
2013 NATIONAL HEIGHT MODERNIZATION PROGRAM PARTNER MEETING

Frankfort, Kentucky

April 30 – May 1, 2013

Final Report

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EXECUTIVE SUMMARY

Representatives from the National Geodetic Survey (NGS), state agencies, and universities met in Frankfort, Kentucky to discuss the progress to-date and future plans for the National Height Modernization Program (NHMP). Many states are working to maintain and improve the vertical component of their “active” and “passive” geodetic networks. Whether through real-time networks, Continuously Operating Reference Stations (CORS), leveling projects, Global Positioning System (GPS) campaign surveys or Light Detection and Ranging (lidar) data collection, there are many ongoing efforts to continue implementing the NHMP. Additionally, NGS continues to develop models, tools, and guidelines to help prepare states for the transition to the new vertical datum in 2022. The NGS Gravity for the Redefinition of the American Vertical Datum (GRAV-D) project continues to make significant progress, and states expressed interest supporting the effort as well. All participants greatly benefitted from this meeting and agree it should continue annually or bi-annually.

BACKGROUND

The National Height Modernization Program (NHMP) developed as a grassroots effort in the late 1990s. At one time in the mid-2000s, the NHMP received up to \$10 million each year in congressionally-mandated funding to assist states in updating and maintaining the "height" component of the National Spatial Reference System (NSRS). While Congress no longer supports the state efforts, NGS has continued to receive annual support to administer the National Height Modernization Program.

The NHMP partner meeting allowed state and university partners to explain the issues and challenges they encounter when determining accurate heights. Thus, the partner meeting was a crucial event because NGS needs to ensure that current and future models and tools will meet the needs of our stakeholders. Exchanging this information significantly improves the effectiveness of the NHMP, whose goal of cost-effectively determining accurate elevations is significant to the Nation because accurate heights are needed to support many areas of public investment including construction projects, floodplain determination, evacuation routes, and ecosystem restoration.

AGENDA AND PRESENTATIONS

The meeting was organized as a series of sessions over the course of one and a half days. First, states provided updates on the progress and challenges implementing their local programs. NGS then provided updates on products, services, and new tools. Other complementary sessions focused on communicating benefits and metrics, administration of real time networks, and development of lidar applications. The final agenda and presentations from these sessions are included as appendices.

SESSION 1: STATE PARTNER UPDATES

All states who received Height Modernization grants in the past were invited to give a presentation updating everyone on their respective programs. Generally, each state shared information regarding how each state defines

Height Modernization (i.e. what are the program goals/ activities), how Height Modernization activities are funded, recent accomplishments, and primary challenges.

All state and university programs vary with their focus between passive network, GPS projects, leveling, real time networks, maintaining databases, and lidar collection. Despite these variations, nearly all programs continually face challenges regarding funding. Partners shared examples of alternative funding sources including, but not limited to Department of Transportation’s State Planning and Research (SPR) Program administered through the Federal Highway Administration (FHWA) and partnerships with emergency response and agencies. Another common point of discussion surrounded when and how states switched their real time network coordinates to the most recent realization of NAD 1983.

A brief summary of the presentations is included below, and the presentation materials, if available, are included in the appendices.

Table 1: Session 1 Presentation Summary

ORGANIZATION	PRESENTER	SUMMARY
California Spatial Reference Center	John Canas	The California Spatial Reference Center (CSRC) was established in 2000. CA experiences significant land motion, but many surveyors would prefer a static datum. Multiple reference frames and epoch dates are in use. There is a California Real Time Network that provides that backbone for the geodetic control network, and it is supported largely through contributing members.
Colorado Department of Transportation	Jonathan Kobylarz and Pamela Fromhertz	Colorado Height Modernization funding focused on outreach efforts, and now a team is forming within state to research past projects and guide future projects. Major challenges include understanding quality of currently published heights and the preponderance of mountainous terrain.
Illinois State Geological Survey	Sheena Beaverson	Illinois Height Modernization Program successfully secured funding through the FHWA SPR Program, and it has focused on installing a leveled geodetic network and acquiring lidar across the state. Recently, it has developed a geodetic database accessible online.
Indiana Department of Transportation	Eric Banschbach	Indiana Height Modernization has included state-wide aerial photography and lidar. In 2010, a state-wide CORS Network was launched, and pilot projects for GPS campaign surveys have been explored. SPR funds have recently been secured, and the current geodetic network will be evaluated and published in an online database.
Kentucky Transportation Cabinet	Danielle Kelly	The Kentucky Transportation Cabinet owns and operates a state-wide CORS network, and the Height Modernization Program will help complete and maintain the network. Kentucky has an online database available to the public, and it will continue to invest in its aerial photography and elevation data program (KYAPED).
Louisiana State University	Joshua Kent	The Center for GeoInformatics (C4G) and the Louisiana Spatial Reference Center (LSRC) lead Height Modernization efforts in Louisiana, including a real-time network, transportable “CORS 911,” monitoring of subsidence, supporting absolute sea-level change monitoring, and conducting user forums.

ORGANIZATION	PRESENTER	SUMMARY
Michigan Department of Transportation	Shawn Roy	Michigan Department of Transportation operates a state-wide real time network, and it updated its coordinates to the latest realization of NAD 83 in January 2013. The program is also planning small leveling products to update heights near stream gauges.
Minnesota Department of Transportation	Dave Zenk	In Minnesota, all High Accuracy Reference Network (HARN) marks have been leveled to 2nd order Class I or better, and 90% of RTN/CORS sites have been leveled to or near. Future plans include re-leveling old lines and densifying the entire state's geodetic control to a 6 or 3 mile grid spacing. Minnesota leverages students to help accomplish many tasks.
New Jersey Department of Transportation	John Knapp	New Jersey has been leveling to its CORS across the state, but recovery from Hurricane Sandy has changed planning priorities. Efforts have been made to revisit coastal bench marks and establish GPS positions. There is significant concern whether or not vertical positions have changed as that would impact flood insurance and the raising of re-built homes.
North Carolina Geodetic Survey	Gary Thompson	North Carolina highlighted the wide spectrum of benefits that geodetic control supports including floodplain mapping, emergency management and subsidence monitoring. NC operates an RTN network and provides updates to users via Twitter. The state is also beginning a state-wide digital ortho-imagery project for acquisition in urban counties. Additionally, the program continues outreach efforts, develops instructional videos, and intends to collect gravity to support GRAV-D.
South Carolina Geodetic Survey	Matt Wellslager	South Carolina has completed Height Mod surveys in 80% of counties, and attempts are made to occupy historical tide gages during Height Mod surveys conducted in the South Carolina Coastal Region in an attempt to improve VDatum. South Carolina also maintains a real time network, and intends to create a database for geodetic control.
University of Southern Mississippi	David Mooneyhan	Height Modernization in Mississippi has been developing since 2000 and was designated as the Gulf Coast Spatial Reference Center in 2007. The real time network (RTN.USM.EDU) was rolled out in 2012, and efforts will continue to upgrade the network and expand the number of partners. A visiting scientist program is being explored and continued advocacy remains a priority.
Washington Department of Natural Resources	Dave Steele	In Washington, the real time network covers 95% of the state, and if both funded and maintained by local and state partners. The planned geodetic network across the state is only 50% complete and funds to complete are currently not available. The Spatial Reference Center of Washington has recently been renamed the Washington Geodetic Survey, and they are establishing new goals.
Wisconsin Department of Transportation	Diane Arendt	Wisconsin maintains a real time network, but the state is considering implementing a nominal recovery fee to offset operational costs. The state is completing monumentation, GPS, and leveling in the final geographic regions (north and northeast). A statewide leveling adjustment was completed in the past year, a new monumentation preservation program has been very successful, and outreach efforts continue.

SESSIONS 2 AND 3: NGS PRODUCTS AND SERVICES UPDATES

NGS shared a series of presentations that outlined the updated NGS strategic plan, discussed topics relevant to the horizontal datum (e.g. CORS and OPUS), and highlighted products and projects relevant to the vertical datum (e.g. GRAV-D and Geoid 12A). The next presentation focused more directly on Height Modernization with an overview of the Program's strategic plan and a detailed presentation based on data from Minnesota. A brief summary of the presentations is included below, and the presentation materials, if available, are included in the appendices.

Table 2: Sessions 2 and 3 Presentation Summary

PRESENTATION TITLE	PRESENTER	SUMMARY
National Geodetic Survey Ten-Year Strategic Plan	Juliana Blackwell	NGS revised its ten year strategic plan this past year, and it now encompasses all the work NGS currently performs in addition to the projects envisioned for the futures. Its goals and objectives include a broad range of activities including geodesy, coastal mapping, and administrative functionality like project management.
CORS, OPUS and Geometric Datums	Neil Weston	Today, the Continuously Operation Reference Station (CORS) Network is a multi-nation, multi-purpose, and cooperative endeavor. The Online Positioning User Service (OPUS) has a suite of operational products and additional products that are still under development. The transition plan to the new datum can begin as early as 2016.
Geoid Modeling Update	Dan Roman	The most recent gravimetric geoid model is USGG2012, and the most recent hybrid geoid model is GEOID12A. Newly developed error grids will help identify where additional observations could help improve the next geoid model. Gravity for the Redefinition of the American Vertical Datum (GRAV-D) continues to progress as airborne data has been collected over 25% of the planned project area. The Geoid Slope Validation Survey of 2011 (GSVS 11) was completed in support of this effort, and another survey (GSVS 14) is planned for Iowa.
National Height Modernization Program Strategic Plan Update	Christine Gallagher	The National Height Modernization Strategic plan closely parallels to the NGS ten year plan to aid with implementation. The Project Management paradigm that NGS is building will also help achieve the goals of the plan. Additionally, and internal height modernization "steering committee" will coordinate the technical expertise and pilot projects across the agency, and the continuing Height Modernization Coordination meeting will provide a monthly opportunity to share those internal plans and discussions with our partners and the public.
Implementing Height Mod in Minnesota	Dave Zenk	The presentation showed the progression of the horizontal and vertical networks in Minnesota as they have developed in the past century. Then, the shifts between different datums and realizations were also shown, and the presentation concluded that are tools and models as continuing to get significantly better over time.

SESSION 4: COMMUNICATING BENEFITS AND METRICS

Sheena Beaverson, from the Illinois State Geological Survey, lead the session to discuss how the National Height Modernization Program and its partners can collectively better communicate benefits of related activities. Communicating benefits, perhaps augmented with the tracking of metrics, can help make a strong case to decision-makers that the program is deserving of continued financial support.

Previous discussions on this topic have been anecdotal, and some states have tried to capture specific stories. Additionally, many state partners and NGS participated in the 2012 Esri Map Gallery Display, and one poster attempted to “rank” states by the number of modern leveled heights, high accuracy GPS observations, and count of total vertical bench marks.

Generally, there was interest in finding ways to access more information from internal NGS databases. For example, adding attributes to shapefiles or providing the number of OPUS solutions in each county on a monthly basis. There was also the reiteration that a professional assessment of the socio-economic benefits of Height Modernization Programs can be indispensable. There were still many discussions to build on at the conclusion of the session, so the following action items were identified and assigned:

- NGS will share the count of OPUS solutions by county on a regular basis (Neil Weston lead).
- NGS will meet with partners to discuss a way for the public to more easily access information from internal NGS databases, e.g. increasing attributes in shapefiles and increasing the products/datasets available in GIS compatible formats (Christine Gallagher lead).
- Illinois Height Modernization Program will organize a group submission to the 2014 Esri Map Gallery Display.

SESSION 5: REAL TIME NETWORKS

Neil Weston, from the National Geodetic Survey, presented a brief overview of best practices for RTN operators. Topics discussed included base station spacing and monitoring, reference frames, the role of CORS, adjustments, as well as data formats and processing.

Then, state partners shared their own experiences and challenges in operating a network and ensuring that users were not “re-selling” their data. Unexpected challenges have arisen with the expansion of agricultural users – both individual farmers and farm equipment vendors. The consensus was that strengthening user agreements, with the assistance of legal counsel, is the best way to proceed. States with more experience offered to share sample agreements with other partners.

SESSION 6: LIDAR AS HEIGHT MODERNIZATION

Danielle Kelly and Dan Farrell, from the Kentucky Transportation Cabinet, presented an overview of their Kentucky Aerial Photography and Elevation Data Program (KYAPED). Given funding constraints, efforts will focus on lidar acquisition on a county by county basis. Kentucky’s specifications were modeled after similar U.S. Geological Survey and Federal Emergency Management Agency documents.

Breaklines have to be developed using a variety of techniques including traditional survey methods as well as mobile mapping and stationary scan datasets. The combination of techniques has proved very used in challenging project areas where there are steep areas without room for workers to survey safely. Additionally, efforts are being made to find comparable projects and show the cost savings of these technologies.

SESSION 7: TRAINING AND UPDATES FOR NEW TOOLS

Finally, NGS shared a series of presentations that highlighted recent or upcoming improvements to products and tools. While each tool was only discussed briefly, NGS will continue to develop resources and training to support their use. Specifically, NGS shared information about GIS tools and a new data explorer, its latest transformation tool, DSWorld, datasheets, OPUS-NET, and an RTN analysis tool. A brief summary of the presentations is included below, and the presentation materials, if available, are included in the appendices.

Table 3: Session 7 Presentation Summary

PRESENTATION TITLE	PRESENTER	SUMMARY
New Geodesy GIS Tools at NOAA's National Geodetic Survey	Michael Dennis	NGS is increasing its use of GIS internally; as a result, more datasets and tools will be GIS compatible. New GIS products include the NGS Data Explorer (released to production); a new datasheet shapefile (released in beta); and a new NGS GIS Toolbox (not yet released to beta). The new Toolbox includes five Toolsets: GPS tools, HTDP, leveling tools, NGS grids, and velocity vectors. The long-term goals is to fully leverage the power of GIS in geodesy.
GEOCON Software Preview	Dave Zenk and Michael Dennis	Since re-adjusting original measurements to a new coordinate system is not always practical, gridded transformation algorithms can be used to convert coordinates. GEOCON converts NAD83 (HARN) to NAD83 (2007). Then, GEOCON 11 converts NAD83 (2007) to NAD83 (2011). Complications arise since some states have more than one HARN realization, and the "quality" of the transformation varies around the country. Additionally, the beta release only uses Bluebook format as the input/output.
DSWorld Demo	Pamela Fromhertz	DSWorld is a tool to explore information in the NGS databases using Google Earth. There have been some recent enhancements including the ability to display all varieties of control (i.e. passive, OPUS-DB, CORS), mark recovery, photo submission, and Geoid12A accuracy estimate map.
NGS Database/Datasheet and OPUS Updates	Neil Weston	NGS is transitioning to an Oracle database, so all datasheet applications must be converted. Other small changes are ongoing, but Oracle conversion is the focus. OPUS-Net is already being used to compute CORS coordinates, and it will be fully deployed in next few months. RTN Analysis tool is still under development, and its further development/release may be delayed due to staffing changes.

ACKNOWLEDGMENTS

NGS thanks the Kentucky Transportation Cabinet, and Danielle Kelly in particular, for hosting the meeting. Further thanks to GRW Aerial Surveys, Inc. for providing snacks and refreshments, especially Wolfgang Ziegler. Additional thanks to NGS Director, Juliana Blackwell, for continuing to champion the National Height Modernization Program and supporting this meeting, in particular. Similarly, thank you to all NGS employees who continue to support the Program and helped plan and coordinate the meeting. All participants at the meeting are commended for their tremendous support and contributions to make this meeting successful. Finally, thank you to all partner states and organizations; your accomplishments continue to lead the Height Modernization Program and showcase its tremendous benefits.

*Christine Gallagher, Acting Height Modernization Program Manager
May 20, 2013*

APPENDICES

APPENDIX A: ATTENDEES

Given numerous travel restrictions across the federal and state government, it was determined that the 2013 NHMP partner meeting would include an option to attend remotely. Many attendees, especially from NGS, took advantage of this option. Table 1 reflects the number of in-person and remote participants, and Table 2 lists that meeting attendees and their organizations.

Table 4: Count of attendees and method of participation

		Day(s) attended		
		1 & 2	1 only	2 only
method	in-person	23		1
	remote	11	8	1

Table 5: Meeting participants (Alphabetical by organization, the last and first name)

Name (First)	Name (Last)	Organization	Attended	Day
John	Russell	Alabama Depart. Of Transportation	remote	1 & 2
John	Canas	California Spatial Reference Center	in-person	1 & 2
Jonathan	Kobylarz	Colorado Depart. Of Transportation	in-person	1 & 2
Dave	Stewart	Colorado Depart. Of Transportation	remote	1 only
Paul	Hartzheim	Geodetic Directions, LLC	in-person	1 & 2
Wolfgang	Ziegler	GRW Aerial Surveys, Inc.	in-person	1 & 2
Joe	Mullins	HMB Professional Engineers, Inc	in-person	1 & 2
Sheena	Beaverson	Illinois State Geological Survey	in-person	1 & 2
Michael	Blumhoff	Illinois State Geological Survey	in-person	1 & 2
Janet	Thornhill	Illinois State Geological Survey	in-person	1 & 2
Eric	Banschbach	Indiana Depart. Of Transportation	in-person	1 & 2
Dan	Farrell	Kentucky Transportation Cabinet	in-person	2 only
Danielle	Kelly	Kentucky Transportation Cabinet	in-person	1 & 2
Brad	Rister	Kentucky Transportation Center	in-person	1 & 2
Joshua	Kent	Louisiana State University	remote	1 & 2
Randy	Osborne	Louisiana State University	remote	1 & 2
Shawn	Roy	Michigan Dept of Transportation	in-person	1 & 2
Bryce	Larsen	Montana Dept of Transportation	remote	1 & 2
David	Campbell	Morehead State University	in-person	1 & 2
Sarah	Wilson	Morehead State University	in-person	1 & 2
John	Knapp	New Jersey Dept. of Transportation	remote	1 only
Juliana	Blackwell	NOAA's National Geodetic Survey	in-person	1 & 2
Michael	Dennis	NOAA's National Geodetic Survey	remote	1 & 2
Mark	Eckl	NOAA's National Geodetic Survey	remote	1 only
Joe	Evjen	NOAA's National Geodetic Survey	remote	2 only
Pamela	Fromhertz	NOAA's National Geodetic Survey	remote	1 & 2
Christine	Gallagher	NOAA's National Geodetic Survey	in-person	1 & 2

Name (First)	Name (Last)	Organization	Attended	Day
Brett	Howe	NOAA's National Geodetic Survey	remote	1 only
Ross	Mackay	NOAA's National Geodetic Survey	remote	1 & 2
Aida	Polite	NOAA's National Geodetic Survey	remote	1 & 2
Dave	Rigney	NOAA's National Geodetic Survey	remote	1 only
William	Stone	NOAA's National Geodetic Survey	remote	1 & 2
Neil	Weston	NOAA's National Geodetic Survey	in-person	1 & 2
Daniel	Winester	NOAA's National Geodetic Survey	remote	1 only
Dave	Zenk	NOAA's National Geodetic Survey	in-person	1 & 2
Gary	Thompson	North Carolina Geodetic Survey	in-person	1 & 2
Matt	Wellslager	South Carolina Geodetic Survey	in-person	1 & 2
Dick	Woods	South Carolina Geodetic Survey	in-person	1 & 2
Gary	Jeffress	Texas A&M University-Corpus Christi	remote	1 only
David	Mooneyhan	University of Southern Mississippi	in-person	1 & 2
D. David	Moyer	University of Wisconsin-Madison	remote	1 & 2
Mark	Huber	US Army Corps of Engineers	remote	1 only
Dave	Steele	Washington Depart. Of Natural Resources	remote	1 & 2
Diane	Arendt	Wisconsin Depart. Of Transportation	in-person	1 & 2

APPENDIX B: AGENDA

National Height Modernization Partner Meeting

Kentucky Transportation Cabinet Conference Center

Frankfort, Kentucky

April 30 – May 1, 2013



Agenda

Day 1: Tuesday, April 30

- 8:30-8:45 **Welcome and introductions**
- Juliana Blackwell, Director, NGS
- 8:45-10:20 **Session 1A: State updates**
- Kentucky: Danielle Kelly, Kentucky Transportation Cabinet
 - Michigan: Shawn Roy, Michigan Department of Transportation
 - Mississippi: Dave Mooneyhan, University of Southern Mississippi
 - New Jersey (remote): John Knapp, New Jersey Department of Transportation
 - North Carolina: Gary Thompson, Chief, North Carolina Geodetic Survey
 - South Carolina: Matt Wellslager, South Carolina Geodetic Survey
- 10:40-12:05 **Session 1B: State updates continued**
- California: John Canas, California Spatial Reference Center
 - Illinois: Sheena Beaverson, Illinois State Geological Survey
 - Colorado: Jonathan Kobylarz, Colorado Department of Transportation & Pam Fromhertz (remote), Colorado Geodetic Advisor
 - Indiana: Eric Banschbach, Indiana Department of Transportation
 - Washington (remote): Dave Steele, Washington Department of Natural Resources
- 1:20-2:00 **Session 1C: State updates continued**
- Minnesota: Dave Zenk, Minnesota Geodetic Advisor (on behalf of Rick Morey)
 - Wisconsin: Diane Arendt, Wisconsin Department of Transportation
- 2:00-3:45 **Session 2: NGS products and services update**
- Juliana Blackwell, Director, NGS
 - Neil Weston, Spatial Reference System Division Chief, NGS
 - Dan Roman (remote): Research geodesist, NGS
- 4:00-4:30 **Session 3: Implementing Height Modernization**
- Session 3A: Implementing the Height Mod Strategic Plan*
- Christine Gallagher, Acting Height Modernization Program Manager, NGS
- Session 3B: Implementing Height Mod in Minnesota*
- Dave Zenk, Minnesota Geodetic Advisor, Implementing Height Mod in Minnesota
- 4:30-5:00 **Session 4: Communicating Benefits & Metrics**
- Sheena Beaverson, Illinois State Geological Survey

Day 2: Wednesday, May 1

- 8:30-9:20 **Session 5: Real time networks**
- Neil Weston, Spatial Reference System Division Chief, NGS
 - Panel discussion
- 9:20-10:00 **Session 6: Lidar as Height Mod**
- Danielle Kelly, Kentucky Transportation Cabinet
 - Group discussion
- 10:20-10:35 **Session 1D: State updates continued**
- Louisiana: Joshua Kent, Louisiana State University
- 10:15-11:45 **Session 7: Training and updates for new tools**
- Session 7A: NGS GIS Tools*
- Michael Dennis (remote), Geodesist, NGS
- Session 7B: GEOCON Software Preview*
- Dave Zenk, Minnesota Geodetic Advisor
 - Michael Dennis (remote), Geodesist, NGS
- Session 7C: DSWorld Demo*
- Pam Fromhertz (remote), Colorado Geodetic Advisor
- Session 7D: NGS Database, Datasheet, and OPUS Updates*
- Neil Weston, Spatial Reference System Division Chief, NGS
- 11:55-12:05 **Day 2 Closing**
- Juliana Blackwell, Director, NGS

APPENDIX C: PRESENTATIONS

Presentations, when available, were posted to the following web page:

<http://www.ngs.noaa.gov/heightmod/PartnerMeetingPresentations.shtml>