Lambert Conformal Conic to Geographic Transformation Formulae

This page explains how to convert Lambert Conformal Conic projection coordinates (N , E) to their geographic equivalents and vice versa.

Projection parameters

The equations on this page use the following parameters which are specific to the particular projection that is being converted to or from. The correct values for different New Zealand projections can be found in the projections (//www.linz.govt.nz/data/geodetic-system/datums-projections-and-heights/projections) section.

a	Semi-major axis of reference ellipsoid
f	Ellipsoidal flattening
ϕ_1	Latitude of first standard parallel
ϕ_2	Latitude of second standard parallel
ϕ_0	Origin latitude
λ_0	Origin longitude
N_0	False Northing
E_0	False Easting
ϕ	Latitude of computation point
λ	Longitude of computation point
N	Northing of computation point
E	Easting of computation point

The following equations are divided into three sections:

Projection constants

Several additional parameters need to be computed before transformations can be undertaken (e , n , F , ρ_0). These parameters are constant for a projection.

$$e = \sqrt{2f - f^2}$$

$$n = \frac{\ln m_1 - \ln m_2}{\ln t_1 - \ln t_2}$$

$$F = \frac{m_1}{n \left(t_1\right)^n}$$

$$\rho = a F t^n$$

where:

$$m = \frac{\cos \phi}{\sqrt{1 - e^2 \sin^2 \phi}}$$

$$t = \frac{\tan\left[\left(\frac{\pi}{4}\right) - \left(\frac{\phi}{2}\right)\right]}{\left(\frac{1 - e \sin \phi}{1 + e \sin \phi}\right)^{\frac{e}{2}}}$$

m_1 and m_2 are obtained by evaluating m using ϕ_1 and ϕ_2 ,

t_0 , t_1 and t_2 are obtained by evaluating t using ϕ_0 , ϕ_1 and ϕ_2 ,

ρ_0 is obtained by evaluating ρ using t_0

Geographic to Lambert conformal projection ()

The conversion of geographic coordinates (ϕ, λ) to projection coordinates (N , E) is achieved in several steps. First, determine t and ρ

at the using the latitude of the computation point (ϕ) and the formulas above. Then evaluate θ at the longitude of the computation point (λ) using:

$$\gamma = n\left(\lambda - \lambda_0\right)$$

The projection northing (N) of the computation point is computed using:

$$N = N_0 + \rho_0 - \rho\cos\gamma$$

Finally the projection easting (E) of the computation point is computed using:

$$E = E_0 + \rho\sin\gamma$$

Lambert conformal projection to geographic ()

The conversion of Lambert projection coordinates (N , E) to geographic coordinates (f , l) is achieved in several steps. First, determine N' , E' ,

ρ', t' and θ' using the following formulas:

$$N' = N - N_0$$

$$E' = E - E_0$$

$$\rho' = \pm\sqrt{\left(E'\right)^2 + \left(\rho_0 - N'\right)^2}, \rho' \text{ has the same sign as } n$$

$$t' = \left(\frac{\rho'}{aF}\right)^{\frac{1}{n}}$$

$$\gamma' = \operatorname{atan}\left(\frac{E'}{\rho_0 - N'}\right)$$

The latitude of the computation point needs to be computed iteratively. The first approximation is obtained from:

$$\phi = \frac{\pi}{2} - 2\,\mathrm{atan}\left(t'\right)$$

This initial estimate of ϕ

is then substituted into:

$$\phi = \frac{\pi}{2} - 2\,\mathrm{atan}\left[t'\left(\frac{1 - e\sin\phi}{1 + e\sin\phi}\right)^{\frac{e}{2}}\right]$$

This value of ϕ should be re-substituted into the above formula until successive values do not change.
This is typically achieved after three iterations.
The longitude of the computation point (λ) is determined using:

$$\lambda = \frac{\gamma'}{n} + \lambda_0$$