Post Processing GPS observations for reliable survey control in eThekwini Municipality (S.Ndlovu – June 2016)

Background:

Survey as a profession has really come a long way when it comes to technology. From traditional instruments such as the theodolites used for taking directions, to using chains to measure distances, to what it is nowadays. Where with the technology available now, it enables a surveyor to carry out major surveys in only a fraction of the time it would have taken one a few decades ago.

One of the modern technologies being used in survey is the GPS. The GPS uses satellites to determine our position on the earth's surface.

Control Networks:

South Africa is fully covered by the National Control Survey System which is of high accuracy and is marked by a network of Trigonometric beacons. It is a requirement that surveys are connected to this control network.

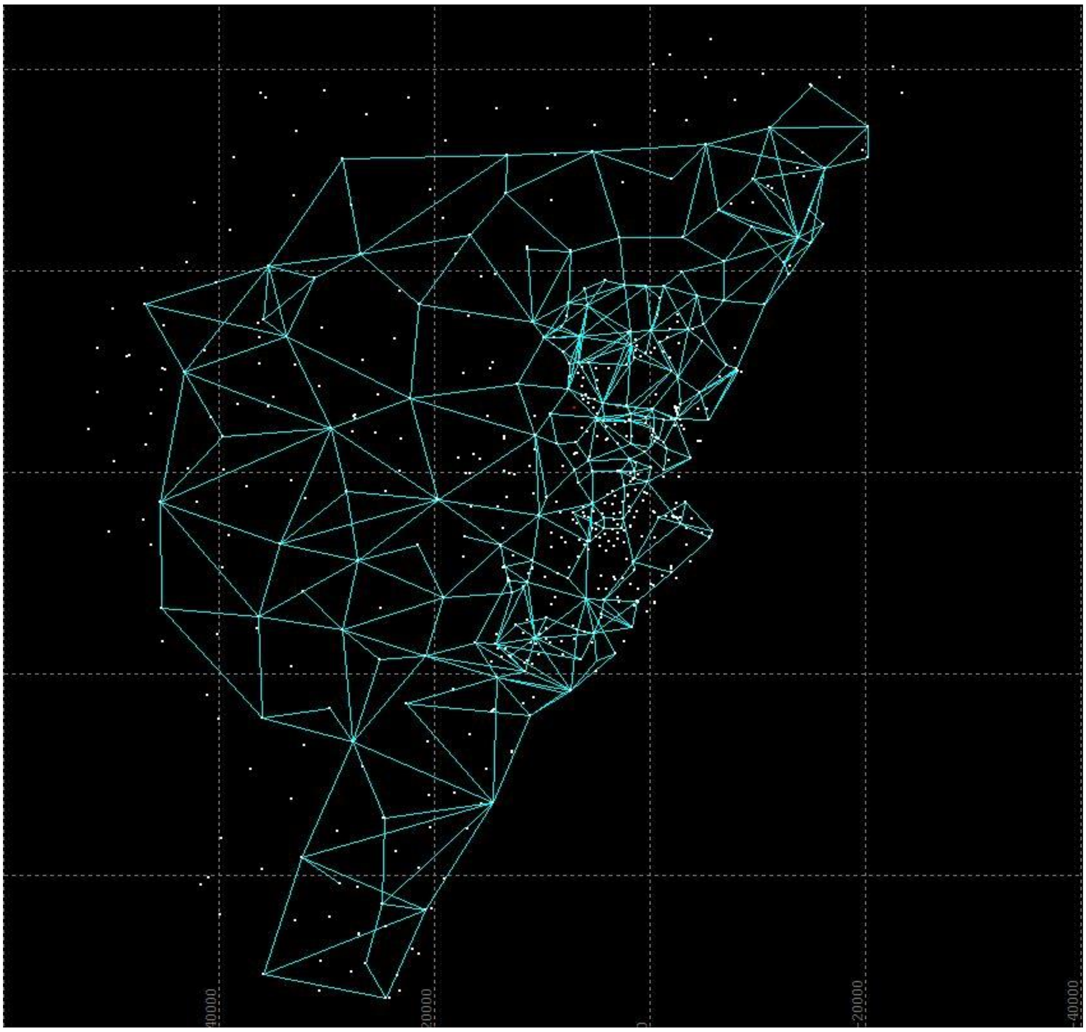

Figure 1.1: shows a control network that is marked by trigonometric beacons covering the whole of EThekwini Municipality

As stated earlier, the accuracy of the network is of a high standard; however, the arrival of new technology has shown flaws within that system. For instance, the coordinates of the trig beacons are calculated to only a tenth of a meter (0.1m) in elevation (z). Using the new technology such as GPS, with accuracies to a millimetre (mm), this can be improved.

With that realisation, a new way of fixing control points for the Municipality was adopted. Here we use GPS and a method of Post Processing to calculate final coordinates for our control points. The Survey branch started using this method in 1999. They observed baselines from selected trig beacons, thus creating a control network of trigs as seen on ***Figure 1.1***. This network now forms the basis for all control surveys for the EThekwini Municipality.

Post Processing:

This method is when you carry out a normal GPS field survey to provisionally fix new control points and later return to office to process the data collected and then calculate their final coordinate, hence the phrase "post processing". The software uses a least squares network adjustment to adjust and determine coordinates within the control network.

We set our GPS bases at two trigonometric beacons and we let them run simultaneously while we observe new control points on site. The result is a double polar effect on the new control point because of the two trig beacons used, which themselves are within a pre-observed network.

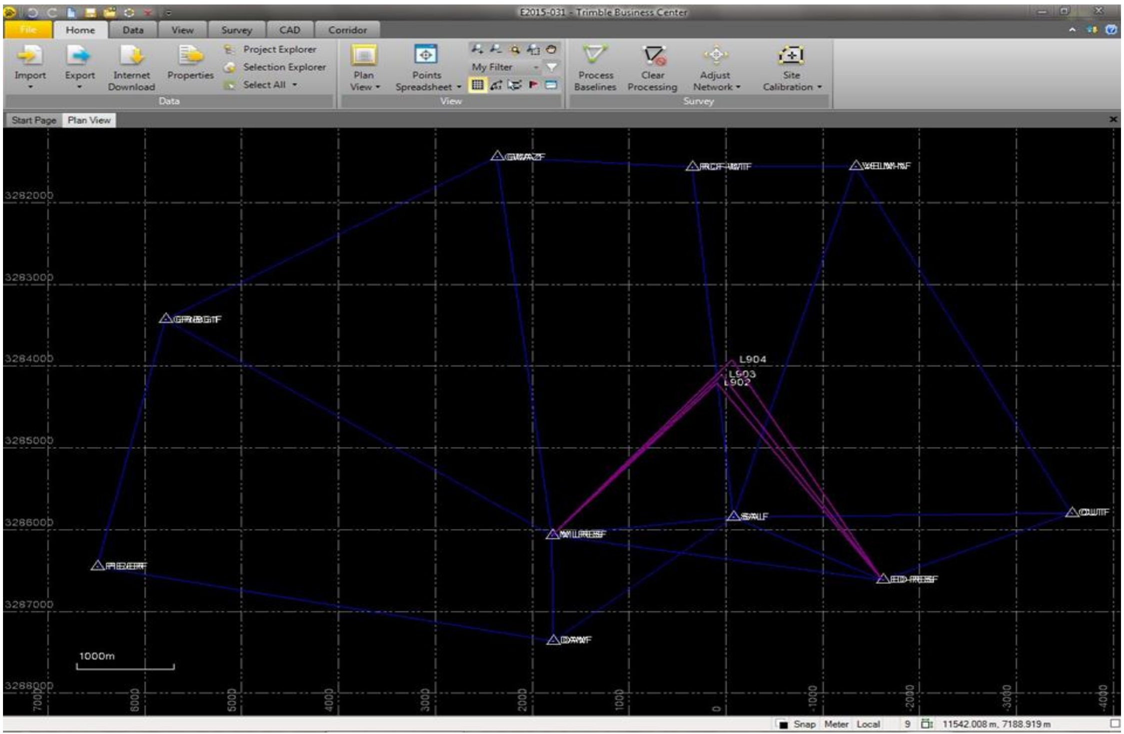

Figure 1.2: shows three (3) new control points that were observed from two trig beacons which themselves are within a pre-observed network with other trig beacons.

We then put the data in a network with surrounding trigs, and look for a best fit for our network and calculate their final coordinates. What that means is every trig in the network, and not only the ones used as bases, influence the final coordinate of the points calculated.

That however, is scrutinized and accepted under the condition that the trigs are in agreement with others on the network. Failing to be in such agreement means we have to eliminate which ever does not agree with the others.

This makes Post Processing more accurate and reliable as compared to RTK because it uses more fixed points to finalise coordinates of new points. Working within the same network means similar results are expected every time because we are using the same parameters.

C:\Users\siya.ndlovu\AppData\Local\Temp\Site Calibration Report.html — Site Calibration Report

Google — Search — More — Sign In

Residual Differences Between GPS and Known Coordinates

Summary

	Maximum residual	Root Mean Square residual	Point
Horizontal	0.021 m	0.013 m	GR/BG1F
Vertical	0.011 m	0.006 m	DAMF
Three-dimensional	0.021 m	0.014 m	DAMF

Point Residuals

Residuals sign: Calculated-Control

GNSS Point		Calculated Point		Grid Point	
Point	GR/BG1F	**Point**	GR/BG1F	**Point**	GR/BG1
Latitude	S29°40'08.81051"	**Easting**	5789.990 m	**Easting**	5789.970 m
Longitude	E30°56'24.68003"	**Northing**	3283436.322 m	**Northing**	3283436.330 m
Height	478.854 m	**Elevation**	478.728 m	**Elevation**	478.810 m
		Horiz. residual	0.021 m	**Type**	Horizontal
		Vert. residual	?		
		3D residual	?		
Point	GWAZF	**Point**	GWAZF	**Point**	GWAZ
Latitude	S29°39'04.30036"	**Easting**	2367.369 m	**Easting**	2367.330 m
Longitude	E30°58'31.97747"	**Northing**	3281448.758 m	**Northing**	3281448.770 m
Height	330.190 m	**Elevation**	330.104 m	**Elevation**	330.240 m
		Horiz. residual	?	**Type**	(Ignored)
		Vert. residual	?		
		3D residual	?		
Point	RCF-WTF	**Point**	RCF-WTF	**Point**	RCF-WT
Latitude	S29°39'08.26075"	**Easting**	349.195 m	**Easting**	349.200 m
Longitude	E30°59'47.01660"	**Northing**	3281570.452 m	**Northing**	3281570.460 m
Height	321.691 m	**Elevation**	321.649 m	**Elevation**	321.600 m
		Horiz. residual	0.009 m	**Type**	Horizontal
		Vert. residual	?		
		3D residual	?		

Figure 1.3

Point	ED-RESF	**Point**	ED-RESF	**Point**	ED-RES
Latitude	S29°41'52.30029"	**Easting**	-1615.135 m	**Easting**	-1615.140 m
Longitude	E31°01'00.08135"	**Northing**	3286621.457 m	**Northing**	3286621.460 m
Height	154.406 m	**Elevation**	154.482 m	**Elevation**	154.400 m
		Horiz. residual	0.006 m	**Type**	Horizontal
		Vert. residual	?		
		3D residual	?		
Point	SALF	**Point**	SALF	**Point**	SAL
Latitude	S29°41'27.34493"	**Easting**	-75.157 m	**Easting**	-75.161 m
Longitude	E31°00'02.79567"	**Northing**	3285852.948 m	**Northing**	3285852.945 m
Height	134.343 m	**Elevation**	134.375 m	**Elevation**	134.380 m
		Horiz. residual	0.005 m	**Type**	Horz and Vert
		Vert. residual	-0.005 m		
		3D residual	0.007 m		
Point	MILRESF	**Point**	MILRESF	**Point**	MILRES
Latitude	S29°41'34.50559"	**Easting**	1796.926 m	**Easting**	1796.930 m
Longitude	E30°58'53.15958"	**Northing**	3286073.579 m	**Northing**	3286073.570 m
Height	177.497 m	**Elevation**	177.494 m	**Elevation**	177.501 m
		Horiz. residual	0.010 m	**Type**	Horz and Vert
		Vert. residual	-0.007 m		
		3D residual	0.012 m		
Point	DAMF	**Point**	DAMF	**Point**	DAM
Latitude	S29°42'16.48845"	**Easting**	1784.514 m	**Easting**	1784.532 m
Longitude	E30°58'53.61349"	**Northing**	3287366.265 m	**Northing**	3287366.264 m
Height	131.264 m	**Elevation**	131.281 m	**Elevation**	131.270 m
		Horiz. residual	0.018 m	**Type**	Horz and Vert
		Vert. residual	0.011 m		
		3D residual	0.021 m		
Point	PIE/ERF	**Point**	PIE/ERF	**Point**	PIE/ER
Latitude	S29°41'46.88461"	**Easting**	6492.588 m	**Easting**	6492.600 m
Longitude	E30°55'58.48622"	**Northing**	3286456.488 m	**Northing**	3286456.490 m
Height	353.594 m	**Elevation**	353.499 m	**Elevation**	353.500 m
		Horiz. residual	0.013 m	**Type**	Horz and Vert
		Vert. residual	-0.001 m		
		3D residual	0.013 m		

Figure 1.4

Figures 1.3 & 1.4 show an extract of results for the calibration done on a network of observations. As can be seen on the Type description, some points on the network have been used for both horizontal and vertical (i.e. **DAM**). Some we've only used their horizontal in the adjustment (i.e. **ED-RES**). Others we've only used their vertical. Lastly, we've chose to eliminate / ignore (i.e. **GWAZ**) and other points completely as a result of their huge errors.

The calibration results as viewed above did show us which observations were in agreement and which ones needed to be eliminated from the network. Horizontal and Vertical residuals show us the magnitude of error in each control point in the network.

We do not pin nor constrain our network to any control point, however, a best fit adjustment is done where the network is floated for a best fit onto the primary points (trig beacons). This way we are able to select points we want to keep active on the network and eliminate those not in agreement (horizontal or vertical) as we wish to, based on the errors they bear when the network is being adjusted.

This method we use of adjusting our control point networks not only is it accurate, but also ensures precision in all our control points, and thus precision in our control surveys.