THE American Surveyor
A Foot In The Past... An Eye To The Future
September 2008

Wildfires!

Calling the Shots in Colorado
Survey Accuracy in a GIS

A Visit to Applanix
Inertial navigation systems

Gear Review
SECO Poles and Prisms

the marriage of GIS & land surveying*

*no shotgun needed

Too often the GIS professional and the surveyor are at odds; a hoity-toity GIS guy looks askance at a muddy-booted surveyor who wants to pin him down on accuracy and boundary issues, and the surveyor gets exasperated with the GIS guy who's defining more parcels in an afternoon than he'll work on in a month, but who can't be bothered to think about metadata concerning monumentation or record survey information. Perhaps some surveyors have the sinking feeling that they missed the boat when it comes to GIS, that a new technology catering to measurement and boundary experts should really have added more to the bottom line of land surveyors than seems to be the case.

But things are changing. As GIS matures, survey grade accuracy is becoming more important and the value of a reliable boundary layer is increasingly obvious. This creates opportunities for land surveying firms, and Flatirons, Inc. of Boulder, Colorado is a good example of a company taking advantage. Flatirons (named for the Flatirons, an iconic mountain range above the city of Boulder) does "Surveying, Engineering & Geomatics" (and yes, they do list surveying before engineering). GIS design and implementation is a big part of their business, so this is a company that has had to think a lot about how surveyors and GIS types can work together. "GIS professionals aren't currently licensed," says J.B. Guyton, a licensed surveyor and CEO of Flatirons, "and the original authorship of GIS

>> By Angus W. Stocking, LS

Bob Thayer, LS, initializes the Trimble VRS Now rover.

documents is important to surveyors. Chad and the other young guys here are helping us bring together the facts on the ground with the relevant legalities, and creating GIS boundaries that can better withstand court challenges." 'Chad' is Chad McFadden, a senior project manager at Flatirons, who adds, "We're both talking about the same points, after all–if we can unify this, we'll be bringing the good things about surveying into GIS."

A recent project for the City of Wheat Ridge, Colorado gave Flatirons the opportunity to try something new: Gather GIS data at survey grade accuracy, in one pass. If things went well, Flatirons would be able to move ahead with projects involving boundary monumentation. As Guyton says, "We're figuring out how to marry these two disciplines, ancient and modern."

New Tech Makes Marriage Possible

Wheat Ridge was working on a critical component of their new GIS, the storm sewer layer. The existing system wasn't working. "They had paper map books," explains McFadden, "but they were more wrong than right. Most of the system information seemed to be in one guy's head, and he was too busy to update map books. So, we started to work on solutions."

Wheat Ridge was working in concert with Jefferson County 911 program and all of the county's cities. This made Flatirons' job easier, as the county had standardized on ESRI software, settled on layer schemes, and worked through datum issues. "We started by converting an old storm water map to GIS. There was no metadata, and it was very inaccurate.

Some points had been sketched in, some maybe surveyed, and some came from design–and there was no way to tell which was which. And it was incomplete; when we checked a few, we'd pop lids and find runs that weren't shown."

Obviously, new fieldwork was needed, and since the project would basically be an "as-built with a GIS deliverable," per McFadden, the work had to be to sub-centimeter horizontal accuracy. This was new territory. GIS fieldwork requires standardized collection of a great deal of data. Gathering techniques have to be efficient and, well, easy: with more than 2,500 intakes, manholes, and outflows in Wheat Ridge, all with multiple attributes, crews would have to move fast and there wouldn't be time to reinvent the wheel every day. By contrast, getting to sub-centimeter typically requires a certain fastidiousness, and the kind of confidence that comes with checking and rechecking. Typically, getting both types of information would take two passes–could Flatirons be fast and fastidious?

Not everyone thought so. "We came up with a method to capture all the data in one pass, at the required accuracy, and that's what we based our bid on. There were two other bidders who said our way wouldn't work. But with some help from Trimble, we proved them wrong."

The help from Trimble came in two forms: a Trimble® VRS Now™ Network RTK Service, and a custom file output from Trimble Geomatics Office™ (TGO) software, simplifying uploading of data into the ESRI GIS.

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> Senior Project Manager, Flatirons

Training and preparation were critical to the success of the project. Here, Heather Robinson works with digital attributes.

The VRS Now Service in Colorado is the first in the nation to feature low band radio, in addition to cellular telephony, as a way to establish links with reference stations. For Devin Kowbuz, another Project Manager at Flatirons, this was a decisive advantage. "In the city, packet data takes a back seat to voice," he explains. "This can affect our ability to stay connected." McFadden adds, "The low band is privately owned by Trimble, and it can't be trumped; we weren't tied to a cell phone company, or limited by their network. The low band is good everywhere VRS Now is accurate." Since base stations didn't have to be set up for RTK, crews could get right to work and about an hour and a half a day was saved, versus conventional RTK. "We bid the job knowing we had the advantage of VRS Now," says McFadden, "To hop out of the truck, grab a rod, and be surveying? That's impressive."

Another issue was data output. As sold, the Trimble Geomatics Office didn't quite meet project GIS data requirements. McFadden wanted a collection process that "forced crews to

Capturing digital photography of the points was a key component of the GIS portion of the project. This photo shows the area around the inlet to identify location.

gather the data," while limiting entries to a 'data dictionary' compatible with the GIS scheme. And since 2,500 nodes with multiple attributes (such as direction, invert, composition, and pipe size) generates a lot of data, he wanted a streamlined download procedure to save office time. "I talked to Trimble, and they sent a developer right to our office who wrote us a piece of custom code for TGO that allowed us to output a single table that integrated flawlessly into the GIS." The code also enforced the desired data collection routine and automated the lengthy collection process making it, if not easy, at least routine.

You're in Flow When Workflow Flows

Two additional issues complicated the survey workflow: Datum issues and the need for photographic documentation.

Relevant maps in the Wheat Ridge system had been created in two different datums–the oldest, in use for about 30 years, was an assumed coordinate system that had been replaced by a 'new city datum' based on NAD83/NAVD88. And to synchronize with the Jefferson County GIS project, Flatirons' project was on State Plane coordinates. "We had three coordinate systems to deal with," says McFadden, "so we created a cheat sheet to convert among the three, and we captured data in the city datum to take advantage of existing search coordinates." To avoid blunders, the city datum was used with truncated values–the 'millions' were removed. Field crews didn't have to think about datum; coordinate information was keyed into data collectors before the day's work. And McFadden used the Trimble TSC2™ data controller to convert to State Plane when needed.

Pictures helped city staff to verify work efficiently. "Wheat Ridge had a lot of people doing office analysis, and pictures made it easier for them to find

FI JOB #: 52492 COWR GIS PHASE IV STORM SEWER AS-BUILT **MANHOLE**
CREW: DATE: _____ TIME: _____ WEATHER: _____
RPT HR NW
OTHER:

PIC #1 NAME: _____
PIC #1 DIRECTION: NW N NE / W E / SW S SE

RTK PT #: _____

OF PIPES IN MH:
1 2 3 4
5 6 7 8

PIC #2 NAME: _____
PIC #2 DIRECTION: NW N NE / W E / SW S SE

N TYPE: RCP CMP VCP PVC
N SIZE: 12 18 24 36 48
N INV: _____

NW TYPE: RCP CMP VCP PVC
NW SIZE 12 18 24 36 48
NW INV: _____

NE TYPE: RCP CMP VCP PVC
NE SIZE 12 18 24 36 48
NE INV: _____

COWR MH# _____

W TYPE: RCP CMP VCP PVC
W SIZE: 12 18 24 36 48
W INV: _____

E TYPE: RCP CMP VCP PVC
E SIZE: 12 18 24 36 48
E INV: _____

SW TYPE: RCP CMP VCP PVC
SW SIZE: 12 18 24 36 48
SW INV: _____

SE TYPE: RCP CMP VCP PVC
SE SIZE: 12 18 24 36 48
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S TYPE: RCP CMP VCP PVC
S SIZE: 12 18 24 36 48
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NOTES:

At right is an example of the custom paper field book used for the City of Wheat Ridge. These forms ensured complete note taking and allowed for greater efficiency in the field.

points without the advantage of RTK. Our pictures of the exterior and interior of structures helped them to confirm and verify location. They could also do quality analysis from the office."

But photography posed its own issues: how do you capture a photo–5,000 of them–and routinely associate it with the right point? And how do you tie that photo to the GIS? Flatirons took two pictures at each structure: a shot of the view from the structure being located, and a shot of the structure itself, for example, a manhole interior. A digital camera was used, and configured to ensure it was providing unique alphanumeric identifiers for each shot. The identifiers and exterior shot direction were then entered as attributes in the data collection routine. Then, using the camera identifier as a key field, scripts were written that linked digital photos to GIS nodes via hyperlinks. But eventually, says McFadden, the photos themselves will be embedded in the GIS.

Data collection, datum adjustment, and photography created a complex workflow all by themselves, and there was still the actual physical work in the field to be considered. McFadden decided on three-person crews: one to pop lids and dip inverts, one to run the GPS, and one to take notes. If they happened to find a run that wasn't marked on city maps, crews were instructed to "chase it to the outfall."

Crews were trained in the desired sequence of field work and data recording, and one crew was used for nearly all the work for consistency. In the end, of 2,500 points gathered, only 20 were found to have entry errors.

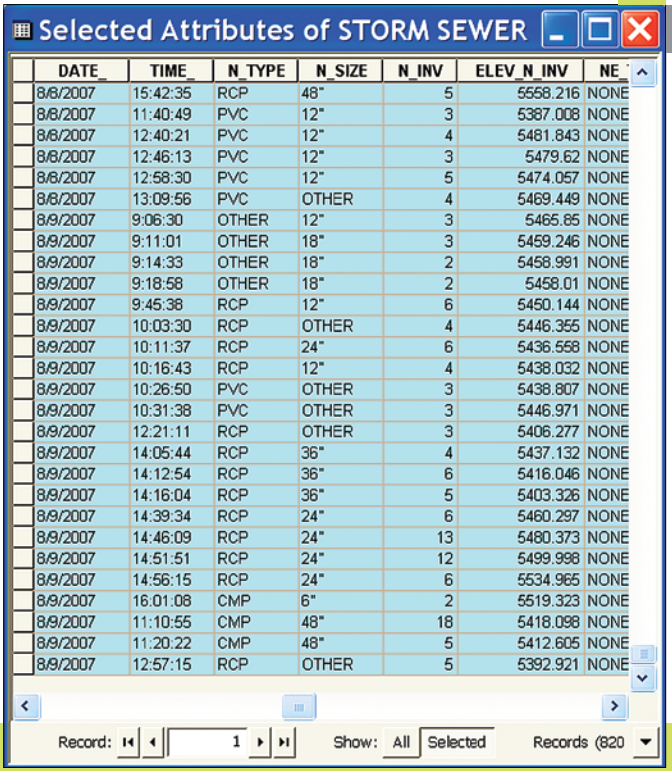
In addition to electronic data collection, each point was also recorded in handwritten notes. Field books for this job were custom printed versions of the data collector routine. "We had to ask ourselves what the acceptable level of risk was," says McFadden. "Field books are ingrained in surveying, and it will be up to each business to determine what's acceptable. If you don't use paper, will it be acceptable in court? Verdict: Probably. But it varies state to state, and we didn't want to take the chance. I will tell you this: Out of 2,500 captured points, we had 20 attribute entry errors, and in all 20 cases they were corrected from field books. So we definitely saved revisits."

Why Wouldn't You Want That?

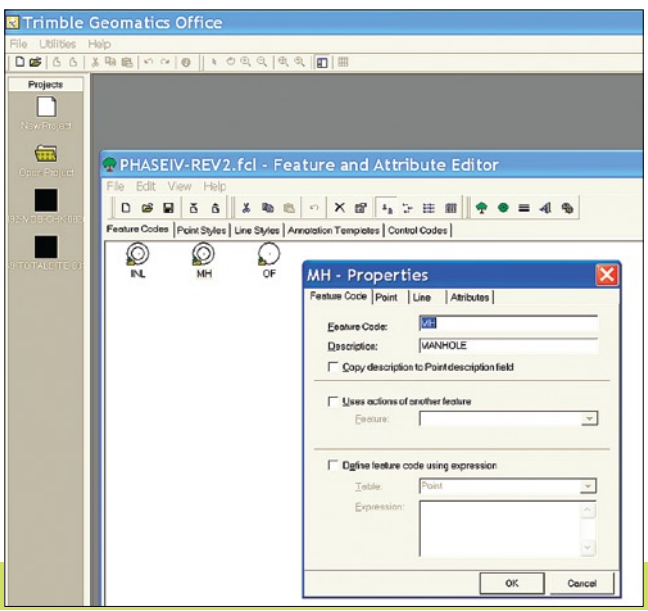
McFadden sums up succinctly: "I can give you real-time data at one centimeter by three centimeter accuracy, with GIS attributes, in one pass: why wouldn't you want that?" Guyton agrees: "If we can bring survey accuracy to GIS, then we can help a GIS map to be recorded and deposited in the same way maps are. We can help limit litigation and liability, and avoid animosity between the professions."

This project has led to similar work in other municipalities, and Flatirons is in the midst of an ongoing project that includes location of boundary and right-of-way monuments. Indeed, since the technology now demonstrably exists to put surveyors–with their specialized knowledge and unique certifying privileges–into GIS where, arguably, they should have been from the beginning, the question has to be asked: "Why wouldn't you want that?"

Angus Stocking worked for 17 years as a land surveyor in several different states. Nowadays he writes professionally (see www.ColoradoWriting.com) and specializes in surveying and related topics. And also, of course, he is occasionally called to settle survey-related happy hour disputes.



The final product: A GIS database of survey information, as viewed in ArcGIS.



In addition to the use of paper field books, a feature code library created in Trimble Geomatics Office allowed field crews to digitally record notes.