Jones County
Iowa

Countywide
G.P.S. Survey
Control Network

2004

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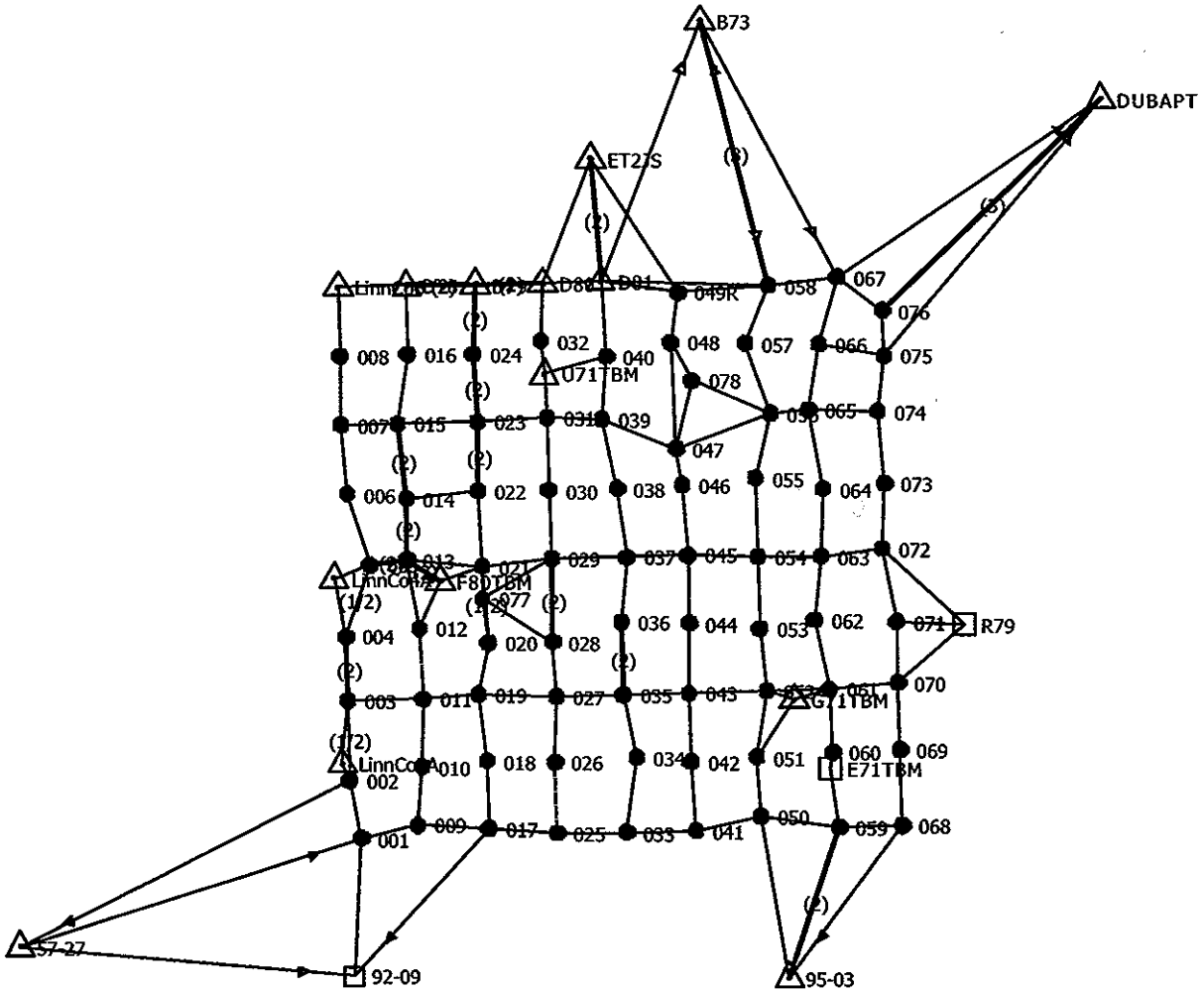

Field surveyor:
GGB & DBC
Computer operator:
GGB
Reference:
Jones County GPS Survey

Scale 1" to 41667 ft
0 75000 sft
US survey feet

0°00'00"

Plot Scale: 1" to 41667 ft
Printed on 12/1/2004, at 11:52:33 AM

Printed from Trimble Geomatics Office

Site: Not selected, System: US State Plane 1983
Zone: Iowa North 1401, Datum: NAD 1983 (Conus)

Project: Jones
USFeet Template

INTRODUCTION

In 2004 Jones County, Iowa, contracted with DC Inc. to complete a high accuracy GPS control survey for the purpose of establishing a county-wide survey control system and for future use in a county wide GIS system.

Seventy eight (78) new control stations were added within the County along with, three (3) existing Linn County GPS control points, and four (4) existing Delaware County GPS control points. An additional four (4) HARN control points, two (2) USGS second order benchmarks, four (4) USGS second order temporary benchmarks, some with horizontal control, and one (1) Johnson County control point were included in the network. A total of ninety six (96) points were measured.

PROJECT REQUIREMENTS

The purpose of this survey was to establish new state plane control throughout the project area, using a new horizontal and vertical control network with GPS survey equipment and techniques. This network was horizontally referenced to the Iowa High Accuracy Reference Network (HARN) of 1996. Vertically the network was referenced to the North American Vertical Datum of 1988 (NAVD88). Because this control would be utilized for many different purposes, it was important that the network geometry be ideal for a strong GPS survey. All new point locations for control were selected with the needs of future multiple uses and GPS survey requirements in mind. In some instances, it was necessary to adjust locations because of physical obstructions or existing land features. In these instances, the network was constructed with the coverage of the county held as primary and the GPS survey needs satisfied secondly. Because both of these philosophies support good geometry the network structure was not compromised.

MONUMENTATION

To perpetuate the GPS control measurements, 78 new permanent monuments were set for Jones County. BERNTSEN driven aluminum rod monuments were selected for the permanent monuments. Each BERNTSEN station monument consists of one three-foot smooth rod section and one three-foot top security fluted rod section with a stamped cap fastened to the top, all constructed of aluminum material. There is a permanent magnet mounted on the underside of the monument cap for future recovery with a magnetic locator. These monuments were driven to approximately 6" below the existing ground surface. For easy access and protection, a 24" long 5" diameter PVC pipe was placed over each rod monument along with a pre-cast aluminum access cover and backfilled with sand to facilitate drainage and to minimize frost movement. For temporary positions rebar points that consist of 1/2" diameter 30" long deformed rebar were set. A steel fence post with a plastic marking cover was placed as a witness point at each new permanent monument position.

Three existing rebar temporary benchmarks were found and re-measured from prior surveys and one new temporary benchmark was set and measured.

The county engineers office handled the coordination of marking the various underground utility locations for each new permanent monument site.

RECONNAISSANCE

The most important criterion for GPS observations at any given location is a clear view to the sky. In terms of network design, it is desirable that the horizontal control be located near the perimeter and also throughout the project site if possible. With this in mind, existing HARN horizontal stations were recovered in and/or near Jones County along with other control that has been adjusted to the HARN. All positions in and near the county were chosen to be included in the network.

Vertical control was selected to provide as much coverage as possible, both at the periphery and in the interior of the project area. In addition, four (4) HARN stations with vertical control and six (6) existing NGS and USGS benchmarks were recovered and included in this survey. Four of the benchmarks were measured using offset points with the remaining benchmarks occupied directly.

FIELD SURVEY

Three Trimble 24 channel dual frequency Geodetic GPS receivers with Everest multi-path mitigation and high performance low elevation satellite tracking were used in this survey. Three model 5800 receivers were used for the survey. GPS observations began Sunday, October 24, 2004. GPS observations were made during daylight and evening hours from Sunday, October 24, 2004, through Friday, October 28, 2004.

Rapid static GPS techniques were utilized to minimize the time and cost of the survey. The satellite "window", where at least six satellites were observable, was open for much of the day with only a few short periods of unacceptable coverage because of the number of satellites or bad geometry. Each measurement period during which all receivers observe satellites simultaneously lasted from 10 minutes to 150 minutes, depending on the distance being measured and the geometry of the satellite constellation. Four separate points had over 2 hours of data recorded and accordingly these points were also processed using OPUS.

DATA ADJUSTMENT

A total number of 234 vectors were observed and processed. Based on statistical indicators from the Trimble Geomatics Office processing software, there was one vector flagged as an outlier at the 95% confidence level. The outlier existed in vertical on a short leg measurement. Nineteen (19) baselines were measured 2 or more times with 51 points occupied once, 32 points occupied twice, 12 points occupied 3 times, and 2 points occupied 4 times during different sessions on the survey. After removal of trivial vectors the final network is comprised of 96 stations and 174 baselines. All data adjustment was performed using the Trimble Geomatics Office least squares adjustment software. An initial free adjustment was performed in NAD83 to check the overall quality of the GPS data and the nature of the control. The initial unconstrained (free) adjustment yielded baseline precisions which ranged from 1:99,300 to 1:2,716,000 with the 3 mile baselines falling in the 1:400,000 range or higher. Once the horizontal and vertical control was verified, subsequent adjustments were performed to arrive at the optimal solutions for each datum.

NAD83 (1996)

The initial free adjustment was performed holding HARN point 57-27 fixed horizontally with the vertical adjustment disabled. Coordinate values on the other HARN control stations were then checked against the published values. The network fit the published HARN values within a few hundredths of a foot. Because all data fit so well the other HARN-referenced stations from other counties were added to the network and a new adjustment performed. After each adjustment a comparison of adjusted coordinates vs. published values was made. By holding all of the existing HARN stations fixed, and the control that was adjusted to the HARN, the precision of the "free" adjustment degraded very little. The Johnson county control point was not held in the adjustment because it was felt that the HARN coordinate on this position was created from a readjustment on the Johnson county network and an existing HARN station was measured that was extremely close to this station.

Once we were satisfied with the horizontal adjustment, we locked the horizontal positions and concentrated on the vertical adjustment. The Geoid 03 Central zone was utilized to provide a model of the height of the Geoid. Adjustments were then performed locking on to the vertical control stations one at a time beginning with 57-27. Vertical control was added station by station with the elevations on the benchmarks being then checked against the published values. All existing vertical control was integrated into the network without creating any outliers.

A final adjustment of both horizontal and vertical was then performed. All of the horizontal control points except the Johnson county control point were held fixed in x and y and all vertical control were held fixed in z. This fully constrained adjustment solved for scale and rotation. In the final adjusted network, 100% of the adjusted vectors have an estimated error of x, y and z baseline precision after adjustment was between 1:97,367 to 1:3,229,862 with the 3 mile baselines again falling in the 1:500,000 range or higher. All of the processed data and error factors were computed using a 95% confidence level factor. The results are well in excess of the first-order precision. OPUS calculations were computed on four stations within the network. One of the positions was a known HARN station. The OPUS solutions compared to the final adjusted positions agreed within 0.03' $\pm$ in horizontal position and within 0.20' $\pm$ in vertical.

CONCLUSION

All measured point accuracies exceed first-order standards. The control point locations are within ($\pm$ 0.05 ft) horizontal position and within $\pm$ 0.10 ft. vertically for benchmark use.

Network Adjustment Report

Project : Jones5

User name	Gary Brown	**Date & Time**	9:02:16 PM 11/22/2004
Coordinate System	US State Plane 1983	**Zone**	Iowa North 1401
Project Datum	NAD 1983/1996 (Conus)		
Vertical Datum	NAD88	**Geoid Model**	Geoid 03 (Conus)
Coordinate Units	US survey feet		
Distance Units	US survey feet		
Height Units	US survey feet		

Adjustment Style Settings - 95% Confidence Limits

Residual Tolerances

To End Iterations : 0.000033sft
Final Convergence Cutoff : 0.016404sft

Covariance Display

Horizontal
Propagated Linear Error [E] : U.S.
Constant Term [C] : 0.00000000sft
Scale on Linear Error [S] : 1.96

Three-Dimensional
Propagated Linear Error [E] : U.S.
Constant Term [C] : 0.00000000sft
Scale on Linear Error [S] : 1.96

Elevation Errors were used in the calculations.

Adjustment Controls

Compute Correlations for Geoid: True

Horizontal and Vertical adjustment performed

Set-up Errors

GPS
Error in Height of Antenna : 0.015sft
Centering Error : 0.015sft