Richard Stanaway Quickclose

using GNSS

Establishing Cadastral Control

2011 Victorian Spatial Summit, 14th September 2011

Case study – control for a typical rural residential subdivision



Why use GNSS?

- no line of sight required
- centimetre precision connection to GDA94 in minutes
- precise MGA94 bearing datum easily computed by inversion of MGA94 coordinates

GNSS techniques are especially suited to rural cadastral surveys

Which GNSS technique should I use?

Static post-processing

slower, extended range, small uncertainties, robust self-checking (with loop closure / network adjustment), requires post-processing software and knowledge no communications required

Single-base RTK

fast, limited range, larger uncertainties, requires independent checks, easy to use radio or GSM/GPRS communications required

Network RTK (NRTK)

fast, extended range, moderate uncertainties, still requires independent checks, easy to use GSM/GPRS modem and 3G coverage required

What GNSS equipment do I need?

Single or Dual frequency?

Single-frequency – effective baseline range 10 km Dual frequency – effective baseline range for < 20 mm precision: 30km (RTK), 50 km (NRTK) or 70 km (Static)

Communications

Single base RTK – requires radio or GSM/GPRS modem NRTK – typically requires GSM/GPRS modem (3G coverage) Static – No communications required, but PP software required

Number of receivers

single-frequency – for use with GPSnet, but limited to < 10 km
 dual-frequency – for use with GPSnet anywhere in Victoria
 single-frequency – can be used to connect to local PSMs < 10 km
 dual/1 single – GPSnet anywhere and local connections < 10 km
 dual-frequency – GPSnet anywhere and connections < 50 km
 receivers – allows for loop closure/network adjustment without reoccupation (static post-processing)

At the office - before the survey

- Obtain Abstracts of Field Notes, plans, maps etc..
- Obtain PSM/PM/PCM information (sketches, coordinates) (nearest cadastral, GDA94 and AHD71 control)
- Identify the nearest GPSnet stations (this dictates what GNSS equipment is to be used)

In the field – initial preparations

- Locate PSMs and cadastral marks (e.g. RMs, Pegs)
- Establish new GNSS stations (can become PSMs/PCMs)

Good sky visibility (away from trees/buildings) with total station visibility to cadastral marks/PSMs under trees visibility to one or two other GNSS stations for bearing determination



Nearest GPSnet and AHD71 control



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Build Local Network Primary GPS Star Picket in conc (future PSM) Secondary GPS Star Picket

Total Station Control (Spike/dumpy)

(PCMs)

GPS survey of primary control



Static GPSNRTK(30 minutes obs @ 10 sec)or(2 observations - am day 1 and pm day 2)

GPSnet GDA94/MGA94 coordinates



GPSnet™ Whittlesea [WHIT]

	SITE IDENTIFICATION					
Name	Whittlesea					
4 Char ID	WHIT					
Operational	03/11/2006					
Station #	- Pending -					
Domes #	- Pending -					
Parish - Permanent Mark #	MORANG PM 365	tv				
	Victoria and Enviro	iment				
	This CORS is Active					
Related CORS						
Commissioned Decommissioned						
-						
and the second sec	HORIZONTAL COORDINATES					
Status - Date	Final - 31/12/2007					
Latitude	37° 38' 42.06219" S					
Longitude	145° 04' 03.45264" E					
Easting [Zone54]						
Northing [Zone54]						
Easting [Zone55]	329 519.876 GD/4					
Northing [Zone55]	5 831 813.629 GDA94/MGA94					
	HEIGHTS					
	Ellipsoidal (h) GRS80					
Status - Date	Final - 31/12/2007					
Antenna Phase Centre APC	163.280 NGS Offset Value 85.0mm					
Base of Antenna BA	163.195 Computed by GA					



GPSnet[™] Woori Yallock [WOOR]

	SITE IDENTIFICATION					
Name	Woori Yallock					
4 Char ID	WOOR					
Operational	14/12/2005					
Station #	- Pending -					
Domes #	- Pending -					
Parish - Permanent Mark #	WOORI YALLOCK PM 242					
	This CORS is Inactive					
Related CORS	WOOR WORI					
Commissioned	14/12/2005 07/06/2011					
Decommissioned	06/05/2011					
	HORIZONTAL COORDINATES					
Status - Date	Final - 31/12/2007					
Latitude	37° 46' 37.41427" S					
Longitude	145° 31' 48.12050" E					
Easting [Zone54]						
Northing [Zone54]						
Easting [Zone55]	370 547.562 E GD/					
Northing [Zone55]	5 817 902.825 N GDA94/MGA94					
	HEIGHTS					
	Ellipsoidal (h) GRS80					
Status - Date	Provisional - 21/12/2009					
Antenna Phase Centre APC	116.937 Non Offset Value 71.4mm					
Base of Antenna BA	116.866 Computed by GA					



X

-

Rename

• 0 E!

Std Dev

0.005

0.005

0.005

2

Help

GPS survey of secondary control



Static GPS (5-6 minute rapid static baselines) from two stations

or **NRTK** (2 observations – ideally am day 1 and pm day 2)

MGA94, GDA94 and AHD coordinate listing

4635	535 Subdivision MGA94 Control					Local Uncertainty Combined				GDA94		
No	type	Zone 55 E	Zone 55 N	AHD RL	σΕ	σΝ	σHt	SF	1:	Latitude	Longitude	
PM40	Plaque	351527.081	5836362.098	253.325	0.003	0.007	0.012	0.999832	5945	-37.60785945	145.31789315	
PM6	Plaque	346986.671	5836649.581	134.865	0.005	0.003	0.008	0.999867	7532	-37.60452510	145.26653449	
PM14	Plaque	350634.144	5836457.097	260.107	0.014	0.011	0.009	0.999834	6024	-37.60685894	145.30780015	
1034	SIP Conc	350789.249	5837027.732	247.257	0.003	0.002	0.008	0.999835	6077	-37.60174294	145.30967304	
1000	SIP	351392.767	5836514.991	244.191	0.004	0.001	0.002	0.999834	6014	-37.60646024	145.31640312	
1001	Dumpy	351425.884	5836760.204	217.991	0.001	0.001	0.001	0.999838	6161	-37.60425632	145.31682795	
1002	SIP Conc	351473.048	5837043.432	260.758	0.003	0.004	0.007	0.999831	5911	-37.60171217	145.31741954	
1003	SIP	351520.141	5837368.439	227.731	0.001	0.004	0.006	0.999836	6091	-37.59879158	145.31801876	
1004	Dumpy	351567.475	5837719.648	242.827	0.001	0.002	0.003	0.999833	5998	-37.59563496	145.31862598	
1005	SIP	351593.371	5837873.150	261.496	0.006	0.002	0.004	0.999830	5891	-37.59425614	145.31895032	
1006	SIP	351363.000	5837762.061	277.439	0.002	0.004	0.004	0.999829	5834	-37.59521982	145.31631931	
1007	SIP	351201.480	5837773.013	278.677	0.001	0.001	0.004	0.999829	5848	-37.59509503	145.31449265	
1008	SIP	350977.269	5837733.797	266.299	0.001	0.002	0.007	0.999832	5944	-37.59541206	145.31194593	
1009	SIP	350926.053	5837501.943	212.695	0.006	0.003	0.008	0.999840	6264	-37.59749268	145.31131880	
1010	SIP	350907.621	5837308.845	222.248	0.003	0.002	0.003	0.999839	6209	-37.59922942	145.31107075	
1011	SIP	351086.406	5837324.914	245.638	0.002	0.003	0.004	0.999835	6046	-37.59911361	145.31309850	
1012	Dumpy	351345.708	5837473.913	243.495	0.002	0.004	0.003	0.999834	6024	-37.59781313	145.31606499	
1013	Dumpy	351043.108	5837130.403	207.632	0.002	0.001	0.004	0.999841	6279	-37.60085906	145.31256863	
1014	SIP	350867.361	5837191.855	203.652	0.001	0.003	0.005	0.999842	6329	-37.60027693	145.31059102	
1015	SIP	350706.841	5837223.751	209.825	0.002	0.002	0.005	0.999842	6314	-37.59996352	145.30877985	
1016	SIP	350478.658	5837227.364	229.188	0.002	0.003	0.004	0.999839	6227	-37.59989390	145.30619672	
1017	SIP	350244.804	5837411.499	188.106	0.004	0.003	0.008	0.999847	6524	-37.59819688	145.30358632	
1018	Dumpy	350167.002	5837276.402	203.578	0.003	0.008	0.009	0.999845	6435	-37.59940138	145.30267769	
1019	SIP	350148.953	5836993.905	241.583	0.003	0.001	0.004	0.999839	6199	-37.60194361	145.30241546	
1020	SIP Conc	350115.547	5836909.473	249.098	0.003	0.004	0.005	0.999838	6159	-37.60269886	145.30201988	
1021	SIP	350059.030	5836607.230	250.263	0.004	0.008	0.008	0.999838	6160	-37.60541271	145.30131795	
1022	Dumpy	350238.968	5836505.359	265.899	0.004	0.006	0.009	0.999835	6044	-37.60635985	145.30333479	
1023	Dumpy	350278.558	5836498.304	268.466	0.001	0.003	0.002	0.999834	6024	-37.60642985	145.30378169	
1024	Nail in bit	350365.158	5836480.470	253.716	0.003	0.005	0.008	0.999836	6097	-37.60660463	145.30475875	
1025	SIP	350584.054	5836484.179	260.702	0.014	0.011	0.009	0.999834	6027	-37.60660680	145.30723843	
1026	SIP	350814.404	5836479.229	251.739	0.002	0.003	0.005	0.999835	6048	-37.60668880	145.30984606	
1027	SIP Conc	351045.706	5836585.640	257.741	0.004	0.006	0.009	0.999833	5983	-37.60576758	145.31248715	
1028	SIP	351287.056	5836581.791	247.520	0.001	0.002	0.006	0.999834	6009	-37.60584131	145.31521955	
1029	SIP	351223.685	5836886.823	209.613	0.001	0.001	0.004	0.999840	6240	-37.60308285	145.31456393	
1030	Dumpy	351115.648	5836963.789	206.583	0.001	0.002	0.002	0.999841	6275	-37.60237193	145.31335616	
1031	Dumpy	351037.421	5836800.818	240.263	0.001	0.002	0.001	0.999836	6084	-37.60382757	145.31243713	

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MGA94 Coordinates & Local Uncertainty from minimally constrained network adjustment report or comparison of two independent NRTK observations

Combined Scale Factor ~ 0.99984 or 1:6,000 (not to 1:20,000 spec for use as plane grid)

GDA94 coordinates

for use in GIS and to compute LTM coordinates

Compute LTM coordinates

GDA94 Ellipsoidal to LTM			E _(LCM)	151024.558	a =	6378137.000	1/f =	298.25722210	GRS80
copy row 40 down for more calculations			N _(LPO)	4170685.159	k ₀ =	0.9997645	e^2=	0.00669438	Ellipsoid
	Long _{CM}	147	k _(LCM)	0.9997645184	e ²	0.006694380			
Version 1.1 27th March 2010 (Freeware, QUICKCLOSE Software - PO Box 1364 Carlton VIC 3053 AUSTRALIA)									
Latitude (decimal °) (negative in Southern Hem.)	Longitude (decimal °) (negative in Western Hem.)	Ellipsoid Height (optional)	Zone	Easting	Northing	Ellipsoid Height	Grid Convergence (decimal °)	Grid (Point) Scale Factor	Combined Height & Grid Scale Factor
-37.6017429388	145.3096730411	247.257	1	1789.249	7027.731	247.257	-1.0315758	1.00003880	1.00000000
-37.6064602440	145.3164031167	244.191	1	2392.867	6514.906	244.191	-1.0275769	1.00003659	0.99999827

4635 Plane Control 30/10/08

No	type	Plane E	Plane N	AHD RL	CSF	1:	
1034	SIP Conc	1789.249	7027.732	247.257	1.00000000	63239924838	
1000	SIP	2392.866	6514.907	244.191	0.99999827	576868	
1001	Dumpy	2425.989	6760.160	217.991	1.00000226	443153	
1002	SIP Conc	2473.161	7043.435	260.758	0.99999537	216137	
1003	SIP	2520.261	7368.495	227.731	1.0000038	2607079	
1004	Dumpy	2567.603	7719.762	242.827	0.99999784	463353	
1005	SIP	2593.503	7873.289	261.496	0.99999482	192967	
1006	SIP	2363.095	7762.182	277.439	0.99999316	146179	
1007	SIP	2201.548	7773.136	278.677	0.99999356	155199	
1008	SIP	1977.300	7733.913	266.299	0.99999632	271855	
1009	SIP	1926.076	7502.021	212.695	1.00000492	203218	
1010	SIP	1907.641	7308.891	222.248	1.00000349	286581	
1011	SIP	2086.455	7324.963	245.638	0.99999916	1194438	
1012	Dumpy	2345.800	7473.987	243.495	0.99999855	688964	
1013	Dumpy	2043.150	7130.420	207.632	1.00000529	189203	
1014	SIP	1867.374	7191.882	203.652	1.00000656	152549	
1015	SIP	1706.827	7223.783	209.825	1.00000618	161896	
1016	SIP	1478.607	7227.397	229.188	1.00000398	251354	
1017	SIP	1244.714	7411.562	188.106	1.00001129	88596	
1018	Dumpy	1166.899	7276.443	203.578	1.00000915	109331	
1019	SIP	1148.848	6993.899	241.583	1.00000325	307751	
1020	SIP Conc	1115.436	6909.454	249.098	1.00000219	455899	
1021	SIP	1058.910	6607.161	250.263	1.00000222	450600	
1022	Dumpy	1238.877	6505.273	265.899	0.99999910	1112747	

Combined Scale Factor

close to 1 highest is 1:88,000 (exceeds 1:20,000 spec for use as plane grid)

GDA94 ellipsoidal coordinates (lat/long) same in both

projections (MGA94 and LTM)

Infilling total station traverse (to cover areas of poor GNSS visibility)



Total station traverse on LTM (Plane) Grid to access locations under trees. Traverse linked to & constrained by GPS control (instrument ppm checked first) 2011 Victorian Spatial Summit, 14th September 2011

GNSS for cadastral surveys - Summary

- GNSS ideal for bringing GDA94/MGA94 into a survey
- Choose the right GNSS equipment and understand its limitations
- Locate local PSMs, PMs and existing cadastral control / marks
- Construct GNSS stations with good sky visibility and total station visibility to marks under trees, buildings etc..
- GNSS survey from GPSnet or nearby 1st/2nd order GDA94 control (long baseline)
- Local GNSS survey and adjustment (short baselines)
- Compute LTM grid and convert GDA94/MGA94 coords to LTM
- Total station survey from adjusted control using LTM coordinates

This presentation at:http://www.quickclose.com.au/publications.htmemail:richard.stanaway@quickclose.com.au

Thank You