

**JEFFERSON COUNTY
GEODETTIC CONTROL NETWORK**

**QUALITY CONTROL
AND
QUALITY ASSURANCE
REPORT**

FOR

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January 2002

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JEFFERSON COUNTY GEODETIC CONTROL NETWORK
Quality Assurance & Quality Control Project Report

It was requested, by contract, that a quality assurance and quality control (QA/QC) of a geodetic survey of Louisville and Jefferson County be performed by FOWLER SURVEYS Inc. The contractor performing the geodetic survey was GRW Aerial Surveys, of Lexington, Kentucky.

1. In addition to the actual QA/QC work, assisting in the planning and technical scoping of the work was required. This consisted of writing technical specifications for the survey of the geodetic network and reviewing the final scope of work.
2. The project was divided into several categories. The first step in re-establishing a network was the field reconnaissance and planning. The existing monuments, along with existing control were recovered. It was decided that the 1986 monumentation would be recovered, visible "buddy point" azimuths established, and new positions determined. The network of monumentation established should be made as convenient as possible to the local surveying community. It should be noted it was decided that the positional accuracy of the station versus the "buddy point" azimuth mark should be the same. In addition to the 1986 monumentation, various existing monuments could be used for densification purposes. New horizontal and vertical positions would be determined on all existing monumentation, as referenced vertically to the North American Vertical Datum of 1988 (NAVD 88) and horizontally to the Kentucky State Plane Coordinate System, North Zone, HARN, NAD83/94.

The QA/QC activities consisted of reviewing the activities of the contractor and advising when necessary.

3. The next step of the geodetic survey was to establish new monuments or use the existing monumentation, with intervisible "buddy point" azimuth marks on an approximate two (2) mile interval grid. The new monuments consist of steel-reinforced concrete with an aluminum disk embedded in the top of the round concrete monument. In some instances, the disk was cemented in a drill hole in an existing structure such as a large headwall, abutment, etc. All of the new monumentation was set so that it was accessible and with open skies for the Global Positioning System (GPS) method of surveying. In addition to the establishment of the monuments on the two mile grid, a description of the monument and digital photographs, facing the disk vertically, then, north, south, east and west would be compiled for ease of recovery.

The QA/QC activities consisted of reviewing the activities of the contractor. Field review of monument installation was made, including verification of locations,

references, etc. Two monuments were randomly selected and a hole was excavated next to the monument to verify the depth of the monument and look at the quality of the monument. Steps were taken to insure that the position of the monuments would not be disturbed. It was found that the monuments were at the specified depth and extremely stable. In a few instances, it was found that the concrete around the aluminum disks had shrunk. It was brought to the attention of the contractor and those problems were corrected. Epoxy was placed around the disk, sealing out any water that could get under the disk and “freeze out” the disk. Almost all of the new monumentation was visited as part of the QA/QC.

4. A network design that would provide a two mile grid with plenty of cross checks on loops was performed by the contractor. Existing *High Accuracy Reference Network* (HARN) monuments within Jefferson County were used in the network adjustment. In addition to this control, other HARN monuments outside the county were used in order to provide a block type adjustment. At least eight bench marks of high accuracy were used in the network survey. Field checks were made between these HARN stations and bench marks by the contractor to insure that the constrained control was of adequate accuracy.

The QA/QC activities consisted of reviewing the activities of the contractor and advising when necessary.

5. After the monumentation, actual measurements, using GPS, were made, tying into the existing HARN monuments within Jefferson County and the surrounding area, blocking the area of adjustment between HARN monumentation. In addition to the HARN monumentation, vertical ties were made to the various 1st order bench marks, in order to reasonably model the local undulations of the geoid within Jefferson County.

The QA/QC activities consisted of reviewing the activities of the contractor and advising when necessary. Random field visits during the measurement process were made in order to actually see the field procedures and insure that they were following the specifications of the contract. In addition to the field review, actual field measurements were made between various monuments. (See measurement comparison sheet attached). These measurements were made with the Global Positioning System (GPS). As can be seen in the measurement comparisons, the accuracy of the two surveys checked very closely; especially considering the short lengths of the baselines that were used in the QA/QC checks. Several measurements were also taken between monuments that were not directly measured by the contractor. These measurements were made in order to check the validity of the network adjustment. These checked as good or better, in some cases, as a direct measurement.

A bench mark, established by the U.S. Army Corps of Engineers in 1970 was used as a QA/QC check. This vertical control monument, TTA-40 1970, was not used by the contractor. A survey tie, by conventional surveying methods, was

made from this bench mark to the new geodetic network, checking the contractor's elevation to GPS 86-15 AZI within 0.010 feet of their published elevation. Additionally, a check was made from the Continuous Operating Reference Station (CORS) at Taylorsville with a very long observation session to new station 18-2001. This provided a horizontal position check of about 0.07 foot in a north direction, 0.01 foot in an east direction and a vertical position check of 0.014 foot, comparing to the contractor's published position. In no instance did any measurement, that was checked, fall outside the 1:100,000 accuracy realm of the contract.

6. The submission of data by the contractor includes all the computations, adjustment iterations, a *.pdf file of the description card, along with a digital photo of the monument taken vertically, and facing north, south, east and west.

The QA/QC activities included reviewing the submitted data accuracy and completeness and comparing actual measurements that were made for a check. The actual network adjustment and measurement results were impressive. The results depict a very accurate check of the existing control that was used to constrain the network. Also, the actual network determined for the two mile grid appears very good. In reviewing the photographs, there seems to be quite a number of photographs that are dark. In some cases, the vertical pictures of the actual disk of the monument are too far from the disk and can not be read. Also, the disk or the top of the rod is blocked by grass. In one instance, two photographs were taken of the same direction. In another instance, the photographs were not taken at the monument location. This was brought to the attention of the contractor to correct the problem. At this date, the contractor is in the process of remedial action.

7. In summary, it appears that Louisville and Jefferson County will have an extremely accurate network for the local surveying community and horizontal /vertical control for their G.I.S. efforts. The contractor performing the actual geodetic survey met or exceeded the specifications of the contract.

Frank W. Fowler,
Kentucky PLS # 2095

22 January, 2002

**JEFFERSON COUNTY GEODETIC NETWORK MEASUREMENT COMPARISONS
(Published versus Field Measured)**

<u>From - To</u>	<u>Azimuth Difference (seconds)</u>	<u>Distance Difference (U.S. Survey Foot)</u>	<u>Elevation Difference (U.S. Survey Foot)</u>
SIMS to SPEER	03.1"	0.017'	0.010'
86-05 to I71T4 Az	04.0"	0.023'	0.020'
86-37 to 86-37 Az	02.0"	0.007'	0.025'
2001-36 to 2001-36 Az	01.0"	0.004'	0.035'
2001-11 to 2001-10 Az	0.00"	0.003'	0.010'
2001-10 to 2001-10 Az	01.0"	0.010'	0.050'
86-15 to 86-15 Az	02.0"	0.035'	0.000'
86-14 to 86-14 Az	03.0"	0.018'	0.000'
2001-28 to 2001-28 Az	02.0"	0.005'	0.010'
2001-37 to 2001-37 Az	02.6"	0.013'	0.043'
2001-31 to 2001-31 Az	02.7"	0.024'	0.010'
86-41 to BC 41-2001	01.1"	0.009'	0.013'
2001-18 Az to 86-41	00.4"	0.002'	0.006'
2001-18 to 2001-18 Az	01.0"	0.007'	0.015'

**AVERAGE DIFFERENCE=
Average Length=
AVERAGE LENGTH RATIO=**

02.0"

**0.013'
2,465'
1:189,600**

0.017'