

Transformation Parameters from Chatham Islands 1979 to NZGD2000

OSG Technical Report 14

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Contents

1	Introduction.....	3
2	Transformation Parameters.....	3
3	Recommendations.....	5
4	Examples	6
	References.....	6
	Appendix A.....	7

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, as part of the restructuring of Valuation New Zealand, the Office of the Valuer-General was 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.

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This technical report is issued under the authority of the Surveyor-General who is responsible for setting geodetic standards, specifications, and guidelines in accordance with departmental policy and statutory requirements.

Any comments or amendments should be forwarded to the Surveyor-General, Land Information New Zealand.

Tony Bevin
Surveyor-General

TRANSFORMATION PARAMETERS FROM CHATHAM ISLANDS 1979 TO NZGD2000

1 Introduction

Land Information New Zealand has implemented a new national geodetic datum, New Zealand Geodetic Datum 2000 (NZGD2000). NZGD2000 replaces Chatham Islands 1979 datum and New Zealand Geodetic Datum 1949 (NZGD49). The new datum provides an accurate geometric reference system for New Zealand and its areas of territorial responsibility. NZGD2000 is a geometric datum, that is the coordinates of defining stations are computed in terms of geocentric cartesian coordinates (XYZ) that are then converted to latitude, longitude and ellipsoid height in terms of the GRS80 reference ellipsoid (Pearse, 2000).

Ellipsoid parameters:

Name	International	GRS80
Semi major axis (metres)	6378388	6378137
1/flattening	297	298.257222101
Reference	DMA, 1987	Moritz, 1980
Used by	Chatham Islands 1979	NZGD2000

The Chatham Islands 1979 datum was based on an adjustment done in 1981 of observations and measurements carried out in 1968, 1970, 1977 and 1979. The 1979 datum superseded the Chatham Islands 1971 datum. The Chatham Islands 1979 datum uses the International (Hayford) Ellipsoid with the origin defined by the astronomical position of trig Astro Station of Latitude 43° 57' 23.60" South and Longitude 176° 34' 28.65" West. Orientation is provided by the adjusted azimuth based on astronomical observations at four stations during 1968, 1970 and 1979 and is Kahunene No 2 to B Kapangatakahu of 115° 58' 47.03".

In 1976 the United States Defense Mapping Agency (DMA) occupied four stations using Doppler and computed World Geodetic System 1972 (WGS72) coordinates for them. These observations pre-dated the establishment of the Chatham Islands 1979 datum and therefore the DMA was only able to compute transformation parameters between Chatham Islands 1971 and WGS72. These WGS72 coordinates have been used to compute transformation parameters between the Chatham Islands 1979 datum and NZGD2000.

2 Transformation Parameters

The four stations which are in the Chatham Islands 1979 adjustment that were observed by Doppler in 1976 are:

Geodetic Code	Name	Doppler Number
BAVC	Satellite Station West (Waitangi West)	30536
BAVJ	D Te Rangaapene	30535
BAVB	Satellite Station East (Pukerakei)	30352
BARW	Kahunene No 2	30531

The WGS72 coordinates for these marks were taken from the Doppler Summary sheets supplied by the US Defense Mapping Agency (DMA) (Appendix A).

Geodetic Code	X	Y	Z
BAVC	-4604522.18	-255539.71	-4391382.62
BAVJ	-4582974.53	-293725.65	-4411454.99
BAVB	-4606032.95	-302573.54	-4386866.89
BARW	-4591187.37	-274853.73	-4404136.79

Table A : WGS72 Coordinates

The Chatham Islands 1979 coordinates for the above four stations were downloaded from the Geodetic Database on 9 May 2000.

Geodetic Code	Latitude	Longitude	MSL Height
BAVC	43 47 29.0952 S	176 49 26.1061 W	30.0
BAVJ	44 02 29.7392 S	176 20 00.0579 W	101.8
BAVB	43 44 05.9367 S	176 14 31.4105 W	51.0
BARW	43 57 00.9596 S	176 34 28.2371 W	74.69

Table B : Chatham Islands 1979 Coordinates

These coordinates (Table B) were converted to the following XYZ values (Table C) using the International Ellipsoid parameters.

Geodetic Code	X	Y	Z
BAVC	-4604695.988	-255514.261	-4391489.354
BAVJ	-4583149.178	-293700.253	-4411563.962
BAVB	-4606206.637	-302547.929	-4386975.395
BARW	-4591361.640	-274827.008	-4404244.717

Table C : Chatham Islands 1979 Coordinates

The Chatham Islands 1979 XYZ values (Table C) were subtracted from the WGS72 XYZ values (Table A) resulting in the following difference and mean value for the stations BAVC, BAVJ and BARB. BARW is used as a check.

Geodetic Code	dX	dY	dZ
BAVC	173.81	-25.45	106.73
BAVJ	174.65	-25.40	108.97
BAVB	173.69	-25.61	108.50
Average	174.05	-25.49	108.07

Table D : Chatham Islands 1979 and WGS72 Coordinate differences

The DMA parameters for conversion between Chatham Islands 1971 and WGS84 are (DMA 1987) :

$$T_x = 175 \text{ m}, T_y = -38 \text{ m and } T_z = 113 \text{ m.}$$

To the average difference (Table D), which convert between WGS72 and Chatham Islands 1979, the parameters to convert between WGS72 and WGS84 were added.

	Tx	Ty	Tz	Rx	Ry	Rz	Scale
WGS72 to WGS84	0	0	4.5	0	0	-0.554	0.2263
Chat1979 to WGS84	174.05	-25.49	112.57	0	0	-0.554	0.2263

Resulting in the 7 parameters to convert from Chatham Islands 1979 to WGS84

To check the parameters were correct there was only one station available, BARW. The Chatham Islands 1979 coordinate from the GDB (Table B) was converted to WGS72 using the parameters in Table D and the difference after subtracting the DMA XYZ values (Table A) were -0.220 m in X, 1.231 m in Y, and 0.143 m in Z.

Without a modern GPS survey of the Chatham Islands control network the below parameters are considered to be the best available from current data.

	Tx	Ty	Tz	Rx	Ry	Rz	Scale
	m	m	m	''	''	''	ppm
Chat1979 to WGS84	174.05	-25.49	112.57	0	0	-0.554	0.2263

Considering the accuracy of the Doppler coordinates and the limited number of stations used to compute these parameters they can equally be considered as the transformation parameters between Chatham Islands 1979 and NZGD2000.

3 Recommendations

The recommended 7 parameter Molodenskii - Badekas transformation of coordinates from Chatham Island 1979 to NZGD2000 are based on Doppler observations. The converted coordinate accuracy is approximately ± 2 metres. The parameters are:

Transformation parameters:

Translation (metres)	$T_x = 174.05$	$T_y = -25.49$	$T_z = 112.57$
Rotation (seconds of arc)	$R_x = 0$	$R_y = 0$	$R_z = -0.554$
Scale change (ppm)	$\Delta_s = 0.2263$		

4 Examples

Station 1

Chatham Island 1979	43 45 00.000 S	176 15 00.000 W
NZGD2000	43 44 58.262 S	176 14 57.801 W

Station 2

Chatham Island 1979	44 15 00.000 S	176 35 00.000 W
NZGD2000	44 14 58.322 S	176 34 57.832 W

References

DMA, **1987**. Supplement to Department of Defense World Geodetic System 1984 Technical Report: Part II - Parameters, Formulas, and Graphics for Practical Application of WGS84. *DMA TR 8350.2-B*, first edition, 30 September.

Moritz, H, **1980**. Geodetic reference system 1980. *Bulletin Geodesique*, Vol. 54, No. 3, pp. 395-405.

Pearse, M.B. (2000): Realisation of the New Zealand Geodetic Datum 2000. *Office of the Surveyor-General Technical Report No. 5*, Land Information New Zealand, Wellington, New Zealand.

Appendix A

Copies of the original DMA coordinate sheets showing the WGS72 coordinates computed from the Doppler Observations.

SUMMARY OF SATELLITE-OBSERVED STATION						
STATION NAME/LOCAL NUMBER WAITANGI WEST		SATELLITE STATION NUMBER Comp. T5/13		LOCATION CHATHAM ISLAND, NEW ZEALAND		DOPPLER NO. 30536
STAMPING ON MARK						
AGENCY (CAST IN MARK)			TYPE OF STATION MARK			
DOPPLER OBSERVATIONS						
EQUIPMENT/SERIAL NO. DHQ 014		HEIGHT OF TRACKING EQUIPMENT REFERENCE POINT ABOVE STATION MARK: 1.368m		TRACKING EQUIPMENT REFERENCE POINT RED BAND ON ANTENNA		
OBSERVED BY (AGENCY) DMATC		SATELLITE(S) OBSERVED 30190 and 30200		PERIOD OF OCCUPATION 13 - 18 JANUARY 1976		
SATELLITE-DERIVED COORDINATES						
PASSES ACCEPTED 41	DEGREES OF FREEDOM: 798	RESIDUAL RMS 0.18m	STATION SET NWL 9D	GRAVITY MODEL NWL 10E	ELLIPSOID NWL 8E	MINIMUM ELEV. ANGLE: 10°
(Satellite-derived coordinates referred to station mark)						
ϕ S 43° 47' 27".518	λ E 183° 10' 35".201	h 36.72m		ACCURACY 1.5 METERS IN EACH AXIS (90% LINEAR ERROR).		
X -4 604 526.31m	Y -255 534.11m	Z -4 391 386.24m				
(Satellite-derived coordinates of station mark transformed to local datum)						
ϕ S 43° 47' 27".494	λ E 183° 10' 35".461	h 41.10m		DATUM WGS 72		
X -4 604 522.18m	Y -255 539.71m	Z -4 391 382.62m		ELLIPSOID WGS 72		
ΔX	ΔY	ΔZ		DATE OF TRANSFORMATION		
GROUND SURVEY COORDINATES OF STATION MARK						
ϕ S 43° 47' 29".1019	λ E 183° 10' 33".9024	DATUM (HORIZONTAL) CHATHAM 1971		ELLIPSOID INTERNATIONAL		
DATE OF ADJUSTMENT	ORDER	SURVEY BY (AGENCY) DEPT OF LANDS & SURVEYS		DATE	LOCATION OF SURVEY DATA NEW ZEALAND	
ELEVATION (H) 28.2m		DATUM (VERTICAL) MSL		GEOID HEIGHT (N)	ELLIPSOID HEIGHT (h)	
ORDER (ELEV.)	ESTABLISHED BY (AGENCY) DEPT OF LANDS & SURVEYS		DATE	SOURCE OF (N)		
CONNECTION TO LOCAL CONTROL						
FROM	TO	() AZ FROM NORTH			DISTANCE	
REMARKS		OTHER RELATED DATA FOR THIS STATION				
		DATA	AVAIL.	LOCATION/REMARKS		
		STATION OCCUPATION REPORT	X	DMATC		
		GEODETTIC INFORMATION REPORT				
		STATION DESCRIPTION				
		SURVEY DIAGRAM				
		STATION SITE SKETCH	X	DMATC		
PHOTOIDENTIFICATION						
ASTRONOMIC COORDINATES						
STATION PHOTOS	X	DMATC				
PREPARED BY/DATE DMATC/DSP/NOV 77	CHECKED BY/DATE DMATC/KLC/DEC 77	REVISED BY/DATE	CHECKED BY/DATE			
DMA FORM 8290-1-R SEP 76						

BAVC : Satellite Station West

SUMMARY OF SATELLITE-OBSERVED STATION						
STATION NAME/LOCAL NUMBER D TE RANGAAPENE			LOCATION OWENGA, CHATHAM ISLAND, NEW ZEALAND		DOPPLER NO. 30535	
STAMPING ON MARK NONE						
AGENCY (CAST IN MARK) NONE			TYPE OF STATION MARK 2 INCH IRON PIPE			
DOPPLER OBSERVATIONS						
EQUIPMENT/SERIAL NO. DHQ 014		HEIGHT OF TRACKING EQUIPMENT REFERENCE POINT ABOVE STATION MARK: 1.247m		TRACKING EQUIPMENT REFERENCE POINT RED BAND ON ANTENNA		
OBSERVED BY (AGENCY) DMATC		SATELLITE(S) OBSERVED 30190 and 30200		PERIOD OF OCCUPATION 18 - 23 JANUARY 1976		
SATELLITE-DERIVED COORDINATES						
PASSES ACCEPTED 44	DEGREES OF FREEDOM: 804	RESIDUAL RMS 0.18m	STATION SET NWL 9D	GRAVITY MODEL NWL 10E	ELLIPSOID NWL 8E	MINIMUM ELEV. ANGLE: 10°
(Satellite-derived coordinates referred to station mark)						
ϕ S 44° 02' 28".149	λ E 183° 40' 01".322	h 106.37m		ACCURACY 1.5 METERS IN EACH AXIS (90% LINEAR ERROR).		
X -4 582 978.69m	Y -293 720.11m	Z -4 411 458.63m		(Satellite-derived coordinates of station mark transformed to local datum)		
ϕ S 44° 02' 28".125	λ E 183° 40' 01".582	h 110.75m		DATUM WGS 72		
X -4 582 974.53m	Y -293 725.65m	Z -4 411 454.99m		ELLIPSOID WGS 72		
ΔX	ΔY	ΔZ		DATE OF TRANSFORMATION		
GROUND SURVEY COORDINATES OF STATION MARK						
ϕ S 44° 02' 29".7604	λ E 183° 39' 59".9230	DATUM (HORIZONTAL) CHATHAM 1971		ELLIPSOID INTERNATIONAL		
DATE OF ADJUSTMENT	ORDER	SURVEY BY (AGENCY) DEPT. OF LANDS AND SURVEYS 1957		LOCATION OF SURVEY DATA DEPT. OF LANDS AND SURVEYS		
ELEVATION (H) 101.6m		DATUM (VERTICAL) MSL		GEOID HEIGHT (N)		ELLIPSOID HEIGHT (h)
ORDER (ELEV.)	ESTABLISHED BY (AGENCY) DEPT. OF LANDS AND SURVEYS		DATE	SOURCE OF (N)		
CONNECTION TO LOCAL CONTROL						
FROM	TO	() AZ FROM NORTH		DISTANCE		
REMARKS		OTHER RELATED DATA FOR THIS STATION				
		DATA	AVAIL.	LOCATION/REMARKS		
		STATION OCCUPATION REPORT	X	DMATC		
		GEODETTIC INFORMATION REPORT				
		STATION DESCRIPTION	X	DMATC		
		SURVEY DIAGRAM				
		STATION SITE SKETCH	X	DMATC		
PHOTOIDENTIFICATION						
ASTRONOMIC COORDINATES						
STATION PHOTOS	X	DMATC				
PREPARED BY/DATE DMATC/DSP/NOV 77		CHECKED BY/DATE DMATC/KLC/DEC 77		REVISED BY/DATE DMAHTC/RBK/JUN 79		CHECKED BY/DATE DMAHTC/BHS/JUN 79
DMA FORM 8290-1-R SEP 76						

BAVJ : D Te Rangaapene

SUMMARY OF SATELLITE-OBSERVED STATION						
STATION NAME/LOCAL NUMBER PUKERAKEI <small>DoSU SATELLITE STATION EAST Camp T5/13</small>			LOCATION KAINGAROA, CHATHAM ISLAND, NEW ZEALAND		DOPPLER NO. 30532	
STAMPING ON MARK NONE						
AGENCY (CAST IN MARK) NONE			TYPE OF STATION MARK TACK IN CENTER OF 2" X 2" PEG			
DOPPLER OBSERVATIONS						
EQUIPMENT/SERIAL NO. DHQ 014		HEIGHT OF TRACKING EQUIPMENT REFERENCE POINT ABOVE STATION MARK: 1.123m		TRACKING EQUIPMENT REFERENCE POINT RED BAND ON ANTENNA		
OBSERVED BY (AGENCY) DMATC		SATELLITE(S) OBSERVED 30190 and 30200		PERIOD OF OCCUPATION 7 - 13 JANUARY 1976		
SATELLITE-DERIVED COORDINATES						
PASSES ACCEPTED 44	DEGREES OF FREEDOM: 872	RESIDUAL RMS 0.20m	STATION SET NWL 9D	GRAVITY MODEL NWL 10E	ELLIPSOID NWL 8E	MINIMUM ELEV. ANGLE: 10°
<i>(Satellite-derived coordinates referred to station mark)</i>						
ϕ S 43° 44' 04".301	λ E 183° 45' 29".980	h 56.91m		ACCURACY 1.5 METERS IN EACH AXIS (90% LINEAR ERROR).		
X -4 606 037.14m	Y -302 567.98m	Z -4 386 870.52m				
<i>(Satellite-derived coordinates of station mark transformed to local datum)</i>						
ϕ S 43° 44' 04".277	λ E 183° 45' 30".240	h 61.29m		DATUM WGS 72		
X -4 606 032.95m	Y -302 573.54m	Z -4 386 866.89m		ELLIPSOID WGS 72		
ΔX	ΔY	ΔZ		DATE OF TRANSFORMATION		
GROUND SURVEY COORDINATES OF STATION MARK						
ϕ S 43° 44' 05".9334	λ E 183° 45' 28".5917	DATUM (HORIZONTAL) CHATHAM 1971		ELLIPSOID INTERNATIONAL		
DATE OF ADJUSTMENT	ORDER	SURVEY BY (AGENCY) DEPT OF LANDS & SURVEYS	DATE	LOCATION OF SURVEY DATA NEW ZEALAND		
ELEVATION (H) 51.1m		DATUM (VERTICAL) MSL		GEOID HEIGHT (N)		ELLIPSOID HEIGHT (h)
ORDER (ELEV.)	ESTABLISHED BY (AGENCY) DEPT OF LANDS & SURVEYS		DATE	SOURCE OF (N)		
CONNECTION TO LOCAL CONTROL						
FROM	TO	() AZ FROM NORTH		DISTANCE		
REMARKS		OTHER RELATED DATA FOR THIS STATION				
		DATA	AVAIL.	LOCATION/REMARKS		
		STATION OCCUPATION REPORT	X	DMATC		
		GEODETTIC INFORMATION REPORT				
		STATION DESCRIPTION				
		SURVEY DIAGRAM				
		STATION SITE SKETCH	X	DMATC		
PHOTOIDENTIFICATION						
ASTRONOMIC COORDINATES						
STATION PHOTOS	X	DMATC				
PREPARED BY/DATE DMATC/DSP/NOV 77	CHECKED BY/DATE DMATC/KLC/DEC 77	REVISED BY/DATE		CHECKED BY/DATE		

DMA FORM 8290-1-R
SEP 76

BAVB : Satellite Station East

SUMMARY OF SATELLITE-OBSERVED STATION						
STATION NAME/LOCAL NUMBER KAHUNENE NO. 2		LOCATION CHATHAM ISLAND, NEW ZEALAND			DOPPLER NO. 30531	
STAMPING ON MARK NONE						
AGENCY (CAST IN MARK) NONE			TYPE OF STATION MARK IRON PIPE			
DOPPLER OBSERVATIONS						
EQUIPMENT/SERIAL NO. DHQ 014		HEIGHT OF TRACKING EQUIPMENT REFERENCE POINT ABOVE STATION MARK: 1.125m		TRACKING EQUIPMENT REFERENCE POINT RED BAND ON ANTENNA		
OBSERVED BY (AGENCY) DMATC		SATELLITE(S) OBSERVED 30190 and 30200		PERIOD OF OCCUPATION 23 - 28 JANUARY 1976		
SATELLITE-DERIVED COORDINATES						
PASSES ACCEPTED 45	DEGREES OF FREEDOM: 835	RESIDUAL RMS 0.23m	STATION SET NWL 9D	GRAVITY MODEL NWL 10E	ELLIPSOID NWL 8E	MINIMUM ELEV. ANGLE: 10°
(Satellite-derived coordinates referred to station mark)						
φ S 43° 56' 59".377	λ E 183° 25' 33".166	h 80.28m		ACCURACY 1.5 METERS IN EACH AXIS (90% LINEAR ERROR).		
X -4 591 191.51m	Y -274 848.17m	Z -4 404 140.42m				
(Satellite-derived coordinates of station mark transformed to local datum)						
φ S 43° 56' 59".353	λ E 183° 25' 33".426	h 84.66m		DATUM WGS 72		
X -4 591 187.37m	Y -274 853.73m	Z -4 404 136.79m		ELLIPSOID WGS 72		
ΔX	ΔY	ΔZ		DATE OF TRANSFORMATION		
GROUND SURVEY COORDINATES OF STATION MARK						
φ S 43° 57' 00".9587	λ E 183° 25' 31".7642	DATUM (HORIZONTAL) CHATHAM 1971		ELLIPSOID INTERNATIONAL		
DATE OF ADJUSTMENT	ORDER 4th	SURVEY BY (AGENCY) DEPT. OF LANDS AND SURVEYS	DATE 1970	LOCATION OF SURVEY DATA DEPT. OF LANDS AND SURVEYS		
ELEVATION (H) 73.27m	DATUM (VERTICAL) MSL	GEOID HEIGHT (N)		ELLIPSOID HEIGHT (h)		
ORDER (ELEV.) LEVELS	ESTABLISHED BY (AGENCY) DEPT. OF LANDS AND SURVEYS	DATE 1970	SOURCE OF (N)			
CONNECTION TO LOCAL CONTROL						
FROM 30531	TO KAPANGATAKAHU	(GEODETTIC) AZ FROM NORTH 295° 58' 56"		DISTANCE		
REMARKS		OTHER RELATED DATA FOR THIS STATION				
		DATA	AVAIL.	LOCATION/REMARKS		
		STATION OCCUPATION REPORT	X	DMATC		
		GEODETTIC INFORMATION REPORT				
		STATION DESCRIPTION	X	DMATC		
		SURVEY DIAGRAM	X	DMATC		
		STATION SITE SKETCH	X	DMATC		
		PHOTOIDENTIFICATION				
ASTRONOMIC COORDINATES						
STATION PHOTOS	X	DMATC				
PREPARED BY/DATE DMATC/DSP/NOV 77	CHECKED BY/DATE DMATC/KLC/DEC 77	REVISED BY/DATE DMAHTC/RBK/JUN 79	CHECKED BY/DATE DMAHTC/BHS/JUN 79			
DMA FORM 8290-1-R SEP 76						

BARW : Kahunene No 2