

The Global Positioning System: A Case Study



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How GPS was used for a "Corridor" type survey and why it was so advantageous.

During the winter of 1986-87, the New York State Department of Transportation (NYSDOT) moved forward with plans to replace 19 aged bridges spanning the historic Erie Canal in Niagara County New York. These bridges were spread out between the City of Lockport and Village of Middleport in Niagara County and included both urban and rural settings. As with most such projects, aerial mapping of the sites and their approaches were the first steps needed.

One of the aftermaths of the tragic New York Thruway bridge collapse, which happened in early 1987, was naturally an increased sense of urgency in completing such rehabilitation projects. Early in the review of the survey needs for this work, it was known that although there was substantial control monumentation available in the City of Lockport, once outside the City limits both vertical and horizontal control became scarce. Alternatives were sought to speed the completion of the design phase.

The horizontal ground control for photogrammetry was required to meet a 1:25,000 closure, and the control needed to be secure for future use through the design and build phases of the projects as well as for supporting long-term survey needs in

the area. Early in the process, it was determined that normal terrestrial surveying between existing monuments (NGS) would involve traverses running between 11 and 15 miles to include three existing first-order control marks that had been recovered. In order to meet the closure specifications it was estimated that up to five crew weeks would be needed, together with supporting office time and administration to complete the effort. The price tag for that work was placed at around \$19,000.

The New York State Department of Transportation hired our firm, Frank T. Tripi and Associates, P.C. (FTA), under a Term Agreement for Surveying Services to perform the surveys. We had twice earlier worked together with NYSDOT to perform Global Positioning System surveys for geodetic monument densification in the southern tier of western New York. GPS became available to the private sector of this country's surveying community in 1983, and has been blossoming ever since. Currently, there are several manufacturers of GPS equipment as well as service companies who will come and observe the data from your control points and provide a detailed report to you listing the locations in whichever format you prefer (latitude/longitude, state plane, etc.).

During the initial planning meeting, which was held on February 11, 1987, NYSDOT directed FTA to determine the feasibility and cost of, first, establishing new geodetic control monuments in the project areas using GPS, and then completing the photo control work using the resulting densified control scheme.

I was selected as the Project Manager for FTA and began by making a thorough review of current literature and contacting as many GPS firms as possible to gather data to establish a Scope of Services for that portion of the work and determine costs for the effort. Ultimately, five firms were identified for discussions and were sent Requests For Proposals based upon the developed Scope.

Initially, three NGS Control Marks were identified and recovered to supply the necessary references for the GPS work. They were "Upper," "Gasport," and "Medina," all first-order NGS points. NYSDOT had used monument Medina in the past and considered it suspect because of the difficulties previously encountered with it. These three monuments form a rough east-west line, in the middle of which were the various project sites. It was decided to set 10 "Monument Pairs" along the Erie Canal to maximize the advantage of the GPS. The advantage was defined as the amount of time and money that could be saved in the residual work needed after the GPS was complete to place all the control traverses where needed.

The high precision capabilities are not available through any other technique.

The Monument Pair concept results from the GPS technology and differs from the previous method of setting a primary mark and azimuth mark. With the pairs, both monuments are considered primary, both were set with subsurface marks and multiple references, and both were observed with equal care to establish New York State Plane Coordinate System, West Zone coordinates. That way, any surveyor could occupy either end of the line formed by the intervisible pairs, sight the other, and begin with reliable coordinates and grid azimuth. This concept is applicable to most "Corridor" type surveys where it would be advantageous to establish known baseline references at road crossings, river crossings, railroads, etc. Depending upon the specific GPS chosen for the work, reliable azimuths can be established between points as close together as a quarter mile.

A procedure was established to ensure efficiency during the GPS portion of the project. It was my responsibility to select the initial 20 monument sites, considering the parameters required for GPS observa-

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