A REVISIT TO

the **new twist** in corner recovery

It's been three years since my initial article titled "A New Twist to Corner Recovery" presented a methodology for use of the Geographic Coordinate Data Base (GCDB) positions to aid in field surveys of the sectionalized lands. Since that initial work, hundreds of practicing surveyors across the western states have attended seminars and implemented the technology. This article will document some changes to the software and share some empirical data evaluating the success of the procedures.

New Twist Technology Changes

At the time of the initial article, no clear standard file format existed for the transfer of "waypoint" data to handheld GPS receivers. The software presented (LX2Garmin) produced a file format supported by the Garmin handheld GPS models. This format creates a .grm file readable by many desktop software packages to transfer waypoints to/from multiple GPS receivers (including many "non-Garmin" models). However, the desktop support and compatibility of files were not fully realized until the adoption of the new XML implementation for GPS handhelds was created. The new format is recognized as a .gpx file, which has a much larger audience – initiated largely by recreational GPS enthusiasts, it has become a *de facto* standard for exchange of data between desktop mapping software and GPS handhelds.

An update to the software has been in use for about a year, renamed to LX2GPSX. The new version continues to support the .grm file, and adds support for the .gpx file format. The benefits of this format are great. For example, selected points or entire townships of GCDB coordinates can be translated into the .gpx format, simply dragging and dropping the resulting file onto the Google Earth icon (assuming the Earth application is installed) results in a 3D representation of the survey on the screen. Most other desktop mapping packages support the .gpx format as well as high-end, survey grade GPS controllers.

A minor revision has also been made to assign the "Reliability" values from the BLM's .LX file to the description field of the .gpx file. Most GPS handhelds provide for a review

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The GCDB expedites field procedures and improves field recovery rates in areas of historically poor corner recovery rates.

of these descriptions while navigating to a point. The reliability indicators are the standard error in Northing and Easting at 95% confidence, based on the fully constrained least squares analysis performed by the GCDB personnel to fit the survey data with the available control. This is not to certify the position, but rather to provide us an estimate of the quality of the coordinate position. Consider an 1884, stone monumented survey in a mountainous area – compared with a 1956, brass cap survey on gentle terrain – we expect differences in the quality of the position. The reliability indicator provides us with an estimate of this uncertainty in terms of Northing and Easting.

Changes in GCDB Access Procedures

At the time of the original article, the BLM's Land Survey Information System (LSIS) which is part of the geocommunicator website (www.geocommunicator.gov) had the capability to serve both the GIS file formats as well as the GCDB "flat file" format which is the native WinGMM-compatible data format. Shortly after the publication, the BLM instituted changes and no longer provides the "flat file" data in a self service manner as before. I've contacted numerous officials at the BLM at the national level requesting this service be restored, but it does not seem probable to expect this anytime soon. The LSIS at this time only serves the data in a GIS format, which sacrifices much information that is valuable to surveyors, the preferred data is in the "flat file" format. The officials at the national GCDB staff have indicated to me that they will personally handle any data requests by surveyors, as have many of the GCDB personnel at the various state offices – thank goodness for a little professional courtesy.

At the national level, Mr. Tim Woods (tim_woods@blm.gov) has been very responsive to data requests for GCDB 'flatfiles', simply send an e-mail describing the township, range, meridian and state. The file received will be a .ZIP file containing multiple individual files. One very strong word of caution – the files received from the national site are ".zipped" from a UNIX platform, because of this – the default Windows unzip utility will *not* correctly extract the files. Numerous other zip utility programs can handle the required conversion to convert the UNIX "linefeed" character to the Windows/DOS-compatible "carriage return + linefeed". One such example is the "unzip" utility that is built into WinGMM. The WinGMM software allows for a full exploration of the township data including the raw data abstracted from plats, control used in the analysis, data identifying the datum and SPC coordinate system used, etc. The full discussion of the GCDB data collection procedures and software is beyond the scope of this article, therefore links to further information are provided below. The LX2GPSX software is a utility to convert points from a WinGMM format to the .gpx format for desktop mapping and field navigation.

At the local level, data requests should be sent to the GCDB staff within the Branch of Cadastral Survey at the local state office. In my case, this is the New Mexico State Office located in Sante Fe. This is perhaps the best way to obtain the data, typically returned as an attachment to an e-mail response to your request. In most cases, the data received from the local office will not have the issue with the .zip file as described above, and is ready to use. The GCDB folks in Sante Fe, Denver, Phoenix, Cheyenne, Billings, Boise, Portland, Sacramento, Reno, Salt Lake City, Anchorage and Springfield, Virginia are very responsive and helpful. They above all appreciate the value of the data and are eager to share. Partnerships are building across the country, in some areas, the U.S. Forest Service and other agencies may have supplemental data that could be of great assistance.

The Ground Truth

In 2005, my colleague Dr. Steve Frank initiated a project involving students from several classes at New Mexico State University (NMSU) to assist with some initial surveying work needed at the newly emerging "Spaceport America" located in southern New Mexico near Las Cruces. Having a retracement task at hand involving over 20 sections of land and having an understanding of the GCDB project, Dr. Frank sought my assistance in obtaining the GCDB data. With the data obtained, we performed a datum transformation to get the data into NAD83 coordinates and loaded nearly 20 handheld GPS receivers to assist the students with navigating to the proximity of the record corners. The project has been a great success! Only a very small percentage of the corners were not recovered. Some monuments were found disturbed or out-of-the-ground, but overall, their recovery rate has been wonderful.

Once located, the students made carrier-phase static GPS measurements on each of the corners, continuously building a large adjustment set for Dr. Frank's final analysis. The network of measurements includes (at time of writing) 68 section and quarter-section corners, numerous horizontal and vertical control points plus several OPUS solutions of selected corners based on long occupations. To evaluate, Dr. Frank compared the found, retraced positions with the "record" locations provided by GCDB.

The township was resurveyed in 1939 by a very famous GLO surveyor named Bandy. Mr. Bandy's work appears in many of the western states and is typically found to be of outstanding quality. The measurements returned by Bandy, along with the available control are the foundation for the GCDB derivation of positions. Bandy's inherent random error was estimated at 115" in alignment and a distance error of 0.1 + 557ppm (approximately 4.5 links in 80 chains, or 1:1760). The township included 24 digitized control points.

The 95% confidence expected errors are reported at 10-13 feet. This survey, some 67 years later, returns the following results comparing actual position versus record GCDB positions:

T16S, R1W, NMPM		
Average distance found corner to GCDB:		15.46 feet
Number of corners found in sample:		68
Number found 0–10 ft:	7	10%
Number found 11–15 ft:	28	41%
Number found 16–20 ft:	26	38%
Number found 21–25 ft:	6	9%
Over 25:	1	1%

In another field example, Mr. Dan Muth shares results of a retracement using GCDB positions, summarized below:

T9NR30E, G&SRM, Arizona		
Average distance found corner to GCDB:		60.89 feet
Number of corners found in sample:		27
Number found 0–10 ft:	4	15%
Number found 11–20 ft:	4	15%
Number found 21–30 ft:	1	4%
Number found 31–40 ft:	3	11%
Number found 41–60 ft:	5	19%
Number found 61 –100 ft:	3	11%
Number found 100 – 155 ft:	7	26%

In this example, a greater variation exists; again this is reflective of the accuracy of the original surveys. Three boundaries and the township interior were surveyed in 1883 by Johnson, and the south boundary of the township was surveyed in 1876 by Foster. In this case, the new control is was added to reflect found corner positions in lieu of the digitized control, the coordinate positions in the vicinity improved by 20-50%, yet another surprise appeared in the northeastern corner of the township. Having no control for several miles, the new coordinate positions generated for this area show a greater uncertainty than the previous analysis indicated. Analysis of this mathematical evidence can yield very valuable information to assist with the corner recovery.

Dan tells me that these techniques have greatly expedited field procedures and is quite convinced that it has potential to improve field recovery rates in areas that have historically had poor corner recovery rates.

In Flathead County, Montana, another friend, Mr. Kurt Luebke, returns the following results comparing his found locations with the BLM's GCDB depiction:

Average distance found corner to GCDB:		39.17 feet
Number of corners found in sample:		22
Number found 0–25 ft:	7	32%
Number found 26–50 ft:	9	41%
Number found 51–85 ft:	6	27%

Interestingly, Kurt also makes a comparison with the same corner positions as represented in the local Flathead County GIS. This GIS system has widely been used as an example of the partnership building on the core data model updated with local records.

Average distance found corner to Flathead County GIS:		11.36 feet
Number of corners found in sample:		22
Number found 0–11 ft:	11	50%
Number found 11–20 ft:	8	36%
Number found 21–27 ft:	3	14%

As can be seen in our final example, much can still be done toward enhancement of the BLM's outstanding product, more on this in a later article.

Further information on the following topics may be found using the URLs listed below:

GCDB: www.blm.gov/gcdb/
LX2GPSX:
http://web.nmsu.edu/~kwurm
Surveying Engineering at NMSU:
www.nmsu.edu/~survey
Spaceport America:
http://spaceportamerica.com/home.html

Visit the site of Spaceport America: Google Earth to: 32.90995N 106.93957W)

Author note: To the students in Surveying Engineering at NMSU, Dr. Steve Frank, Mr. Dan Muth, Mr. Kurt Luebke, the Cadastral Surveyors and GCDB professionals of the BLM, GMM/WinGMM development team, and hundreds of practitioners – thanks!

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