National Enhanced Elevation Assessment (NEEA)

Part 1: Project Management Plan

Today's highly successful 3DEP program for nationwide QL2 LiDAR was a direct result of the findings and conclusions of the NEEA that USGS called "the most comprehensive benefit/cost analysis ever performed for any layer of The National Map."

This is the first of several articles by the author that explains how this assessment was conducted.

Prime contractors for USGS Geospatial Products and Services Contracts expect challenging task orders. As the Senior Project Manager for all of Dewberry's USGS contracts since 1998, I received a truly challenging task order in June of 2010 for what ultimately became known as the National Enhanced Elevation Assessment (NEEA). The task order, named *Assessment of the Business Requirements and Benefits of Enhanced National Elevation Data*, tasked Dewberry to conduct a study to develop and refine requirements and to identify implementation alternatives and associated benefits and costs for a National Enhanced Elevation Data Program that meets Federal, State and other national business uses and needs. The study's findings were expected to establish a baseline understanding of national business uses, needs and associated benefits, for LiDAR and/or other technologies to enhance the responsiveness of USGS and partner agency programs, and to inform the design of an enhanced future program that balances requirements, benefits and costs at a national scale. Little did I realize at the time the demanding level of effort required for the next 18 months to meet this challenge.

The Statement of Work (SOW) included five major tasks, each with sub-tasks:

1. Documentation of Business Uses (BU's) and inventory of existing and planned elevation data:
   a. Design a methodology for collecting Federal and State BU's and perform collection of BU information
      i. Design an interview guide to document BU's
      ii. Propose how to best quantify BU benefits
      iii. Conduct design meetings for Government review and comment
      iv. Perform the collection of Federal BU's
      v. Receive and incorporate USGS-provided State BU's
      vi. Perform the collection of non-governmental BU's (added later)
   b. Design a methodology to inventory and aggregate significant existing Federal and State elevation data
   c. Develop a geodatabase to capture and store BU and elevation inventory data
2. Aggregation and analysis of BU and elevation inventory:
   a. Aggregate and analyze requirements data
   b. Determine business benefits
   c. Determine the costs
3. Assess emerging data collection technology and related issues
   a. Evaluate technology trends
   b. Evaluate IFSAR technology
   c. Evaluate coastal zone considerations
   d. Identify key risks that could hamper a consistent national implementation

BY DR. DAVID F. MAUNE

Table 1. NEEA's pre-defined Business Uses (BU's) and user-defined Functional Activities (FA's)

Business Uses (BU's)	Examples of Functional Activities (FA's)
BU#01 Natural resources conservation	Soils and wetland conservation; erosion control; rainfall penetration. Modeling of biological and ecological systems.
BU#02 Water supply and quality	Watershed assessment for protected water supplies. Runoff into streams, sedimentation analysis. Non-point source pollution modeling.
BU#03 River and stream resource management	Stream channel analysis and mapping. Stream bank erosion analysis.
BU#04 Coastal zone management	Analysis of coastal erosion and inundation. Hurricane storm surge and wind damage modeling and assessment.
BU#05 Forest resources management	Forest health assessment. Determination of standing inventory of forest resources. Analysis of carbon stocks for trade. Harvest systems planning.
BU#06 Rangeland management	Assessment of rangeland health. Mapping for soil erosion potential due to grazing.
BU#07 Wildlife and habitat management	Determination of wildlife habitat conditions based on forest stand profile and vegetation structure.
BU#08 Agriculture and precision farming	Farm pond design. Irrigation system design. Detailed site analysis to support precision farming. Analysis of farm sedimentation and runoff.
BU#09 Geologic resource assessment & hazards mitigation	Geologic mapping and analysis. Seismic fault analysis. Landslide hazard mapping and assessment.
BU#10 Resource mining	Open mine volume computations. Stockpile analysis. Environmental impact assessment and site restoration.
BU#11 Renewable energy resources	Assessment of roof tops for solar energy potential. Analysis of wind energy potential and planning of turbine placement on wind farms. Low head power potential for hydropower.
BU#12 Oil and gas resources	Site selection for wells and facilities. Construction planning. Pipeline routing. Environmental impact assessment and mitigation.
BU#13 Cultural resources preservation and management	Discovery and analysis of Native American and other historical cultural sites. Site protection and preservation planning.
BU#14 Flood risk management	Flood risk modeling and mapping of riverine and coastal areas. Dam/dike/levee safety analysis.
BU#15 Sea level rise and subsidence	Modeling the effects of sea level rise or subsidence.
BU#16 Wildfire management, planning & response	Determination of forest fuel and fire susceptibility. Fire behavior modeling to support wildfire suppression activities. Wildland/urban interface building identification. Post fire analysis to determine landslide prone areas.
BU#17 Homeland security, law enforcement and disaster response	Line of sight analysis in urban areas. Flood risk analysis resulting from acts of terrorism. Landslide risk assessment in urban areas.
BU#18 Land navigation and safety	Route selection for new roads. Slope analysis for smart cars. GPS navigation visualization.
BU#19 Marine navigation and safety	Nautical charting. Bathymetric measurements of near-shore submerged coastal topography.
BU#20 Aviation navigation and safety	Determination of in-flight hazards and path obstructions. Aeronautical charting. Runway construction and repair.
BU#21 Infrastructure and construction management	Water, sewer and powerline planning and analysis. Stormwater modeling. Cut and fill analysis for earth-moving. Building site analysis. Road infrastructure; dams, reservoirs and levees.
BU#22 Urban and regional planning	Park design and planning. Zoning. Building footprint mapping. Regional transportation planning. Virtual city creation.
BU#23 Health and human services	Malarial epidemiology based on standing water and terrain conditions.
BU#24 Real estate, banking, mortgage, insurance	Risk assessment for flood insurance. Building permit compliance.
BU#25 Education K-12 and beyond	Development of 3-D visualizations to help students understand the Earth they live on.
BU#26 Recreation	Trail and vista site planning. Orienteering. Golf course planning. Ski slope modeling/analysis. Recreational lake design. Hiking maps and guides.
BU#27 Telecommunications	Telecommunication tower site selection. Design of radio and radar systems. Interference analysis. Path profiles.

4. Technology infrastructure alternatives
   a. Develop enterprise information technology infrastructure alternatives
5. Develop program implementation scenarios
   a. Develop implementation scenarios
   b. Evaluate implementation scenarios

The task order was administratively managed by Tim Saultz and Gail Dunn of the National Geospatial Technical Operations Center (in Rolla, MO), with Greg Snyder of the USGS National Center (Reston, VA) as USGS' technical point of contact. For many weeks, Dewberry held face-to-face meetings with Larry Sugarbaker and Greg Snyder of USGS to better understand USGS' terminology and expectations and to reach consensus on approaches to be taken. In the beginning, I didn't understand what USGS meant by Business Uses, program implementation scenarios, or enterprise information technology infrastructure alternatives. I had a vague idea of the importance of the geodatabase which ended up being the key to the success of the NEEA. Working closely with Larry and Greg on nearly a daily basis until the spring of 2012, I came to appreciate their thoughtful planning in laying out their vision of what this study should entail.

Dewberry prepared numerous technical and cost proposals before the task order was officially negotiated and signed by USGS on 8/18/10. The Project Management Plan alone took several months to prepare, with numerous iterations; that plan alone was 113 pages long.

One of our key planning decisions pertained to the identification of 27 pre-defined Business Uses (BU's) to be linked to hundreds of user-defined Functional Activities (FA's), consistent with guidance in **Table 1**, developed as part of our Project Management Plan.

Other important planning considerations included the identification of five Quality Levels for enhanced elevation data as summarized in **Table 2**, and five update frequencies (annually, 2-3 years, 4-5 years, 6-10 years, and >10 years).

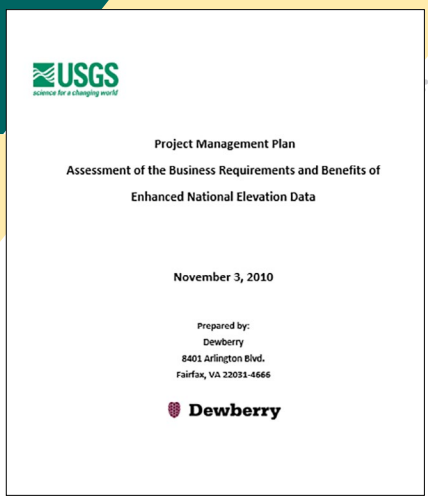
> "I am extremely proud that the careful planning for the NEEA by USGS and Dewberry resulted in today's 3DEP program with consistent elevation specifications for QL2 lidar nationwide, except for QL5 IfSAR in Alaska."

Note: With publication of the *USGS Lidar Base Specification* V1.2, USGS modified its RMSEz specification to 10 cm for both QL1 and QL2 LiDAR to be consistent with the *ASPRS Positional Accuracy Standards for Digital Geospatial Data* (ASPRS, 2014).

The following items were documented in our final Project Management Plan,

Table 2. NEEA's pre-defined elevation data Quality Levels (QL's)

Elevation Quality Levels (QL)	Source	Horizontal Resolution Terms			Vertical Accuracy Terms	
		Point Density	Nominal Pulse Spacing (NPS)	DEM Post Spacing	Vertical RMSEz	Equivalent Contour Accuracy
QL 1	LiDAR	8 pts/m^2	0.35 m	1/27 arc-sec ~1 meter	9.25 cm	1-ft
QL 2	LiDAR	2 pts/m^2	0.7 m	1/27 arc-sec ~1 meter	9.25 cm	1-ft
QL 3	LiDAR	1 – 0.25 pts/m^2	1 – 2 m	1/9 arc-sec ~3 meters	≤18.5 cm	2-ft
QL 4	Imagery	0.04 pts/m^2	5 m	1/3 arc-sec ~10 meters	46.3 cm – 139 cm	5 – 15 ft
QL 5	IFSAR	0.04 pts/m^2	5 m	1/3 arc-sec ~10 meters	92.7 cm – 185 cm	10 – 20 ft



USGS
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Project Management Plan

Assessment of the Business Requirements and Benefits of Enhanced National Elevation Data

November 3, 2010

Prepared by:
Dewberry
8401 Arlington Blvd.
Fairfax, VA 22031-4666

Dewberry

accepted on 11/03/1010, which included the following major sections:

- Introduction, including project scope, project approach, communications and risk management
- Task 1 plans for collecting Business Uses, including the Sharepoint site, frequently asked questions (FAQs), Survey Monkey questionnaire, examples of user benefits and methods for estimating cost savings, plans for agency interviews/workshops, inventory of elevation data, and development of the master geodatabase
- Task 2 plans for aggregation and analysis of user requirements data, user benefits, and costs
- Task 3 plans for evaluation of technology trends, IFSAR technology, evaluation of coastal zone considerations, and identification of key risks
- Task 4 plans for development of enterprise IT infrastructure alternatives
- Task 5 plans for development and evaluation of program implementation scenarios
- Project schedule and deliverables
- Appendix A explained 17 FAQs to assist Survey Monkey questionnaire responders and promote consistency from questionnaire responses
- Appendix B provided examples of financial and other benefits, methods for estimating financial and other tangible benefits, operational improvements and customer service improvements
- Appendix C was the Survey Monkey questionnaire to be used for initial information gathering
- Appendix D was the sample guide used for workshops and/or interviews with 34 Federal agencies, 50 states, and 13 non-governmental organizations that validated 602 mission-critical Functional Activities
- Appendix E included instructions to agency Points of Contact (POCs), risk mitigation strategies, and deliverable checklists

I believe the entire project was successful largely because of our thorough up-front planning. Future articles will include details on how the various SOW tasks were conducted for the NEEA and how the NEEA provided the blueprint for today's 3D Elevation Program (3DEP).

Dr. David Maune is an Associate Vice President at Dewberry Consultants LLC where he is an elevation specialist and manages photogrammetric, LiDAR, IFSAR and acoustic mapping projects for USGS, NOAA, FEMA, USACE, and other federal, state and county governments. He authored the National Enhanced Elevation Assessment (NEEA) report referenced in this article. He specializes in independent QA/QC of LiDAR data produced by others and is perhaps best known as the editor and primary author of the 1st and 2nd editions of *Digital Elevation Model Technologies and Applications: The DEM Users Manual* published by ASPRS. He is a retired Army Colonel, last serving as Commander and Director of the U.S. Army Topographic Engineering Center (TEC), now the Army Geospatial Center (AGC).