

## Height Modernization Lets Michigan's Positioning Network Go Vertical

*Accurate positioning information is necessary for highway project surveying and is a key input for many intelligent transportation systems applications. But establishing a network of vertical reference points is a technical challenge. Michigan DOT recognized the potential time and cost savings that might be realized through research into development of a network of vertical data reference points. The benefits of this research extended to many users beyond the agency.*

### Problem

In 2000, Michigan led the nation in designing and building a statewide network of permanent reference stations - Global Positioning System (GPS) receivers that provided precise latitude and longitude data. The Continually Operational Reference System (CORS) served as a network of control points and generated tremendous savings in time and effort, both for surveying and construction.

However, a fundamental limitation of GPS technology does not allow traditional CORS reference stations to deliver accurate data on the third axis - elevation of the Earth's surface. As a result, Michigan DOT continued to expend significant time and labor to determine elevations on construction projects. In addition, work done to calculate elevation points (benchmarks) for a site would often need to be redone years later for rehabilitation or other follow-up work.

### Approach

Michigan DOT joined a nationwide movement toward height modernization led by the National Oceanic and



*Michigan DOT took highly accurate vertical measurements after installing each survey monument.*

Atmospheric Administration ([www.ngs.noaa.gov/heightmod](http://www.ngs.noaa.gov/heightmod)). Height modernization involves the creation of a network of permanent reference points where each is individually established to provide accurate vertical reference data. Michigan DOT required vertical referencing data accurate to within a centimeter, matching the horizontal accuracy provided by CORS.

The agency's multiphase height modernization plan included adding highly accurate height data to some existing CORS stations to create 3D marks and also constructing new marks with vertical data only. A major task included leveling, or measuring and calculating the accurate height of each of these monuments.

Given the initial expenses of height modernization, another critical need was to determine the most appropriate distribution of vertical and 3D marks. States participating in this movement had taken different approaches for geographic coverage, and

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### Project Information

**Project Name:** Height Modernization, Phases III and IV

**Start Date:** May 2008

**End Date:** Fieldwork completed September 2009; data verification and integration forthcoming

**Total Cost:** \$1.2 million

**Cost Sharing:** 20% MDOT, 80% FHWA through the SPR, Part II, Program

### MDOT Project Manager

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Michigan DOT sought an approach that would provide the best return on its investment.

## Research

In the pilot phases of this research, Michigan DOT adapted CORS to accommodate vertical data. In the first deployment of height modernization, the agency blanketed Wayne, Oakland, Macomb and St. Clair counties in southeast Michigan with marks to provide vertical reference. While dense coverage in this region was highly successful, using this method to cover the entire state was viewed as cost-prohibitive.

Michigan DOT decided for the next phases of the research to focus on the state's corridors of significance, setting vertical marks every 3 km and 3D marks every 7.5 km to 10 km. Working with Surveying Solutions, Inc., of Standish, Michigan, the agency established vertical reference points along 1,200 miles of highway. Including all the phases of research, the agency estimates that 18 to 20 percent of the corridors of significance have been upgraded with vertical data.

## Results

Michigan's height modernization research and the resulting program are unmitigated successes. The strategic placement of marks along corridors of significance was useful for planning and surveying Michigan DOT projects and for facilitating the use of GPS-assisted machinery during construction.

A number of users beyond Michigan DOT are benefiting from height modernization in the state. This includes

city and county road commissions and drain commissions that use the marks to create accurate 3D as-built drawings as well as farmers who now use CORS and the state's vertical reference data for a variety of GPS-assisted agricultural vehicles. Michigan's data also feeds into a national database that provides critical information to federal agencies on environmental planning and management.

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*"The strategy of applying height modernization to Michigan's corridors of significance helped us save money and cover more ground in less time."*

*Andrew Semenchuk, P.S.  
Project Manager*

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## Value

The ultimate proof of height modernization is the savings it delivers. A Michigan DOT design survey project using the new vertical data can realize a 30 to 50 percent cost savings for leveling, control, mapping and photogrammetry. One case study of a five-mile photogrammetric control project showed completion of leveling in four days compared with an estimated five weeks using conventional techniques. After a project using height modernization data goes to construction, Michigan DOT realizes further benefits: painless, repeatable georeferencing for contractors, inspectors and the construction staking team. And since the permanent vertical control can be used years later during rehabilitation, height modernization proves to pay off again and again for Michigan DOT. ■

## Michigan Department of Transportation



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Information on this research project is available online at [www.ngs.noaa.gov/heightmod/Michigan.shtml](http://www.ngs.noaa.gov/heightmod/Michigan.shtml).