid2009 is a gravimetric geoid defined in relation to the GRS80 reference ellipsoid. It is based on the EGM2008 global gravity model and was enhanced with additional terrestrial and satellite-based gravity field information. GPS-levelling observations were not used in the computation of NZGeoid2009. The NZGeoid2009 surface over New Zealand is approximately equal to the GRS80 ellipsoid near Stewart Island/Rakiura and 35 metres above it near Cape Reinga in Northland.

The geoid is defined on a one arc-minute grid (approximately 2 km in New Zealand). It is published on the LINZ website www.linz.govt.nz/nzvd, where it can be downloaded as an ASCII grid or as coordinate triplets over a range of areas.



New Zealand Quasigeoid 2009 (NZGeoid2009) relative to the GRS80 ellipsoid (2 metre contours)

Datum offsets

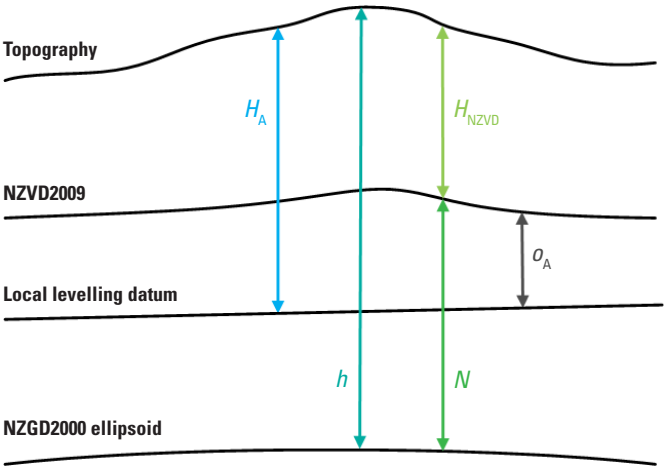
A large proportion of New Zealand height information currently relates to one of 13 local levelling datums. These datums are based on local determinations of mean sea level and the subsequent precise levelling of benchmarks in their hinterland. Offsets have been defined between the local levelling datums and NZVD2009 to enable the local heights to be efficiently transformed to the national datum. The offset between the local datums and NZVD2009 are given in the following table.

Local Levelling Datum	Offset, o_A (metres)	Standard Deviation (metres)
One Tree Point 1964	0.06	0.03
Auckland 1946	0.34	0.05
Moturiki 1953	0.24	0.06
Gisborne 1926	0.34	0.02
Napier 1962	0.20	0.05
Taranaki 1970	0.32	0.05
Wellington 1953	0.44	0.04
Nelson 1955	0.29	0.07
Lyttelton 1937	0.47	0.09
Dunedin 1958	0.49	0.07
Dunedin-Bluff 1960	0.38	0.04
Bluff 1955	0.36	0.05
Stewart Island 1977	0.39	0.15

Note: the offsets are measured from the local levelling datum to NZGeoid2009, and are positive when above the local datum.

Transformations to and from NZVD2009

NZVD2009 provides a convenient and consistent method of transforming heights between different vertical datums and height systems. The relationships between the main vertical datums used in New Zealand are illustrated in the figure below:



Relationship between vertical datums

Heights can be transformed between vertical datums using the equations below, together with a datum offset and the geiod grid. Note that to compute the NZGeoid2009 value for a height, the NZGD2000 horizontal position of the height is required to enable interpolation from the grid file.

NZGD2000/GNSS ellipsoidal height to NZVD2009

$$H_{NZVD} = h - N$$

Local levelling datum height to NZVD2009

$$H_{NZVD} = H_A - o_A$$

NZGD2000 ellipsoidal height to local levelling datum

$$H_A = h - N + o_A$$

Where:

H_{NZVD} is the NZVD2009 height

h is the NZGD2000 or GNSS ellipsoidal height

N is the NZGeoid2009 value bi-linearly interpolated at the NZGD2000 position of h from the grid

H_A is the local levelling datum height (datum A)

o_A is the local levelling datum offset (datum A) from the table

These conversions can also be completed online at:

www.linz.govt.nz/coordinateconversion

FURTHER INFORMATION

LINZ standards, fact sheets, and up-to-date information are available on the LINZ website:
www.linz.govt.nz

Further information is available from:
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