Toitu te Land whenua Information New Zealand

Proposal for Datum 2000 Meridional Circuits

OSG Technical Report 8
Office of the Surveyor-General

16 April 1999

Contents

Foreword

Land Information NZ (LINZ) was established on 1 July 1996 and took over the responsibility for the policy, regulatory and core government service delivery functions of the former Department of Survey and Land Information (DoSLI), the Land Titles Office, and for the purchase of hydrographic services from the New Zealand Defence Force. From July 1998 the Office of the Valuer-General was also established within LINZ.

LINZ is focused on advising Government, administering the Crown's interests in land and making Government held land information available to the public. It is the government spatial referencing authority, and the steward and standard setter for core national land databases including: the spatial referencing system, cadastral system, land titles, topography, hydrography, Crown property (excluding the conservation estate) and valuation. Its vision is to provide world class land and seabed information services.

Chief Executive:
Dr Russ Ballard
PO Box 5501
Wellington
Phone: 0-4-460 0110
Fax: 0-4-472 2244
Email: info@linz.govt.nz
Internet: http://www.linz.govt.nz

This document is issued by the Office of the Surveyor-General to:

- document proposals for development of NZGD2000 meridional circuits;
- obtain approval for the implementation of NZGD2000 meridional circuits.

Report Contributors

The material in this report was prepared following discussion and assessment of options with:

Graeme Blick (report author)
Tadeusz Dawidowski
Don Grant
Jim Hall
Merrin Pearse
John Ritchie
Mack Thompson

Comments on the report should be directed to:

Graeme Blick
Office of Surveyor General
Land Information new Zealand
PO Box 5501
Wellington
gblick@linz.govt.nz

Executive Summary

Currently 28 Meridional Circuits have been defined in New Zealand in terms of New Zealand Geodetic Datum 1949 (NZGD49) on which most cadastral surveys are carried out. In August 1998 Land Information New Zealand approved the adoption and implementation of a new geocentric datum, New Zealand Geodetic Datum 2000 (NZGD2000). 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.

The New Zealand Geodetic Strategic Plan (LINZ, 1998) identified the following goal:

> ***To support multiple projections and authoritative transformations of coordinates between those projections and the official geocentric (three dimensional) datum, to an acceptable and defined accuracy.***

In terms of this goal new projections are required in terms of NZGD2000 to replace the existing circuits. The following recommendations are made:

- ***It is recommended that the 28 meridional circuits in terms of NZGD49 be replaced with 28 meridional circuits in terms of NZGD2000 on Transverse Mercator projections. To distinguish from the existing circuits the new circuits will be referred to as "Circuit 2000" eg Wellington Circuit 2000.***

- ***The circuit origin of the NZGD2000 circuit projections will retain the numeric values of their NZGD49 equivalents rounded down to the nearest second.***

- ***The NZGD49 circuit projections central meridian scale factors will be retained for the NZGD2000 circuit projections.***

- ***The coordinates of NZGD2000 circuit false origins will be 800 000m N and 400 000m E.***

- ***The initial stations of the NZGD49 projections will not be located at the origin of the NZGD2000 circuit projections. Therefore the new projections will not have initial stations.***

- ***The NZGD2000 circuit projections will be based on, and will use in calculations, the GRS 80 ellipsoid associated with NZGD2000 (rather than the International ellipsoid associated with NZGD49). The SI Standard for the metre will be adopted.***

PROPOSAL FOR DATUM 2000 MERIDIONAL CIRCUITS

1 Introduction

1.1 *Old Cadastral Circuits*

In the late 1870s 28 meridional circuits were established, 9 in the North Island and 19 in the South Island to organise local cadastral surveys and control bearings. Circuit boundaries generally coincided with the boundaries of provinces or followed physical features such as rivers or mountain ranges. The present land districts differ from the old provinces and in some cases, but not always, circuit boundaries were changed to coincide with land districts.

Each meridional circuit was a defined region of the country with a plane surface fitted to the area onto which survey points were projected. In the case of the Old Cadastral Circuits no account was taken of scale corrections due to the effect of earth curvature. Circuit origin stations were established and astronomical observations made to determine latitude, longitude, and azimuth at these stations. By the early 1880s all existing triangulation within each circuit had been oriented in terms of the astronomical meridian passing through the origin. This then formed the basis for early surveys in New Zealand and for local topographic and cadastral mapping.

1.2 *Geodetic Circuits*

After the development of the New Zealand Geodetic Datum in 1949 (NZGD49) it became possible to develop an ellipsoidal coordinate system over New Zealand (using the ellipsoid for NZGD49, the International Ellipsoid). The original circuits were retained with new coordinates for each origin being computed in terms of NZGD49 for all but one circuit, Hawkes Bay. A Transverse Mercator projection was defined for each circuit. In the case of the Hawkes Bay circuit, it was defined following the 1931 Napier earthquake and subsequent loss of records during the ensuing fire. Extensive re-survey was carried out and adjusted onto a Transverse Mercator projection resulting in the Hawkes Bay Datum 1931. In 1975 the Hawkes Bay circuit was integrated into NZGD49. The scale correction in each circuit was set at 1.0 except for North Taieri where 0.99996 was adopted because the origin was set to one side of the circuit. Straight normals are used to project a point onto a reference ellipsoid. The Transverse Mercator projection is then used to calculate northing and easting coordinates from longitude and latitude ellipsoidal coordinates.

During the passage of time some physical marks defining the location of the origin of circuits have been destroyed (eg Poverty Bay). In these cases the origin coordinate now defines a geographical position (eg Poverty Bay Initial) which does not have an associated physical mark. On the West Coast of the South Island readjustment of the 1949 datum using new data resulted in new coordinates for circuit initial stations (the physical mark). In these cases the adopted coordinate for the circuit origin now

defines a geographical position and the physical mark has a re-computed position. Lee [1978] provides a detailed summary of the development of the meridional circuits and New Zealand Geodetic Datum 1949.

As at the time of writing this report 57 meridional circuits are defined:

- 28 plane circuits referred to as Old Cadastral
- Hawkes Bay circuit in terms of Hawkes Bay Datum 1931 on a Transverse Mercator projection
- 28 circuits in terms of NZGD49 on Transverse Mercator projections.

1.3 *Metrication of Meridional Circuit*

The International Spheroid is defined in metric units. When NZGD49 was established, utilising the International Spheroid, New Zealand was using imperial units (links/feet) so it was necessary to convert from metres to imperial units. At the time the conversion factor adopted was the Sears (1927) meter-foot relationship:

1 metre = 39.370147 inches

from which the conversion factor from metres to links was derived:

1 metre = 4.970978156 links (l link = 0.20116765 m)

NZGD49 meridional circuit links were derived using the Sears ratio.

On metrication of meridional circuits in 1972 (refer to Lands and Survey Technical Circular 1972/10) the SI Standard value for the metre was adopted where:

1 link = 0.201168 m (exactly)

This causes a scale difference of approximately 1.7ppm between the meter as defined by Sears and the SI Standard. The effect of this is that a meridional circuit distance derived between two points (having taken projection scale factor into account) will still be different by approximately 1.7ppm relative to the reduced distance as measured between the same two points using a modern EDM or GPS equipment (see sec. 2.7). A more significant effect in survey calculations is that failure to take this factor into account when calculating coordinates will result in an error in coordinates. At 100km from the circuit origin, the error will be approximately 0.17m.

At the time of metrication every circuit initial station was assigned false origin coordinates of 700 000m N and 300 000m E (see sec. 2.6). At this time other special provisions were made for the following circuits:

1. **Mt. Eden.** A scale factor of 0.9999 was adopted because the scale enlargement in this circuit was too large for cadastral surveys (see sec. 2.5).

2. **North Taieri Circuit.** The scale factor of 0.99996, already used in this circuit, was adopted unchanged (see sec 2.5).

3. **Bluff Circuit.** The known error in the position of the initial station on Geodetic Datum 1949 was corrected giving a false origin of 699 999.58m N and 3000 002.66m E (see sec 2.6).

4. **Hawkes Bay Circuit.** Surveys in this circuit were converted to Geodetic Datum 1949 and the use of the Hawkes Bay Circuit 1931 discontinued.

1.4 *Adoption 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) [*LINZ* 1998a and *Office of Surveyor-General Policy* 98/4]. One of the effects of this new datum is that the coordinates (latitude and longitude) of points in terms of the new datum will move by approximately 200m relative to NZGD49.

The New Zealand Geodetic Strategic Business Plan (*LINZ*, 1998b) identified the following goal:

> ***To support multiple projections and authoritative transformations of coordinates between those projections and the official geocentric (three dimensional) datum, to an acceptable and defined accuracy.***

This brings a requirement to consider map projections in terms of NZGD2000. The use of the new datum, and with it the adoption of a new spheroid, requires that the current definition of the circuits must change to be consistent with the new datum.

This report considers the options for, and provides a list of recommendations on, the future form of the meridional circuits in terms of NZGD2000. The principle being followed, is that any change should minimise confusion and disruption to the survey community.

2 Options

2.1 *Should Meridional Circuits be Retained or a National System Developed?*

All cadastral surveys in terms of the current survey regulations are made in terms of either one of the current NZGD49 28 meridional circuits or one of the plane coordinate systems (Old Cadastral Datums) that preceded them. Other project surveys, i.e. for engineering works, are also often carried out on the meridional circuits.

During the early 1970s there was a proposal to replace the 28 circuits with one uniform projection. The New Zealand Map Grid (NZMG) developed as a national metric mapping projection, was suggested to unify the system and avoid some of the potential problems that occur when surveys straddle circuit boundaries. This proposal did not meet with wide approval for cadastral survey, mainly because it would have resulted in large bearing changes which would have varied from place to place. Accordingly, the use of NZMG as the official projection for cadastral surveys was never adopted. However it has been used extensively for topographic and metric cadastral mapping and for general GIS applications.

With a need to establish new projections in terms of NZGD2000, a valid question to consider is the feasibility and appropriateness of moving to a new national projection for cadastral surveys. For the same reasons previously identified it is considered appropriate to retain the meridional circuits and not move to a new national system at this stage, particularly while paper plans continue to be used and referred to. However, it is acknowledged that in future when a fully digital system has been implemented, as proposed in the Land Information New Zealand automation of the survey and title system phase II (CRS II), there may be merit in again considering the use of one unified projection for all cadastral survey purposes.

It is recommended that the use of the 28 meridional circuits should be retained through development of new circuit projections which are in terms of NZGD2000.

2.2 *Should the Spatial Definition and Name of the Present Circuits be Retained?*

The opportunity to change the spatial coverage, number, and name of the present circuits was considered. There are currently 19 circuits in the South Island and 9 in the North Island, one of which, Mt Eden, is elongated and covers a large east-west extent. However, it is recommended for simplicity, and to avoid future confusion, that the number and spatial coverage of the present 28 circuits be retained.

To distinguish the new circuits from the existing circuits, present circuit names should be retained with the addition of “2000” following the name, eg Wellington Circuit would become Wellington Circuit 2000.

Recommendation

It is recommended that the 28 meridional circuits in terms of NZGD49 be replaced with 28 meridional circuits in terms of NZGD2000 on Transverse Mercator projections. To distinguish from the existing circuits the new circuits will be referred to as "Circuit 2000" eg Wellington Circuit 2000.

2.3 *Should the Origins be Moved to a New Location?*

Changing circuit origins by a large distance (eg kms) was considered, principally because the origins in some circuits, eg North Taieri, where it is located to one side of the circuit, are not well placed. The effect of changing the origin by kms would cause a large change in convergence and thus a large bearing swing between the old and new circuits. It was considered that the introduction of a large bearing swing would cause disruption and confusion, accordingly, it is recommended that origins remain essentially unchanged.

2.4 *Should Origins be Transformed to Datum 2000 Coordinates?*

The current origins of many circuits are marked by a physical mark (eg A North Taieri). In some circuits the physical mark has been destroyed and an unmarked geographical location is the origin (eg Poverty Bay Initial), while in other circuits the coordinates of the physical mark marking the origin have been changed by readjustment which in effect causes the position of the projection origin to shift relative to the physical mark (eg Buller Initial).

Consideration was given to retaining the present physical location of the origin, be it a physical mark or geographic location and transforming to Datum 2000 coordinates or alternatively, retaining present circuit origin coordinate (latitude and longitude) values as the origin (i.e. the NZGD49 numerical value will be retained as the NZGD2000 value).

To retain the present physical location of the origin, be it a physical mark or geographic location, and transform to Datum 2000 coordinates has the effect of retaining the rectangular coordinates of both the initial station and the nominal origin. The coordinate values of geodetic control points in a circuit would stay approximately the same, within several metres, though changes will occur due to the readjustment and the enhanced accuracy of the new datum.

The second option of retaining the current circuit origin values has the effect of moving the physical location of the origin, in terms of Datum 2000, by approximately 200m. All origins would become a geographic location rather than a physical mark. With this option the projection coordinates of all geodetic control points in a circuit including the initial station in terms of NZGD2000, will change by approximately 200m. This shift is sufficiently small as to not cause a significant bearing swing between the old and new systems. It was considered that there were no reasons for retaining a physical mark at the origin.

The second option is preferred because it will avoid confusion where it is unclear what projection coordinates are in terms of, i.e. the change from the old to the new circuits will result in a 200m shift which should be apparent. The origin of each of the circuits will not be named as no physical mark will mark their position.

2.5 *Should Origin Coordinates be Simplified?*

To help avoid confusion with NZGD49 circuit origin coordinate values, simplifying circuit origin coordinates was considered. To simply coordinates it is recommended to round circuit origin coordinates down to the nearest second from their NZGD49 values. This has the effect of moving the physical location of the circuit origin by up to 30m in addition to 200m described in Section 2.4 above.

Recommendation

The circuit origin of the NZGD2000 circuit projections will retain the numeric values of their NZGD49 equivalents rounded down to the nearest second.

2.6 *Should the Present Central Meridian Scale Factors be Retained?*

The scale correction in each circuit is currently 1.0 except for North Taieri where 0.99996 was adopted because the origin was set to one side of the circuit, and Mt Eden where 0.9999 was adopted because of the large east-west coverage of the circuit. In the latter two cases this results in two meridians with a scale correction of zero rather than one meridian passing through the origin with zero scale correction as in other cases. One option considered was to set the scale factor in all new circuits to 1.0, however it was considered that this would cause confusion and result in unnecessarily large scale corrections in parts of the North Taieri and Mount Eden circuits. Accordingly, it is recommended to retain the present scale factors for each circuit.

Recommendation

The NZGD49 circuit projections central meridian scale factors will be retained for the NZGD2000 circuit projections.

2.7 *Should the Coordinates of the False Origin be Changed?*

The current circuit origins are all assigned a set of false coordinates of 700 000m N and 300 000m E except for the Bluff Circuit where they are 699 999.58m N and 300 002.66m E because of a misidentified origin mark. This is designed in such a way that no coordinate in a circuit will be less than 0, exceed 999 999, nor will there generally be overlap in the northing or easting value of any point in a circuit.

There is already confusion between the circuit coordinates determined in terms of Old Cadastral and NZGD49 and to have a third set of meridional circuits with coordinates similar to the previous two would add to the confusion. It is recommended that the

new circuit false origin coordinates be changed by a significant amount, 100 000 m north and east, and that the new false circuit origin coordinates be 800 000m N and 400 000m E. It is recognised that this will result in some coordinates greater than 999 999.99m N, however this was felt preferable to having negative coordinates or a situation where northings and eastings could be confused.

Recommendation

The coordinates of NZGD2000 false origins will be 800 000m N and 400 000m E.

Recommendation

The initial stations of the NZGD49 projections will not be located at the origin of the NZGD2000 circuit projections. Therefore the new projections will not have initial stations.

2.8 *Should the SI Standard for the Metre be Adopted?*

The current meridional circuits adopted the Sears (1927) meter-foot relationship. Modern spatial reference systems (eg ITRF and NZGD2000) and survey equipment, including GPS, have adopted the metre defined by the SI Standard. In order that the new circuits are compatible with modern spatial reference systems and survey equipment it is recommended that the SI Standard for the metre be adopted for the new circuits.

The scale factor between the Sears and SI metre, 1.7ppm, will be incorporated into any transformation developed between the old and new circuits.

2.9 *Compatibility with NZGD2000*

NZGD49 used the International ellipsoid as its reference ellipsoid. To develop new circuits in terms of NZGD2000 requires the adoption of the reference spheroid used to define this new datum, Geodetic Reference System 1980 (GRS 80) ellipsoid.

Recommendation

The NZGD2000 circuit projections will be based on, and will use in calculations, the GRS 80 ellipsoid associated with NZGD2000 (rather than the International ellipsoid associated with NZGD49). The semi-axis major and flattening associated with ellipsoid will be used. The SI Standard for the metre will be adopted.

3 Description of Circuits

3.1 *NZGD49 Circuits*

The 28 current NZGD49 circuits are all on a Transverse Mercator projection that uses the International spheroid, defined by:

Semi-Major Axis	6 378 388 m
Flattening	1/297

Each circuit is defined by:

Name
Initial Station
Origin Latitude
Origin Longitude
False Origin North
False Origin East
Datum
Projection
Scale Factor

The values for each of these parameters for each circuit are defined in Annex A.

3.2 *Proposed NZGD2000 Circuits*

The proposed 28 NZGD2000 circuits will be on a Transverse Mercator projection that uses the spheroid adopted for NZGD2000, Geodetic Reference System 1980 (GRS80) defined by:

Semi-Major Axis	6 378 137 m
Flattening	1/298.257222101

Using the same parameters defining the NZGD49 circuits, except that the new circuits will not have an initial station, a set of proposed values are provided for each circuit in Annex B.

4 References

Lands and Survey Technical Circular *1972/10*.

Lee, L.P. 1978: First-Order Geodetic Triangulation of New Zealand 1909-49 and 1973-74. *Department of Lands and Survey Technical Series Report No. 1*.

LINZ 1998a: A proposal for geodetic datum development. *Land Information New Zealand Office report OSG Technical Report 2.1*.

LINZ 1998b: New Zealand Geodetic Strategic Business Plan. *Land Information New Zealand Office report OSG Technical Report 3.*

New Zealand Geodetic Datum 2000. *Land Information New Zealand, Office of Surveyor-General Policy 98/4*

Annex A

NZGD49 Meridional Circuits

The spheroid adopted for NZGD49, the International spheroid, is defined by:

Semi-Major Axis	6 378 388 m
Flattening	1/297

Circuits

Name	Mount Eden 1949
Initial Station	16 Mt Eden
Origin of Latitude	36 52 47.5150 S
Origin of Longitude	174 45 51.6217 E
False Northing	700 000m N
False Easting	300 000m E
Datum	New Zealand Geodetic Datum 1949
Projection	Transverse Mercator
Scale Factor	0.9999

Name	Bay of Plenty 1949
Initial Station	F Maketu
Origin of Latitude	37 45 40.4993 S
Origin of Longitude	176 27 58.3101 E
False Northing	700 000m N
False Easting	300 000m E
Datum	New Zealand Geodetic Datum 1949
Projection	Transverse Mercator
Scale Factor	1.0000 0000

Name	Poverty Bay 1949
Initial Station	Poverty Bay Initial
Origin of Latitude	38 37 28.9300 S
Origin of Longitude	177 53 08.2906 E
False Northing	700 000m N
False Easting	300 000m E
Datum	New Zealand Geodetic Datum 1949
Projection	Transverse Mercator
Scale Factor	1.0000 0000

Name	Hawkes Bay 1949
Initial Station	A Hawkes Bay
Origin of Latitude	39 39 03.3455 S
Origin of Longitude	176 40 25.2499 E
False Northing	700 000m N
False Easting	300 000m E
Datum	New Zealand Geodetic Datum 1949
Projection	Transverse Mercator
Scale Factor	1.0000 0000

Name	Taranaki 1949
Initial Station	A Huirangi
Origin of Latitude	39 08 08.7299 S
Origin of Longitude	174 13 40.8423 E
False Northing	700 000m N
False Easting	300 000m E
Datum	New Zealand Geodetic Datum 1949
Projection	Transverse Mercator
Scale Factor	1.0000 0000

Name	Tuhirangi 1949
Initial Station	18 Tuhirangi
Origin of Latitude	39 30 44.8934 S
Origin of Longitude	175 38 24.1325 E
False Northing	700 000m N
False Easting	300 000m E
Datum	New Zealand Geodetic Datum 1949
Projection	Transverse Mercator
Scale Factor	1.0000 0000

Name	Wanganui 1949
Initial Station	Mt Stewart
Origin of Latitude	40 14 31.0097 S
Origin of Longitude	175 29 17.1586 E
False Northing	700 000m N
False Easting	300 000m E
Datum	New Zealand Geodetic Datum 1949
Projection	Transverse Mercator
Scale Factor	1.0000 0000

Name	Wairarapa 1949
Initial Station	Opaki
Origin of Latitude	40 55 31.9175 S
Origin of Longitude	175 38 50.4588 E
False Northing	700 000m N
False Easting	300 000m E
Datum	New Zealand Geodetic Datum 1949
Projection	Transverse Mercator
Scale Factor	1.0000 0000

Name	Wellington 1949
Initial Station	Mt Cook
Origin of Latitude	41 18 04.7507 S
Origin of Longitude	174 46 35.8432 E
False Northing	700 000m N
False Easting	300 000m E
Datum	New Zealand Geodetic Datum 1949
Projection	Transverse Mercator
Scale Factor	1.0000 0000

Name	Collingwood 1949
Initial Station	Collingwood Initial
Origin of Latitude	40 42 53.1326 S
Origin of Longitude	172 40 19.3674 E
False Northing	700 000m N
False Easting	300 000m E
Datum	New Zealand Geodetic Datum 1949
Projection	Transverse Mercator
Scale Factor	1.0000 0000

Name	Nelson 1949
Initial Station	BH Botanical Hill
Origin of Latitude	41 16 28.3610 S
Origin of Longitude	173 17 57.5405 E
False Northing	700 000m N
False Easting	300 000m E
Datum	New Zealand Geodetic Datum 1949
Projection	Transverse Mercator
Scale Factor	1.0000 0000

Name	Karamea 1949
Initial Station	Karamea
Origin of Latitude	41 17 23.6815 S
Origin of Longitude	172 06 32.5015 E
False Northing	700 000m N
False Easting	300 000mE
Datum	New Zealand Geodetic Datum 1949
Projection	Transverse Mercator
Scale Factor	1.0000 0000

Name	Buller 1949
Initial Station	Buller Initial
Origin of Longitude	41 48 38.8903 S
Origin of Longitude	171 34 52.5362 E
False Northing	700 000m N
False Easting	300 000mE
Datum	New Zealand Geodetic Datum 1949
Projection	Transverse Mercator
Scale Factor	1.0000 0000

Name	Grey 1949
Initial Station	Grey Initial
Origin of Latitude	42 20 01.2994 S
Origin of Longitude	171 32 59.1767 E
False Northing	700 000m N
False Easting	300 000mE
Datum	New Zealand Geodetic Datum 1949
Projection	Transverse Mercator
Scale Factor	1.0000 0000

Name	Amuri 1949
Initial Station	Isolated Hill
Origin of Latitude	42 41 20.8197 S
Origin of Longitude	173 00 36.4802 E
False Northing	700 000m N
False Easting	300 000mE
Datum	New Zealand Geodetic Datum 1949
Projection	Transverse Mercator
Scale Factor	1.0000 0000

Name	Marlborough 1949
Initial Station	Goulter Hill
Origin of Latitude	41 32 40.1520 S
Origin of Longitude	173 48 07.4668 E
False Northing	700 000m N
False Easting	300 000mE
Datum	New Zealand Geodetic Datum 1949
Projection	Transverse Mercator
Scale Factor	1.0000 0000

Name	Hokitika 1949
Initial Station	Hokitika Initial
Origin of Latitude	42 53 10.7605 S
Origin of Longitude	170 58 47.9766 E
False Northing	700 000m N
False Easting	300 000mE
Datum	New Zealand Geodetic Datum 1949
Projection	Transverse Mercator
Scale Factor	1.0000 0000

Name	Okarito 1949
Initial Station	Okarito Initial
Origin of Latitude	43 06 36.4613 S
Origin of Longitude	170 15 39.3330 E
False Northing	700 000m N
False Easting	300 000mE
Datum	New Zealand Geodetic Datum 1949
Projection	Transverse Mercator
Scale Factor	1.0000 0000

Name	Jacksons Bay 1949
Initial Station	Jacksons Bay Initial
Origin of Latitude	43 58 40.0904 S
Origin of Longitude	168 36 22.5612 E
False Northing	700 000m N
False Easting	300 000mE
Datum	New Zealand Geodetic Datum 1949
Projection	Transverse Mercator
Scale Factor	1.0000 0000

Name	Mount Pleasant 1949
Initial Station	Mt Pleasant
Origin of Latitude	43 35 26.2953 S
Origin of Longitude	172 43 37.8969 E
False Northing	700 000m N
False Easting	300 000mE
Datum	New Zealand Geodetic Datum 1949
Projection	Transverse Mercator
Scale Factor	1.0000 0000

Name	Gawler 1949
Initial Station	A Gawler Downs
Origin of Latitude	43 44 55.3616 S
Origin of Longitude	171 21 38.6945 E
False Northing	700 000m N
False Easting	300 000mE
Datum	New Zealand Geodetic Datum 1949
Projection	Transverse Mercator
Scale Factor	1.0000 0000

Name	Timaru 1949
Initial Station	A(68) Mt Horrible
Origin of Latitude	44 24 07.9933 S
Origin of Longitude	171 03 26.1030 E
False Northing	700 000m N
False Easting	300 000mE
Datum	New Zealand Geodetic Datum 1949
Projection	Transverse Mercator
Scale Factor	1.0000 0000

Name	Lindis Peak 1949
Initial Station	Lindis Peak Initial
Origin of Latitude	44 44 06.9647 S
Origin of Longitude	169 28 03.9183 E
False Northing	700 000m N
False Easting	300 000mE
Datum	New Zealand Geodetic Datum 1949
Projection	Transverse Mercator
Scale Factor	1.0000 0000

Name	Mount Nicholas 1949
Initial Station	Mt Nicholas
Origin of Latitude	45 07 58.4493 S
Origin of Longitude	168 23 55.1083 E
False Northing	700 000m N
False Easting	300 000m E
Datum	New Zealand Geodetic Datum 1949
Projection	Transverse Mercator
Scale Factor	1.0000 0000

Name	Mount York 1949
Initial Station	Mt York
Origin of Latitude	45 33 49.4142 S
Origin of Longitude	167 44 19.9024 E
False Northing	700 000m N
False Easting	300 000m E
Datum	New Zealand Geodetic Datum 1949
Projection	Transverse Mercator
Scale Factor	1.0000 0000

Name	Observation Point 1949
Initial Station	Observation Pt Initial
Origin of Latitude	45 48 58.3078 S
Origin of Longitude	170 37 42.9426 E
False Northing	700 000m N
False Easting	300 000m E
Datum	New Zealand Geodetic Datum 1949
Projection	Transverse Mercator
Scale Factor	1.0000 0000

Name	North Taieri 1949
Initial Station	A North Taieri
Origin of Latitude	45 51 41.4481 S
Origin of Longitude	170 16 57.3208 E
False Northing	700 000m N
False Easting	300 000m E
Datum	New Zealand Geodetic Datum 1949
Projection	Transverse Mercator
Scale Factor	0.99996

Name	Bluff 1949
Initial Station	Observation Spot No 2
Origin of Latitude	46 36 00.0346 S
Origin of Longitude	168 20 34.3392 E
False Northing	699 999.58m N
False Easting	300 002.66m E
Datum	New Zealand Geodetic Datum 1949
Projection	Transverse Mercator
Scale Factor	1.0000 0000

Annex B

NZGD2000 Meridional Circuits

The spheroid adopted for NZGD2000, the Geodetic Reference System 1980 (GRS80) spheroid, is defined by:

Semi-Major Axis	6 378 137 m
Flattening	1/298.257222101

Proposed Circuits

Name	Mount Eden 2000
Origin of Latitude	36 52 47 S
Origin of Longitude	174 45 51 E
False Northing	800 000m N
False Easting	400 000m E
Datum	New Zealand Geodetic Datum 2000
Projection	Transverse Mercator
Scale Factor	0.9999

Name	Bay of Plenty 2000
Origin of Latitude	37 45 40 S
Origin of Longitude	176 27 58 E
False Northing	800 000m N
False Easting	400 000m E
Datum	New Zealand Geodetic Datum 2000
Projection	Transverse Mercator
Scale Factor	1.0000 0000

Name	Poverty Bay 2000
Origin of Latitude	38 37 28 S
Origin of Longitude	177 53 08 E
False Northing	800 000m N
False Easting	400 000m E
Datum	New Zealand Geodetic Datum 2000
Projection	Transverse Mercator
Scale Factor	1.0000 0000

Name	Hawkes Bay 2000
Origin of Latitude	39 39 03 S
Origin of Longitude	176 40 25 E
False Northing	800 000m N
False Easting	400 000m E
Datum	New Zealand Geodetic Datum 2000
Projection	Transverse Mercator
Scale Factor	1.0000 0000

Name	Taranaki 2000
Origin of Latitude	39 08 08 S
Origin of Longitude	174 13 40 E
False Northing	800 000m N
False Easting	400 000m E
Datum	New Zealand Geodetic Datum 2000
Projection	Transverse Mercator
Scale Factor	1.0000 0000

Name	Tuhirangi 2000
Origin of Latitude	39 30 44 S
Origin of Longitude	175 38 24 E
False Northing	800 000m N
False Easting	400 000m E
Datum	New Zealand Geodetic Datum 2000
Projection	Transverse Mercator
Scale Factor	1.0000 0000

Name	Wanganui 2000
Origin of Latitude	40 14 31 S
Origin of Longitude	175 29 17 E
False Northing	800 000m N
False Easting	400 000m E
Datum	New Zealand Geodetic Datum 2000
Projection	Transverse Mercator
Scale Factor	1.0000 0000

Name	Wairarapa 2000
Origin of Latitude	40 55 31 S
Origin of Longitude	175 38 50 E
False Northing	800 000m N
False Easting	400 000m E
Datum	New Zealand Geodetic Datum 2000
Projection	Transverse Mercator
Scale Factor	1.0000 0000

Name	Wellington 2000
Origin of Latitude	41 18 04 S
Origin of Longitude	174 46 35 E
False Northing	800 000m N
False Easting	400 000m E
Datum	New Zealand Geodetic Datum 2000
Projection	Transverse Mercator
Scale Factor	1.0000 0000

Name	Collingwood 2000
Origin of Latitude	40 42 53 S
Origin of Longitude	172 40 19 E
False Northing	800 000m N
False Easting	400 000m E
Datum	New Zealand Geodetic Datum 2000
Projection	Transverse Mercator
Scale Factor	1.0000 0000

Name	Nelson 2000
Origin of Latitude	41 16 28 S
Origin of Longitude	173 17 57 E
False Northing	800 000m N
False Easting	400 000m E
Datum	New Zealand Geodetic Datum 2000
Projection	Transverse Mercator
Scale Factor	1.0000 0000

Name	Karamea 2000
Origin of Latitude	41 17 23 S
Origin of Longitude	172 06 32 E
False Northing	800 000m N
False Easting	400 000mE
Datum	New Zealand Geodetic Datum 2000
Projection	Transverse Mercator
Scale Factor	1.0000 0000

Name	Buller 2000
Origin of Longitude	41 48 38 S
Origin of Longitude	171 34 52 E
False Northing	800 000m N
False Easting	400 000mE
Datum	New Zealand Geodetic Datum 2000
Projection	Transverse Mercator
Scale Factor	1.0000 0000

Name	Grey 2000
Origin of Latitude	42 20 01 S
Origin of Longitude	171 32 59 E
False Northing	800 000m N
False Easting	400 000mE
Datum	New Zealand Geodetic Datum 2000
Projection	Transverse Mercator
Scale Factor	1.0000 0000

Name	Amuri 2000
Origin of Latitude	42 41 20 S
Origin of Longitude	173 00 36 E
False Northing	800 000m N
False Easting	400 000mE
Datum	New Zealand Geodetic Datum 2000
Projection	Transverse Mercator
Scale Factor	1.0000 0000

Name	Marlborough 2000
Origin of Latitude	41 32 40 S
Origin of Longitude	173 48 07 E
False Northing	800 000m N
False Easting	400 000mE
Datum	New Zealand Geodetic Datum 2000
Projection	Transverse Mercator
Scale Factor	1.0000 0000

Name	Hokitika 2000
Origin of Latitude	42 53 10 S
Origin of Longitude	170 58 47 E
False Northing	800 000m N
False Easting	400 000mE
Datum	New Zealand Geodetic Datum 2000
Projection	Transverse Mercator
Scale Factor	1.0000 0000

Name	Okarito 2000
Origin of Latitude	43 06 36 S
Origin of Longitude	170 15 39 E
False Northing	800 000m N
False Easting	400 000mE
Datum	New Zealand Geodetic Datum 2000
Projection	Transverse Mercator
Scale Factor	1.0000 0000

Name	Jacksons Bay 2000
Origin of Latitude	43 58 40 S
Origin of Longitude	168 36 22 E
False Northing	800 000m N
False Easting	400 000mE
Datum	New Zealand Geodetic Datum 2000
Projection	Transverse Mercator
Scale Factor	1.0000 0000

Name	Mount Pleasant 2000
Origin of Latitude	43 35 26 S
Origin of Longitude	172 43 37 E
False Northing	800 000m N
False Easting	400 000mE
Datum	New Zealand Geodetic Datum 2000
Projection	Transverse Mercator
Scale Factor	1.0000 0000

Name	Gawler 2000
Origin of Latitude	43 44 55 S
Origin of Longitude	171 21 38 E
False Northing	800 000m N
False Easting	400 000mE
Datum	New Zealand Geodetic Datum 2000
Projection	Transverse Mercator
Scale Factor	1.0000 0000

Name	Timaru 2000
Origin of Latitude	44 24 07 S
Origin of Longitude	171 03 26 E
False Northing	800 000m N
False Easting	400 000mE
Datum	New Zealand Geodetic Datum 2000
Projection	Transverse Mercator
Scale Factor	1.0000 0000

Name	Lindis Peak 2000
Origin of Latitude	44 44 06 S
Origin of Longitude	169 28 03 E
False Northing	800 000m N
False Easting	400 000mE
Datum	New Zealand Geodetic Datum 2000
Projection	Transverse Mercator
Scale Factor	1.0000 0000

Name	Mount Nicholas 2000
Origin of Latitude	45 07 58 S
Origin of Longitude	168 23 55 E
False Northing	800 000m N
False Easting	400 000m E
Datum	New Zealand Geodetic Datum 2000
Projection	Transverse Mercator
Scale Factor	1.0000 0000

Name	Mount York 2000
Origin of Latitude	45 33 49 S
Origin of Longitude	167 44 19 E
False Northing	800 000m N
False Easting	400 000m E
Datum	New Zealand Geodetic Datum 2000
Projection	Transverse Mercator
Scale Factor	1.0000 0000

Name	Observation Point 2000
Origin of Latitude	45 48 58 S
Origin of Longitude	170 37 42 E
False Northing	800 000m N
False Easting	400 000m E
Datum	New Zealand Geodetic Datum 2000
Projection	Transverse Mercator
Scale Factor	1.0000 0000

Name	North Taieri 2000
Origin of Latitude	45 51 41 S
Origin of Longitude	170 16 57 E
False Northing	800 000m N
False Easting	400 000m E
Datum	New Zealand Geodetic Datum 2000
Projection	Transverse Mercator
Scale Factor	0.99996

Name	Bluff 2000
Origin of Latitude	46 36 00 S
Origin of Longitude	168 20 34 E
False Northing	800 000m N
False Easting	400 000m E
Datum	New Zealand Geodetic Datum 2000
Projection	Transverse Mercator
Scale Factor	1.0000 0000