Federal Geographic Data Committee
Elevation Theme Strategic Plan

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Elevation Theme National Geospatial Data Asset Datasets		Dataset Manager Agency
1	1 meter Digital Elevation Models (DEMs) - USGS National Map	DOI-USGS
2	1/3rd Arc-second Digital Elevation Models (DEMs) - USGS National Map	DOI-USGS
3	5 meter Alaska Digital Elevation Models (DEMs) - USGS National Map	DOI-USGS
4	Digital Elevation Models from NOAA/NCEI	DOC-NOAA
5	Global Multi-Resolution Terrain Elevation Data	DOI-USGS
6	Lidar Point Cloud - USGS National Map	DOI-USGS
7	MultiBeam Bathymetric Data Base (MBBDB)	DOC-NOAA
8	National Flood Hazard Layer (NFHL)	DHS-FEMA
9	NCEI Marine Trackline Geophysics Database	DOC-NOAA
10	NOS Hydrographic Surveys Collection	DOC-NOAA
11	Shuttle Radar Topography Mission (SRTM)	DOI-USGS
12	U.S. Coastal Lidar Elevation Data - Including the Great Lakes and Territories, 1996 – present	DOC-NOAA

Elevation Theme definition: Elevation is the measured vertical position of the earth surface and other landscape or bathymetric features relative to a reference datum typically related to sea level. These points normally describe bare earth positions but may also describe the top surface of buildings and other objects, vegetation structure, or submerged objects. Elevation data can be stored as a three-dimensional array or as a continuous surface such as a raster, triangulated irregular network, or contours. Elevation data may also be represented in other derivative forms such as slope, aspect, ridge and drainage lines, and shaded relief.

The definition above, while descriptive, lacks context for why elevation data is so very important to our nation. The Elevation Theme team recognizes that the acquisition and management of quality elevation

data is essential to put actionable geospatial data in the hands of decision-makers to inform decisions in such high risk areas as emergency planning, climate adaptation and resilience, economic investment, infrastructure development and habitat protection. Elevation data are also critical inputs for modeling to prepare for and respond to hazards such as hazardous weather, flooding, storm surge, and landslides. Accurate elevation data can foster understanding and help people mitigate the negative effects of these challenges, protect biodiversity and habitats, and characterize areas of the United States that have never been well mapped, such as the Arctic. Mapping to acquire high quality terrestrial, coastal, ocean and Great Lakes elevation data – from the mountains to our shorelines to the nearshore and bathymetric depths of our oceans – is more essential today than ever before. People must have accurate and up-to-date elevation data in order to make informed choices on land and off, whether for the safety of residents, environmental protection, security or economic decisions.

3D Nation: The Vision

The Elevation Theme team has adopted a vision of the U.S. as a 3D nation, where we contribute to making communities more resilient and the U.S. economy more competitive by working to build a modern, accurate elevation foundation from our highest mountains to our deepest oceans. Coordinated through the Federal Geographic Data Committee Elevation Theme, 3D Nation unites terrestrial and coastal/ocean mapping agencies in common purpose to achieve an authoritative national geospatial foundation in support of national mapping needs.

To be competitive in the 21st century, our Nation must be GPS-enabled and ready with 3D maps to capitalize on all that GPS positioning accuracies offer. The United States is GPS-enabled, but we need maps and elevation data accurate to centimeters rather than hundreds of meters. Critical decisions are made across our Nation every day that depend on elevation data, ranging from immediate safety of life and property to long term planning for infrastructure projects. The quality and timeliness of these decisions depends upon actionable information supported by accurate elevation data. The Elevation theme recognizes that current data and resources to acquire heights and depths nationwide are inadequate or insufficient to meet the challenge. The member agencies of the FGDC 3D Nation Elevation Subcommittee have recognized and accepted this challenge and have developed programs that if fully implemented would result in national datasets sufficient to meet these needs.

3D Nation: What

These highly precise and demanding needs require geodetic control network improvements that the *Geodetic Control Theme* is working toward, along with improvements to the foundational topographic and bathymetric datasets and derived products managed by Elevation Theme agencies. The overall 3D Nation goal is to provide the most accurate foundation for mapping our changing world. In some instances, data more than 100 years old, with accuracy errors in the hundreds of meters, need to be replaced with data that are accurate to within centimeters of their real-world positions. 3D Nation is intended to ensure access to an accurate, routinely updated, continuous elevation surface from the land to the coasts to the depths of our oceans and Great Lakes.

Based upon past evaluations of the benefits of elevation data to society, an expanded 3D Nation capability will reap significant returns for a broad set of applications and user groups. A number of recent economic benefits studies have documented the tremendous value of elevation data to the

Nation across multiple sectors: military, research, civil, and commercial. The need for elevation data has also long been underscored in many national strategy statements and studies such as the National Ocean Policy, the National Strategy for the Arctic Region, the Climate Action Plan and the National Enhanced Elevation Assessment (NEEA). NEEA, conducted in 2011, is a particularly good resource that captured national level requirements for enhanced elevation data, estimated the benefits and costs of meeting those requirements, and evaluated multiple national enhanced elevation program scenarios.

3D Nation: How

The Elevation Theme agencies are leading on improving the national mapping foundation, making incremental advances within current resources by coordinating the topographic and bathymetric mapping data contributions of the agencies and partners in the 3D Elevation Program (3DEP), the Interagency Working Group on Ocean and Coastal Mapping (IWG-OCM), and relevant elevation data activities of other Federal, state, academic and private sector groups. The concept of 3D Nation serves as a unifying goal for all these efforts, providing a consistent set of standards and objectives for an authoritative National geospatial foundation to support national mapping needs.

Working to achieve a 3D Nation will provide an updated foundation for mapping our natural resources, transportation systems, businesses, public and private lands, and ecosystems in a changing world. We envision a mobile-ready, GPS-enabled nation in the 21st Century where knowledge of geographic location energizes the economy, saves lives, reduces fuel consumption, conserves valuable resources and reduces the cost of government services. The FGDC 3D Nation Subcommittee seeks to ensure that mapping in the United States is of the highest quality, repeatable, and consistent everywhere. We hope to pave the way for modern technologies to add that third dimension to our maps whether they are on our ships, in our cars, in our hands, or viewed on the Internet. Now is the time to focus on the Nation's elevation data, in support of our critical infrastructure, rich natural resources and sensitive ecosystems.

3D Nation: Who

For terrestrial elevation data, 3DEP fills the primary leadership role for data acquisition, interagency coordination, and partnership development. The IWG-OCM fills a similar role for bathymetric data of our coasts and oceans. There is significant collaboration between the two groups, resulting from shared goals and overlapping member agencies. The agencies comprising 3DEP and the IWG-OCM are the primary implementers of this strategic plan, working with states, localities, tribes, the private sector, academia and others. Those federal partner agencies include:

Bureau of Land Management
Bureau of Ocean Energy Management
Defense Installation Spatial Data Infrastructure
Department of Homeland Security
Department of Transportation
Federal Aviation Administration
Federal Emergency Management Agency
National Aeronautics and Space Administration
National Geospatial-Intelligence Agency
National Oceanic and Atmospheric Administration

National Park Service
National Science Foundation
Natural Resource Conservation Service
Office of Surface Mining Reclamation and Enforcement
Tennessee Valley Authority
United States Census Bureau
United States Army Corps of Engineers
United States Coast Guard
United States Fish & Wildlife Service
United States Forest Service
United States Geological Survey
United States Navy

Elevation Theme Strategic Plan in support of a 3D Nation:

Goal 1:
Increase the *quantity* of comprehensive elevation data that can be incorporated into the building of a 3D Nation.

Objective 1.1
Improve on the existing good collaboration among federal agencies, states, academia, private sector and other partners on elevation data acquisition by identifying and addressing obstacles to coordination.

Anticipated Outcomes
Collaborating on elevation mapping data requirements and acquisition will create more opportunities to "**MAP ONCE, USE MANY TIMES.**" Ensuring awareness of existing publicly available data will aid in effective planning and avoid duplication of efforts. The goal is to be more efficient with taxpayer dollars and eliminate redundant data collections in order to more effectively achieve the vision of the United States as 3D nation.

Action 1.1.1
All Elevation theme agencies commit to using the publically available U.S. Federal Mapping Coordination Site, with -- at minimum -- annual updates of mapping data needs and plans, to increase opportunities for collaboration and reduce redundancies, while meeting Office of Management and Budget Circular A-16 policy and Government Accountability Office directives for federal sharing of geospatial data acquisition plans.

Action 1.1.2
Mapping agencies plan their current and outyear acquisition schedules utilizing the U.S. Federal Mapping Coordination Site and sites such as the U.S. Interagency Elevation Inventory (repository of existing high-accuracy topographic and bathymetric elevation

data) to evaluate overlapping or adjacent requirements for potential partnering on geospatial data acquisition and to avoid duplication of effort.

Action 1.1.3
Elevation Theme Community members continually conduct outreach to non-federal partners for transparency and to increase awareness of and use of the sites by all interested participants.

Objective 1.2
Develop and adopt best practices for federal elevation data acquisition.

Anticipated Outcomes
Communicating with a broad range of stakeholders about multi-year federal mapping plans and improving public awareness of federal mapping coordination tools (i.e. web mapping applications such as the U.S. Federal Mapping Coordination Site and the U.S. Interagency Elevation Inventory) will increase stakeholder support and participation in elevation data acquisition, and ensure that the partnership process with non-federal organizations is open and fair. Improved engagement with stakeholders and end users will ensure that NGDA datasets meet the critical business needs of the geospatial user community.

Action 1.2.1
Comprehensively document user needs for elevation datasets and design the program to meet user needs and maximize return on investment.

Action 1.2.2
Pursue active engagement at the executive and operational levels via interagency forums focused on elevation mapping, including the 3DEP Executive Forum and Working Group and the Interagency Working Group on Ocean and Coastal Mapping.

Action 1.2.3
Move from acquisition planning on a project-by-project or ad-hoc basis towards a systematic, multi-year plan to accelerate partnerships and funding for high quality nationwide elevation coverage, building upon the 3DEP phased approach towards a unified Federal strategy for elevation data acquisition.

Action 1.2.4
Refine, communicate, and implement best practices to work towards a unified Federal plan for elevation mapping through 3DEP, the National Coastal Mapping Strategy, and the IWG-OCM.

Action 1.2.5
Seek to improve non-federal awareness and participation in elevation data acquisition and multi-year planning.

External Factors, Challenges, and Opportunities

Challenges: resources and funding for achieving nationwide coverage of high-quality elevation data; agreement among agencies and partners on best practices; some continued data acquisition outside of federal coordination channels that results in lost opportunities for funding partnerships and improved efficiencies; no widely-accepted standards yet for emerging technologies (i.e. topobathymetric lidar); some continued data acquisition that does not meet federal standards, which results in data investments that do not contribute to national holdings; agency and partner awareness of the U.S. Federal Mapping Coordination Site; utilization of Federal Mapping Coordination Site and other data inventory sites for research and planning. Opportunities: Collaboration in gathering elevation data, shared resources. Frameworks for sharing information on best practices already exist, such as the 3DEP Executive Forum and Working Group, and the IWG-OCM. Some agencies are already using Representational State Transfer (REST) services to push automatic updates for upcoming mapping project plans to the U.S. Federal Mapping Coordination Site, which keeps the information on the site continually up-to-date. Implementing this technology at more agencies that acquire elevation data will improve the utility of the site.

Goal 2:

Increase the *quality* of elevation datasets available for incorporation into the building of a 3D Nation.

Objective 2.1

Lead or facilitate the development and coordination of geospatial standards for elevation data. Increase awareness and use of federal geospatial standards throughout the geospatial community through FGDC standards endorsement opportunities, NGDA Elevation Theme Community webpage, education and outreach.

Anticipated Outcomes

Use of recommended standards will facilitate the development, sharing, and use of geospatial data. Elevation mapping technologies such as lidar are evolving quickly, industry standard file formats change, and data quality in terms of accuracy and spatial resolution has increased dramatically in recent years. The development of standards and specifications addresses these changes and promotes consistency across surveys. Recent examples of useful standards include the topographic lidar quality levels established by the USGS Lidar Base Specification, the bathymetric lidar quality levels established by the IWG-OCM draft National Coastal Mapping Strategy, the NOAA National Ocean Service Hydrographic Surveys Specifications and Deliverables document, and the American Society for Photogrammetry and Remote Sensing (ASPRS) specification for lidar point clouds delivered in LAS format. Greater awareness and use of elevation standards by the universe of elevation data acquirers and processers will lead to more interoperable, multi-purpose data for a wider range of users.

Action 2.1.1
Identify existing standards or facilitate the development of new standards within the Elevation Theme Community that enhance interoperability of elevation data, are national in scope, and reduce technical obstacles to sharing data for multiple uses, including web data services for elevation data.

Action 2.1.2
In consultation with the geospatial community, evaluate and refine those standards for consideration as FGDC standards per the FGDC Standards Reference Model criteria.

Action 2.1.3
Initiate the FGDC Standards Approval Process for any standard deemed appropriate to pursue to promote widespread adoption and adherence to standards throughout the geospatial community.

Action 2.1.4
Publicize elevation data standards used by federal agencies that may not meet the FGDC endorsement bar, e.g. topographic/topobathymetric lidar quality levels.

Objective 2.2
Evaluate new types of elevation data collected by Federal agencies that are currently not included the NGDA elevation dataset for addition to the NGDA portfolio to promote the managing of these important data as a capital asset.

Anticipated Outcomes
As new mapping technologies emerge, federal agencies are collecting elevation data using a multitude of sensors mounted on a variety of platforms, across both land and nearshore environments. The value of taxpayer-funded elevation datasets acquired and maintained by federal agencies is recognized, so that those datasets receive same/similar care as existing NGDA datasets. This in turn will lead to greater elevation data availability and accessibility for users broadly.

Action 2.2.1
Maintain the health of the Elevation Theme by broadening the types of topographic and bathymetric datasets collected by federal agencies to be considered for inclusion as an NGDA elevation datasets. Evaluate datasets against the FGDC Steering Committee criteria for NGDA Dataset endorsement, and pursue the addition process where appropriate.

Examples of additional datasets to explore initially include the U.S. Army Corps of Engineers datasets below:

USACE National Coastal Mapping Program Bathymetric and Topographic Lidar Point Clouds and DEMs	DOD-Army
Joint Airborne Lidar Bathymetry Technical Center of Expertise an interagency collaboration in airborne coastal mapping and charting, bathymetric lidar, and topo-bathymetric lidar	DOD-Army/Navy DOC-NOAA DOI-USGS
USACE Inland Electronic Navigation Charts	DOD-Army
USACE Navigation Channel 3D Framework	DOD-Army
USACE eHydro Navigation Channel Data	DOD-Army
USACE Geospatial Repository and Data Management System (GRiD) for all USACE lidar point cloud data	DOD-Army
USACE Photogrammetry Technical Center of Expertise for photogrammetry and topographic lidar	DOD-Army

Action 2.2.2
Conduct an LMA on each newly added NGDA dataset to understand whether/where gaps exist in management of that dataset for attention.

Objective 2.3
Continue to evolve and improve key datasets based on documented needs from federal, state, and local agencies, tribes, and private and not-for profit organizations.

Action 2.3.1
Use the documented user requirements in NEEA to guide elevation data acquisition, standards on data accuracy, data refresh cycle decisions, prioritizing geographic areas of interest, and the development of value-added geospatial products.

Action 2.3.2
Conduct a NEAA follow-on study to continue capturing end user needs for and benefits from coastal bathymetric data, and to identify requirements for re-mapping after nationwide coverage of high quality elevation data is achieved.

External Factors, Challenges, and Opportunities
Challenges: resources; different agency approaches to data acquisition standards.
Opportunities: sharing of best practices; increasing public awareness of standards.

Goal 3:
Ensure that the NGDA elevation datasets are robustly managed, meet user needs, and are readily available to the public through federal geospatial programs.

Objective 3.1
Using the Elevation Theme NGDA Lifecycle Maturity Assessment (LMA) scores as a guide, work to improve the overall health of every NGDA dataset and strengthen the NGDA management plans.

Anticipated Outcomes
The infrastructure and governance for managing NGDAs in the Elevation Theme is well-established and continually improved to efficiently manage and maintain accessibility to increasingly large volumes of elevation data and derived products. All Elevation Theme NGDAs should measure 5/5 for every LMA category, including for such high priority areas as data reliability, maintenance and archive, which translate into increased data accessibility to meet the needs of users.

Action 3.1.1
For any NGDA with LMA scores below 5/5, identify what is impacting performance (e.g. insufficient resources, IT issues, processes are not well-defined or updated) and determine steps needed to improve scores (e.g. elevate importance and need for resources to agency leadership, leverage another agency's process, ensure that the IT infrastructure is sufficient to enable data accessibility and utility).

Action 3.1.2
Define Federal roles and responsibilities in providing effective management and access to existing NGDAs to ensure that portfolio management requirements and other federal data management policies are met.

Objective 3.2
Leverage the existing strategic plans and initiatives that support each of the NGDA Elevation Theme datasets. For example, the USGS 3D Elevation Program Initiative's A Call for Action and the draft National Coastal Mapping Strategy are primary strategic documents that provide guidance on elevation data acquisition, data standards, stewardship, dissemination, interagency coordination, and related topics.

Anticipated Outcomes
Awareness of, and external support for, federal agencies to maintain and improve the NGDA datasets is critical to their continued health.

Action 3.2.1
Catalogue the NGDA-supporting strategic plans and initiatives, describing lead agency(ies), partners, goals and gaps.

Action 3.2.2
Utilize the Elevation Theme Community Page to publicize the information resulting from Action 3.2.1.

External Factors, Challenges, and Opportunities

Challenges: resources; technology capabilities and limitations; agency-specific priorities on management of NGDA datasets.
Opportunities: sharing of best practices; refining of requirements; leveraging resources and existing interagency partnerships.