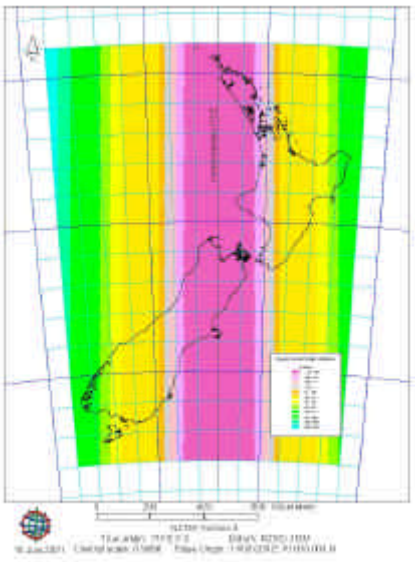
Land Information

Fact Sheet date 3 October 2001

New Zealand Transverse Mercator Projection

This fact sheet explains the technical details of the New Zealand Transverse Mercator Projection.



New Zealand Transverse Mercator Projection in terms of New Zealand Geodetic Datum 2000 Approved.

LINZ has approved the implementation of a new Transverse Mercator Projection in terms of New Zealand Geodetic Datum 2000.

In August 1998 Land Information New Zealand approved the adoption and implementation of a new geocentric datum, New Zealand Geodetic Datum 2000 (NZGD2000) to replace the existing New Zealand Geodetic Datum 1949 (NZGD49). One of the major effects of this new datum is that the coordinates (latitude and longitude) of points in terms of the new datum will change by approximately 200m relative to the old datum.

For mapping purposes since 1972, the New Zealand Map Grid (NZMG) was used. This was defined in terms of NZGD49 by an intrinsic set of formula. Because NZGD2000 uses a different reference ellipsoid a new projection was required to be defined in terms of NZGD2000.

Following wide consultation, Land Information New Zealand announced on 1 July 2001 a new national mapping projection in terms of NZGD2000, New Zealand Transverse Mercator (NZTM).

LINZ will adopt this new Transverse Mercator Projection in terms of NZGD2000 for it's national mapping series, and that use of this projection be encouraged by other spatial data users.

Effect on Small Scale Mapping

LINZ proposes to establish:

- a new national map series called *NZTopo50* series at a map scale of 1:50,000 for the landmass of New Zealand. This new series will replace the current *Topomap 260* map series. The current *Topomap 260* map series will be retained until such time as the replacement series is introduced.
- a new national map series called *NZTopo250* series at a map scale of 1:250,000 for the landmass of New Zealand. This new series will replace the current *Topomap 262* map series. The current *Topomap 262* series will be retained until such time as the replacement series is introduced.

Technical Details

Projection Name: New Zealand Transverse Mercator Projection (NZTM)
Datum: New Zealand Geodetic Datum 2000 (NZGD2000)
Origin Latitude: 0° South
Origin Longitude: 173° East
False Northing: 10 000 000m N
False Easting: 1 600 000m E
Scale Factor: 0.9996

Conversion between Ellipsoidal and Grid Coordinates

For more information refer to http://www.anzlic.org.au/icsm/gdatm/index.html

Meridian Distance

The distance along the meridian from the equator to the latitude ϕ is given by the approximated using the series expansion, as shown below.

$m = a\{A_0\phi - A_2 Sin2\phi + A_4 Sin4\phi - A_6 Sin6\phi\}$

where:

$A_0 = 1-(e^2/4)-(3e^4/64)-(5e^6/256)$
$A_2 = (3/8)(e^2+e^4/4+15e^6/128)$
$A_4 = (15/256)(e^4+3e^6/4)$
$A_6 = 35e^6/3072$

When the GRS80 ellipsoid parameters, for the Map Grid of Australia, are substituted this formula for meridian distance reduces to the one shown below. However, when writing a computer program, the previous series expansion should be used, to maintain flexibility.

$m = 111132.952547\,\phi - 16038.50841\,Sin2\,\phi + 16.83220089\,Sin4\,\phi - 0.021800767\,Sin6\,\phi$

where ϕ in the first term is in degrees and 111132.952547 is the mean length of 1 degree of latitude in metres (G).

Foot-point Latitude

The foot-point latitude (ϕ') is the latitude for which the meridian distance equals the true northing divided by the central scale factor ($m = N'/k_0$). This value can be calculated directly, once three other values are available.

$n = (a-b)/(a+b) = f/(2-f)$
$G = a(1-n)(1-n^2)(1+(9/4)n^2+(225/64)n^4)(\pi/180)$
$\sigma = (m\pi)/(180G)$

The foot point latitude (in radians) is then calculated by:

$\phi' = \sigma+((3n/2)-(27n^3/32))Sin2\sigma+((21n^2/16)-(55n^4/32))Sin4\sigma+(151n^3/96)\,Sin6\sigma+(1097n^4/512)Sin8\sigma$

Radius of Curvature

The radii of curvature for a given latitude are also required in the evaluation of Redfearn. s formulae.

$\rho = a(1-e^2)/(1-e^2Sin^2\phi)^{3/2}$
$\nu = a/(1-e^2Sin^2\phi)^{1/2}$
$\psi = \nu/\rho$

Geographical to Grid

$t = Tan\,\phi$
$\omega = \lambda-\lambda_\theta$
$E' = (K_\theta \nu \omega Cos\phi)\{1 + Term1 + Term2 + Term3\}$
$Term1 = (\omega^2/6)Cos^2\phi(\psi-t^2)$
$Term2 = (\omega^4/120)Cos^4\phi[4\psi^3(1-6t^2)+\psi^2(1+8t^2)-\psi 2t^2+t^4]$
$Term3 = (\omega^6/5040)Cos^6\phi(61-479t^2+179t^4-t^6)$
$E = E' + False\ Easting$
$N' = K_\theta\{m + Term1 + Term2 + Term3 + Term4\}$
$Term1 = (\omega^2/2)\nu Sin\phi\ Cos\ \phi$
$Term2 = (\omega^4/24)\nu Sin\phi\ Cos^3\phi(4\psi^2+\psi-t^2)$
$Term3 = (\omega^6/720)\nu Sin\phi\ Cos^5\phi$
$[8\psi^4(11-24t^2)-28\psi^3(1-6t^2)+\psi^2(1-32t^2)-\psi(2t^2)+t^4]$
$Term4 = (\omega^8/40320)\nu Sin\phi\ Cos^7\phi(1385-3111t^2+543t^4-t^6)$
$N = N' + False\ Northing$

Grid Convergence

$\gamma = Term1 + Term2 + Term3 + Term4$

Where:

$Term1 = -\omega Sin\phi$
$Term2 = -(\omega^3/3)Sin\phi Cos^2\phi\ (2\ \psi^2-\psi)$
$Term3 = -(\omega^5/15)Sin\phi Cos^4\phi[\psi^4(11-24t^2)-\psi^3(11-36t^2)+2\psi^2(1-7t^2)+\psi t^2]$
$Term4 = -(\omega^7/315)Sin\phi Cos^6\phi(17-26t^2+2t^4)$

Point Scale Factor

$k = k_0 + k_0\,Term1 + k_0\,Term2 + k_0\,Term3$
$Term1 = (\omega^2/2)\,\psi\,Cos^2\phi$
$Term2 = (\omega^4/24)\,Cos^4\phi[4\psi^3(1-6t^2) + \psi^2(1+24t^2) - 4\psi t^2]$
$Term3 = (\omega^6/720)\,Cos^6\phi\,(61-148t^2+16t^4)$

Grid to Geographical

In the following formulae t, ρ, ν and ψ are all evaluated for the foot point latitude.

$E. = E - False\ Easting$
$x = E'/(K_\theta \nu')$
$\phi = \phi' - Term1 + Term2 - Term3 + Term4$
$Term1 = (t'/(K_\theta\rho'))(xE'/2)$
$Term2 = (t'/(K_\theta\rho'))(E'x^3/24)[-4\psi'^2+9\psi'(1-t'^2)+12t'^2]$
$Term3 = (t'/(K_\theta\rho'))((E'x^5)/720)[8\psi'^4(11-24t'^2)-12\psi'^3(21-71t'^2)+15\psi'^2(15-98t'^2+15t'^4)+180\psi'(5t'^2-3t'^4)+360t'^4]$
$Term4 = (t'/(K_\theta\rho'))(E'\,x^7/40320)(1385+3633t'^2+4095t'^4+1575t'^6)$
$\omega = Term1 - Term2 + Term3 - Term4$
$Term1 = x\,Sec\phi'$
$Term2 = (x^3/6)Sec\phi'(\psi'+2t'^2)$
$Term3 = (x^5/120)Sec\phi'[-4\psi'^3(1-6t'^2)+\psi'^2(9-68t'^2)+72\psi' t'^2+24t'^4]$
$Term4 = (x^7/5040)Sec\phi'(61+662t'^2+1320t'^4+720t'^6)$
$\lambda = \lambda_\theta + \omega$

Grid Convergence

$x = E'/k_{\theta\nu}$
$t' = Tan\phi'$
$\gamma = Term1 + Term2 + Term3 + Term4$
$Term1 = -t'\,x$
$Term2 = (t'\,x^3/3)(-2\psi'^2+3\psi'+t'^2)$
$Term3 = (-t'\,x^5/15)[\psi'^4(11-24t'^2)-3\psi'^3(8-23t'^2)+5\psi'^2(3-14t'^2)+30\psi\ 't'^2+3t'^4]$
$Term4 = (t'\,x^7/315)(17+77t'^2+105t'^4+45t'^6)$

Point Scale

$x = (E'^2/k_\theta^2\rho'\nu')$
$K = k_\theta + k_\theta Term1 + k_\theta Term2 + k_\theta Term3$
$Term1 = x/2$
$Term2 = (x^2/24)[4\psi'(1-6t'^2)-3(1-16t'^2)-24t'^2/\psi']$
$Term3 = x^3/720$

Further information is available from:

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