NEBRASKA ELEVATION

Business Plan

Approved: March 26, 2015

Nebraska Information Technology Commission GIS Council
and
Office of the Chief Information Officer

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Foreword

This business plan was coordinated through the Nebraska Information Technology Commission (NITC) GIS Council. Administrative and staff support was provided from the Office of the Chief Information Officer (CIO). This plan follows national guidelines of the Federal Geographic Data Committee (FGDC) Fifty States Initiative, Cooperative Agreements Program (CAP). The Fifty States Initiative is a joint effort between FGDC and the National States Geographic Information Council (NSGIC) to advance the National Spatial Data Infrastructure (NSDI) through planning and coordination of diverse stakeholders involved with geospatial data, applications and services.

The statewide elevation dataset, which is the focus of this business plan, is a component of the Nebraska Spatial Data Infrastructure (NESDI). The NESDI is a collection of eleven geospatial datasets that the GIS community has determined are essential to the efficient operation of the state's public and commercial business. Conceptually, these datasets are current, comprehensive, accurate, and detailed enough to meet the needs of the majority of users. Each, individually, supports a number of important business functions. In addition, these layers are spatially congruent and can be integrated with other layers to facilitate more complex and sophisticated analyses. This is where the real power of GIS lies.

Acknowledgements

The resources and information for the plan could not be possible without the leadership of the Elevation Working Group. This working group was chartered to gather input, discuss and help create the business plan. Various industry and other state partners were solicited for information summarized within this plan. This business plan coordination was led by Nathan Watermeier, GIS Coordinator within the Office of the CIO. Members are:

Josh Lear, Nebraska Department of Natural Resources (NDNR)
Rebecca Groshens, Nebraska Department of Natural Resources (NDNR)
Amy Zoller, Nebraska Department of Natural Resources (NDNR)
Ken Hartwig, Nebraska Department of Roads (NDOR)
Doug Hallum, Conservation and Survey Division, University of Nebraska (CSD)
Les Howard, Conservation and Survey Division, University of Nebraska (CSD)
Jim Langtry, U.S. Geological Survey (USGS)
Shandy Bittle, Natural Resources Conservation Service (NRCS)
Eric J. Morrison, U.S. Army Corp of Engineers (USACE)

Executive Summary

This plan is intended to facilitate the acquisition of high-resolution elevation data for the State of Nebraska, which is consistent with the first programmatic goal identified in the Nebraska GIS Strategic Plan which was adopted in 2012.

Improved elevation data is needed to support public and private applications related to emergency preparedness, natural resources conservation, and engineering design. Elevation data is essential for flood map modernization, dam safety, transportation modeling, precision agriculture, urban planning, and correction of aerial photography which serves as a base for mapping applications of all types.

Estimates of the potential benefits of high-resolution data for Nebraska run as high as $11 million per year. Light Detection and Ranging (LiDAR) technology represents a cost-effective option to capture improved elevation data for the entire state to replace data that are too old and too coarse for most of the abovementioned applications.

Nebraska issued a Request for Information (RFI) (appendix IV) to acquire information on a range products and derivatives and the associated costs. Costs range from \$168/ Mi^2 for an entry-level LiDAR product with no derivatives to \$296/Mi^2 for LiDAR that is higher resolution, more accurate, and comes with a number of valuable derivatives. The total cost to acquire LiDAR elevations for the rest of the state ranges from $5.5 million to $9.9 million.

This business plan was primarily written with an emphasis on obtaining, managing, and distributing statewide LiDAR by a coalition of Nebraska partners. Nebraska has acquired LiDAR over 60% of the state via a number of ad hoc projects, mostly in areas with higher population and infrastructure density, a.k.a. the low-hanging fruit. Collecting elevation data for the remainder of the state will run into more challenging issues. Assembling and coordinating stakeholders and funding and will require a much more organized approach. No single department is currently responsible for statewide acquisition of elevation data. Therefore, the State GIS Coordinator and the GIS Council have developed a plan which builds on and enhances the collaborative approach used successfully in past LiDAR projects by improving the coordination required to execute a program of this magnitude. This is accomplished by the recommended development of a state LiDAR program under the direction of a state agency. This program would provide for the management of the state's elevation data from acquisition to distribution. Program activities include the development of plans for stewardship, distribution, and marketing of the state's elevation data. As this plan is being written, efforts are being made to build on the states existing collection of elevation data. Program development will, of a necessity, occur simultaneously with on-going LiDAR acquisition.

The acquisition of improved elevation data is a multi-year effort. A phased approach is described in this plan for acquiring LiDAR for the rest of the state in 6 years. New, cost-effective opportunities to acquire LiDAR are becoming available. In January of 2015, the federal government initiated a 3D Elevation Program (3DEP), that is designed to acquire high-resolution elevation data for the nation in 8-10 years. And, although this program specifies a higher standard for LiDAR, 3DEP is accompanied by a costshare component and is emerging as a viable alternative for acquiring LiDAR in Nebraska.

1.0 Program Goals and Objectives

1.1 Strategic Foundation for Business Plan

The Nebraska Geospatial Strategic Plan identified, as one of four goals, "to facilitate the creation, maintenance, analysis, and publishing of quality geospatial data". Elevation is classified as part of the NESDI. Elevation involves a detailed geospatial description of the land surface, including structures and vegetation on the land surface, and can be used to enforce spatially distributed geodetic control onto orthophotography.

Standards and guidelines have been developed for the Elevation dataset including data content standards, data schema descriptions, data compilation and accuracy standards, and metadata standards. A formal communication process will also be defined for the exchange of data and information between data stewards and the geospatial community of users.

1.2 Goals and Objectives

The goal of this business plan is to facilitate the acquisition, maintenance, and distribution of a high quality statewide Elevation dataset to replace the relatively coarse existing data and capitalize on increasing volumes of data being collected with newer Light Detecting and Ranging (LiDAR) technologies. Specific discovery, planning, and implementation objectives include:

Discovery

- Document stakeholder expectations and develop core requirements for LiDAR.
- Identify a set of standards and a standard elevation product that will meet the majority of stakeholder requirements and expectations in a cost-effective manner.
- Identify buy-up alternatives for contributing partners (Contours, breaklines, hydro-enforced or hydro-flattened DEMs, etc.)
- Identify and evaluate providers.
- Request program cost estimates from solution/data providers.
- Identify obstacles to acquisition of LiDAR.

Planning

- Define an elevation program management team.
- Identify an elevation data steward and responsibilities including storage and management strategies.
- Develop alternative scenarios for completing "standard product" LiDAR coverage for the state (see "LiDAR Statewide Acquisition Project" map).
- Identify program funding sources.

Implementation

- Market Business Plan.
- ***Pursue*** program funding source(s) and encumber funds.
- Implement acquisition projects.

Follow-up

- Advertise and publish data.
- Conduct post-project reviews.

2.0 Benefits and Justification

2.1 Anticipated Benefits

Elevation data is foundational to the development of the NESDI framework data layers (Applied Geographics, 2012). Elevation is used to rectify imagery which is subsequently used as a base map for most of the other geospatial data layers in the NESDI. Elevation data in the form of Digital Elevation Models (DEMs) and shaded relief images derived from them is valuable as a base map in its own right. LiDAR supports many scientific and engineering applications that enable government at all levels to fulfill their obligations to the public and has been collected for approximately 60% of the state. Projects and programs used to justify these acquisitions in Nebraska include applications relating to hydrology, engineering and natural resources:

Hydrology and hydraulics

- Base Flood Elevation (BFE) determinations
- Floodplain and inundation mapping
- Dam breach analysis

- Water modeling

Engineering design and design reviews
- Bridge and roadway design
- Siting of transmission lines, power lines, cell towers, pipelines
- Flood control structures
- Conservation structures
- Water diversion and delivery structures

Natural resources applications
- Conservation planning
- Modeling of landforms, habitat, vegetation, etc.
- Channel morphology
- Reservoir storage
- Vegetation and land cover studies
- Precision farming
- Agricultural conservation practices
- Soil survey

Miscellaneous
- Cartographic applications
- Imagery rectification
- Fire modeling
- Archaeological investigation

A national study, the National Enhanced Elevation Assessment (NEEA), (Dewberry, 2011) identified 27 Business Uses for LiDAR, many of which may have potential benefits for Nebraska. The Business Uses are:
1. Natural Resources Conservation
2. Water Supply and Quality
3. River and Stream Resource Management
4. Coastal Zone Management
5. Forest Resources Management
6. Rangeland Management
7. Wildlife and Habitat Management
8. Agriculture and Precision Farming
9. Geologic Resource Assessment and Hazard Mitigation
10. Resource Mining
11. Renewable Energy Resources
12. Oil and Gas Resources
13. Cultural Resources Preservation and Management
14. Flood Risk Management
15. Sea Level Rise and Subsidence
16. Wildfire Management, Planning and Response
17. Homeland Security, Law Enforcement, and Disaster Response
18. Land Navigation and Safety
19. Marine Navigation and Safety
20. Aviation Navigation and Safety
21. Infrastructure and Construction Management
22. Urban and Regional Planning
23. Health and Human Services
24. Real Estate, Banking, Mortgage, Insurance
25. Education K-12 and Beyond

26. Recreation
27. Telecommunications

These important applications require current, high-quality elevation information. This information has typically been gathered on a project by project basis that is generally more costly in terms of time and money. A statewide elevation dataset would provide instantaneous access to accurate elevation data reducing costs and time required for field visits

2.2 Return on Investment and Shared Value

The benefits of high quality topographic data fall into two major categories - efficiency and effectiveness. Efficiency benefits consist of cost savings or costs avoided when a particular project is undertaken. For example, LiDAR elevations may be sufficient to support preliminary conservation engineering design reducing the need for more expensive topographic surveys. Effectiveness benefits include value added to a particular project, either by doing an existing task better (to a higher level of quality) or by being able to do new tasks that were not possible before. An example of this is the accuracy and precision with which approximate flood zones can be mapped or the volume of man-made lakes can be estimated with a 10 meter DEM versus a LiDAR DEM. Often efficiency benefits are large enough to outweigh the costs in a GIS project. The value of effectiveness is difficult to measure, and the full benefits of the projects are therefore typically underestimated. Based on the findings in the NEEA, USGS estimated benefits to the state of Nebraska of a LiDAR dataset that is specific to their standards. LiDAR has potential benefits in the areas of precision agriculture, natural resources conservation, and flood risk management of nearly 10 million dollars annually.

3.0 Background

3.1 USGS Topographic Map Series

3.1.1 USGS Topographic Contours
USGS produced 7.5 minute topographic quadrangles for the conterminous US over a period of 60 years. Many applications that required elevation information during that period were supported by the contours on those quadrangles.

Fifty-four thousand 7.5 minute USGS topographic maps were developed for the U.S. at a cost of approximately $3 billion (2007 dollars) (Craun, 2010). At an average cost of $55,000 per quadrangle, Nebraska's 1435 maps cost approximately $79 million. Assuming that the costs for developing the contours were proportional to the costs of developing the other layers the contour-based elevation data for Nebraska cost in the neighborhood of 10-12 million dollars.

3.1.2 Suitability Assessment of Existing Infrastructure
The contours are accurate to between 2.5 and 10 feet and are derived from information that is anywhere from 24 to over 70 years old. A statewide digital elevation dataset was derived from these contours in the mid-1990s. DEMs derived from these contours are accurate to within 2.5 to 10 feet relative to the contours that they were derived from. USGS level 2 DEMs are available in resolutions as fine as ten-meter cells. Ten meter cells are large and mask many important but smaller landscape features. Today these DEMS are considered too old and too coarse to support any but the most general of applications. They are not hydro-enforced and require additional processing for hydrologic applications.

3.2 LiDAR

Airborne LiDAR is the technique most used to collect accurate elevation data today. Elevations are collected by measuring the distance from a precisely located airborne platform using lasers. It is fast and efficient compared to other techniques. Approximately 60% of Nebraska has LiDAR elevations which were collected as 14 separate LiDAR projects since 2009

LiDAR collected over the last five years in support of Nebraska applications was justified on the basis of:

- Emergency management and response planning (floodplain mapping, dam safety assessments, hydrologic and hydraulic analysis, and CBFEs)
- Natural Resources and Environmental Science (conservation planning, research, and delivery)
- Infrastructure planning - reduction of planning costs (engineering design and design reviews, evaluating alternative options for Infrastructure, field survey planning)
- Permit Process Improvement
- Research (hydrologic modeling)
- Economic Development
- GIS Infrastructure (orthophotography rectification, database development, cartography)

Most of the existing LiDAR was collected at a Nominal Point Spacing (NPS) of 1.4 meters and is accurate to 18.5 cm Fundamental Vertical Accuracy (FVA), which was the industry standard at the time of collection. One project along the Platte River has a 0.7 meter NPS and is accurate to 9.25 cm. Portions of Cuming County were collected at a 2 meter NPS which is accurate to 37.1 cm.

Each project had a list of deliverables that varied from project to project. At a minimum, each specified classified and unclassified LiDAR points and a bare-earth DEM. Breaklines were developed for some of the projects.

3.2.1 LiDAR Acquisition

For most of Nebraska's larger LiDAR projects, the federal government initiated or played a significant role in planning, management, procurement, and funding. The Natural Resources Conservation Service (NRCS) has been the leader in many of these efforts and has developed a significant amount of expertise in the process. Other federal projects were conducted by the U.S. Army Corp of Engineers, (USACE), and the Federal Emergency Management Agency (FEMA).

All of Nebraska's existing LiDAR collections were done on a project basis. Project specifications were matched and coverage was aligned with existing LiDAR for most projects. On one occasion, LiDAR specifications were different which resulted in matching challenges and discontinuities along project boundaries.

LiDAR projects in Nebraska have generally been collaboratively funded. Federal agencies, typically NRCS, would put together a project using federal funding. On many occasions, this funding served as "seed" funding to which state and local dollars were added resulting in an expansion of the original project area. Often this funding came at the last moment compressing the planning window and severely limiting the opportunities for collaborators to contribute to the projects

3.2.2 Historical LiDAR Costs in Nebraska

Historical cost information was obtained by analyzing information from the approximately 60% of the state of Nebraska is covered by LiDAR elevations. This data was collected over the course of many LiDAR acquisition projects beginning with the South Central LiDAR Project in 2009. Most of this LiDAR was collected at a1.4 meter point spacing. Information available for each project varied considerably and while the average costs are representative of all projects, some of the costs that were broken out represent only those projects for which the information was available.

Existing LiDAR data cost, on average, \$154/Mi^2 for the areas covered. These costs generally can be categorized as project management costs (\$5/Mi^2), acquisition costs (\$141/Mi^2), and QA/QC costs (\$8/Mi^2). Acquisition costs include all post-processing costs including IMU/GPS processing, classification, limited development of breaklines and contours, DEM processing etc. Each project had a list of deliverables that varied from project to project.

3.2.3 Stewardship of LiDAR.

Stewardship ensures that the data is current and available to meet the needs of the GIS community. None of the 14 projects had a specific line-item for stewardship. LiDAR data was shared and a number of agencies ended up with copies of data. Stewardship of the LiDAR data within these agencies was minimal and targeted to specific agency needs and the costs internalized.

3.2.4 Distribution.
LiDAR requires a great deal of disk space. Large file size can make sharing LiDAR data a challenge. For the most part, LiDAR was shared by copying the data onto portable hard drive and physically moving the drives. The data is also available on a limited basis for download through the Department of Natural Resources website.

3.2.5 Acquiring the remainder of the state.
Forty percent of the state, much of it in the Sandhills, remains unmapped. These areas are irregular in shape and occur in lower population areas making planning and funding more of a challenge. It is conceivable that the demand for LiDAR in these areas is not sufficient to generate an acquisition project. In that case, it will be necessary to find a suitable alternative for elevation data.

4.0 Program Requirements

4.1 Organizational Needs

There is an opportunity to maximize the states participation in LiDAR acquisition and maintenance. Nebraska has made substantial progress in the acquisition of a statewide LiDAR database. Nearly 60 % of Nebraska has LiDAR coverage acquired due largely to NRCS's need for and willingness to pursue LiDAR acquisition. Many state and local entities have expressed a willingness to invest in LiDAR projects. The goal is to improve upon the state's ability to participate in LiDAR acquisition and maintenance in an efficient and effective manner. The approach is based upon a recognized need to increase coordination and opportunities to collaborate. Ultimately this should result in a more rapid acquisition of a uniform, accurate elevation dataset. In addition, this document seeks to plan for maintenance of this dataset and distribution to a wider audience.

4.1.1 Coordination of Stakeholders, Procurement and Funding
There are potentially many state and local agencies that require quality elevation data and that would be willing to contribute to a well-planned LiDAR acquisition. Identifying these stakeholders and coordinating their support is a time-consuming process. Due to widely varying budget cycles, spending priorities, and the spending limitations of potential collaborators, coordination of collaborators is challenging and opportunities to acquire LiDAR efficiently are missed. This is especially true if the planning window is short. Nebraska's ad hoc LiDAR acquisition is characterized by narrow planning windows. Potential collaborators may be overlooked and state and local governments are often unable to respond to the opportunities to collaborate. The development of an Acquisition Plan will permit the identification of priorities and lay out the costs of future LiDAR acquisitions in advance of the project. This would allow potential collaborators to see the benefits of investing in LiDAR and the timeframe in which their area of interest (AOI) is due to be acquired and would provide them with an opportunity to plan their LiDAR investments in advance of the project.

Procurement refers to obtaining the LiDAR acquisition and QAQC services. The process includes purchase planning, provider research and selection, preparation and processing of contracts, coordination of funding, receipt of LiDAR products, and approval of payment.
A well-defined and documented procurement process will provide an opportunity for collaborators to budget for LiDAR investments and invest when money is available. Providing potential collaborators with a well-conceived plan worthy of their investments, along with a procurement process that will allow them to invest in LiDAR according to their individual budgets would allow the state and its partners to rapidly respond to any opportunities provided by the initiation of a LiDAR acquisition from any entity.

The Office of the CIO (OCIO) is located within the Department of Administrative Services which provides administrative and budgetary services for the office and other state agencies and partnering entities. The OCIO provides overall IT policy, governance, planning and oversight, IT coordination for state agencies, and development, oversight, and operation of enterprise shared systems. It provides administrative oversight to the OCIO GIS Shared Services and the NITC GIS Council. This unit can provide the necessary coordination of funding and procurement activities to support the NESDI designated by the NITC GIS Council. The OCIO can also provide administrative support to handling contracts, procurement and follow through on acquisition projects.

USGS provides the option for procurement through a General Products and Services Contract (GPSC) for projects done in partnership with USGS.

4.1.2 Stewardship support

Acquiring LiDAR for the state of Nebraska represents, at a minimum, a $13 million dollar investment. Significant steps to protect this investment are warranted. Stewardship of LiDAR involves receipt of the LiDAR products from the vendor after they have undergone the required QA/QC processes, management of this data, and development of derivative products. Some storage and management are being done. Some derivatives are being made. Most are done within an individual agency, for agency-specific needs, available but not specifically shared. Deliberate, forward-looking, comprehensive development of products and derivatives that increase the value of the elevation dataset is currently not being done.

Specific projects will require more current or higher-resolution LiDAR than is currently available. These LiDAR datasets represent valuable refinements and updates to a statewide elevation dataset. Planning for updates and refinements in coordination with collaborators should be a component of proper stewardship.

Stewardship ensures that Nebraska's elevation dataset adequately represents the landscape and that the data is secure and available for distribution to the LiDAR community. Stewardship is an important component to preserving LiDAR investments and should be conducted by an agency with specific authorization and dedicated funding. Development of a LiDAR stewardship plan is recommended which would:

- Identify a state agency responsible for stewardship
- Define stewardship for Nebraska LiDAR
- Determine cost estimates and account for the necessary funding for stewardship.(Approximately $1,620,000 for a stewardship program that runs until 2030)

USGS provides for limited stewardship through the 3DEP.

4.1.3 Distribution

LiDAR data must be easily accessible to the community of users to achieve the highest return on investment. LiDAR is being distributed to some small degree by the Department of Natural Resources and others. LiDAR point clouds and/or a 2-meter DEM are available by request from the Department. Many mechanisms for distribution exist including:

- The National Map distributes the National Elevation Dataset (NED) which is a raster product developed by USGS using sources that include LiDAR
- The Center for LiDAR Information Coordination and Knowledge (CLICK) is a USGS portal designed to facilitate data access to all of the elevation products, user coordination and education of LiDAR remote sensing for scientific needs.
- 3DEP data distribution will include QL2 LiDAR classified and unclassified full point cloud, breaklines (if collected for hydro-conditioning), 1-meter DEMs generated from QL2 LiDAR, and will include enhanced spatial metadata. The data will be distributed through EarthExplorer on the USGS website and through The National Map. Older source DEMs will remain accessible as historical data.
- NebraskaMap is Nebraska's gateway to web-based geospatial resources.

Some or all of these mechanisms could be used in combination to make LiDAR widely accessible. Many commonly used elevation products and derivatives should be made available include:

- Contours
- Hydro-enforced DEMs
- DEMs at different Ground Sample Distances (GSD)
- Digital Surface Models (DSM)

A LiDAR Distribution plan that identifies the best method of providing access to elevation data may make use of some or all of the above mechanisms to make elevation data accessible to the widest variety of users.
A plan for distribution of LiDAR should include:

- Data formats
- Identification and prioritization of derivative products
- Identification of web-enabled data layers
- Web services
- Funding
- Distribution mechanisms

4.1.4 Coordination of LiDAR in the future
Elevation data becomes progressively out-of-date due to natural and manmade changes to the landscape requiring updates of affected areas to remain current. The life of an elevation dataset might be extended indefinitely via an update program provided the underlying data is sufficient for the applications it is intended to support.

Alternatively, 3DEP anticipates replacing LiDAR on a cyclical basis.

4.1.5 The 3D Elevation Program
National Digital Elevation Program member agencies sponsored a study to document the national requirements for improved elevation data. The study was conducted by Dewberry and Associates and the final report, the National Enhanced Elevation Assessment, was released in 2012. The NEEA conducted a comprehensive review of the most prevalent business uses for elevation data across the country and reports the “asked for” accuracy, precision, and refresh periods.
This study found that an improved national program for the systematic collection of LiDAR for the entire country has the potential to generate $1.2 to $13 billion nationally in new benefits each year. Based upon the findings of the NEEA study, USGS has initiated 3DEP to systematically collect high-resolution LiDAR nationwide on an 8-year cycle. This is a collaborative program led by USGS in coordination with state and local stakeholders. 3DEP requires collecting LiDAR at higher (0.7m) resolution and processing the data to achieve an elevation dataset suitable for inclusion in the National Map. The program will be collaboratively funded by federal, state, local branches of government. Total cost to map Nebraska to the 3DEP program standard would be approximately $25.86 million. This program may have much potential to provide benefits to Nebraska and the GIS Council is actively seeking to participate in this program where it is cost-effective.

4.2 Legislative Support

A state agency assigned an appropriate level of authority, responsibility, and funding will ensure that LiDAR is collected to an appropriate standard, in a reasonable amount of time, is managed properly, and is made available to the widest possible constituency.

Nebraska’s LiDAR challenge is to coordinate systematic statewide LiDAR acquisition around the various funding and other constraints. Plans for acquisition, procurement, stewardship, distribution, and coordinating future Elevation programs must be developed. These organizational needs would be more efficiently and effectively addressed under a state LiDAR program. Currently, no Nebraska state agency is responsible for coordinating state efforts to acquire and maintain a statewide elevation dataset, and no state agency or department has the authority or the resources for a statewide LiDAR program. A formal LiDAR program coordinated by a state agency would ensure an appropriate level of state government input in the collaborative efforts to acquire LiDAR. Authorizing a LiDAR program is the responsibility of the legislature.

4.3 Data, Application and Product Components

The fundamental data product of LiDAR is the point cloud. A LiDAR point cloud starts out as a series of ranging measurements from a known point in space. These points are pre-processed to convert them to elevations and to remove systematic displacement. The data are then post-processed and individual points within the point cloud are adjusted for systematic errors and classified according to project specifications (bare ground, buildings, tree canopy, etc.). Once the point cloud has been adjusted and classified, a long list of products can be derived from it including DEMs, DSMs, contours, TINs, etc. Each of these derivatives can be presented in a variety of ways but often these require ancillary data such as breaklines to improve the aesthetic quality or analytical suitability of the product.

There are a large number of derivatives which can be created from a LiDAR point cloud provided the point cloud is accurate and properly classified. The need for these derivatives is application-specific and it is not economically feasible or practical to create all of them. There are a few derivatives that have widespread utility. The focus of this document is to ensure that the collection and processing of the point cloud is done to agreed-upon, uniform standards to promote uniformity and facilitate cross project analyses and to identify a select set of derivatives which would be considered essential deliverables.

A short list of derivatives includes:

- Triangulated Irregular Network (TIN) – is a surface comprised of adjacent, non-overlapping triangles that are defined by the mass points
- Digital Elevation Model (DEM) – a raster surface model of the bare earth. DEMs are interpolated from the mass points.
- Digital Surface Model (DSM) - is a raster surface model of the earth that includes buildings, tree canopies, etc. DSMs are interpolated from the mass points.
- Elevation contours – are vector elevation components where a line represents a single elevation

Breaklines are ancillary information used to augment or “condition” an elevation model. Breaklines can make a substantial difference in how suited a derivative product is for a given application but they will not improve the characteristics of the point cloud. Breaklines are used to create:

- Hydro-flattened DEM - a DEM in which the surface of lakes, reservoirs, and larger rivers have been processed with breaklines to have a smooth surface.
- Hydro-enforced DEM - A hydro flattened DEM that has had additional processing to enforce the downward flow of water in smaller streams.
- Hydro-conditioned DEM – is a hydro-enforced DEM in which sinks in the landscape have been filled.

Elevation derivatives

- Hillshades
- Slope, aspect, and curvature maps

4.3.1 Nebraska Standard Product

The Elevation workgroup developed the concept of a “Nebraska Standard LiDAR Product” which represents the minimum set of deliverables that should be included in all Nebraska LiDAR projects. This standard product is based upon the LiDAR point cloud, classification, and derivatives most requested of LiDAR acquired up to the time this business plan was written. The standard product includes the entire LiDAR point cloud, classified and unclassified, metadata, and a bare-earth 2-meter DEM. This basic package does not include breaklines or contours.

4.3.2 Value-Added Elevation Product

Certain LiDAR users and/or applications require LiDAR derivatives that include additional processing to meet requirements. A “Value-Added” LiDAR package was defined for the purposes of discussion to accommodate these requirements. The Value-Added LiDAR package includes the development of hydraulic breaklines and contours. DEMs and other derivative products would be processed with this additional information. Processing DEMs with hydraulic breaklines results in an improved product for hydrologic / hydraulic processes.

4.3.3 USGS 3DEP Product

3DEP requirements for LiDAR products and deliverables are more stringent than those described for Nebraska's standard product. USGS requires LiDAR point clouds are collected at a 0.7m NPS (9.25 cm RMSE). USGS also requires a hydro-flattened, bare-earth DEM. Hydro-flattening results in a cartographically pleasing DEM but does not improve the suitability of the elevation model for hydrologic / hydraulic processes.

4.4 Standards

Accuracy and precision are a function of acquisition parameters and are set during acquisition and subsequent processing. Accuracy and precision of the point cloud, for all practical purposes, cannot be improved after it has been collected. Therefor the standards are focused on the density and accuracy of the point cloud. This document recommends the adoption of the National Geospatial Program's LiDAR Base Specification Version 1.0 standards. The Elevation Workgroup developed a set of draft recommendations for the collection of LiDAR elevations based upon this work. These recommendations essentially are the Version 1 standard with additional specifics regarding the NPS and FVA requirements as follows:

Minimum – QL3 (1.4 meter NPS, 18.5cm RMSE, 2 meter DEM) – Recommend that no LiDAR is collected to a lower standard under any circumstances

4.4.1 Standards.
LiDAR standards document the levels of accuracy, precision, and coordinate systems that are considered acceptable or desirable to support the needs of the user community. Project-based planning and prioritization may not be considered by the larger elevation community which may lead to the acquisition of elevation data that is not compatible with other LiDAR datasets, and that may not reflect priorities of all potential users. The development of a set of Nebraska-specific standards would help ensure that collected LiDAR will meet the needs of the majority of stakeholders. This data will spatially match adjacent acquisitions and will be compatible all respects so that the utility of the elevation data is unaffected by the boundaries of any one project. Draft Nebraska LiDAR standards have been developed and submitted to the NITC (Appendix I).

4.5 Technology Requirements

Hardware – A uniform, QL3 statewide dataset would require approximately 15 TB of storage for processing and handling. As the density of the LiDAR point cloud and the resolution of derivative products increase, the storage requirements for a statewide elevation dataset will also increase.
Software – specific software is required for processing .las files, and for creating breaklines, DEMs, and contours
Staff – data management, processing of minimum derivatives, processing of additional derivatives

4.6 Human Resource Requirements

A LiDAR program management team is necessary to coordinate collection, stewardship, distribution of LiDAR data, and to maximize the benefits realized. At a minimum, the following roles are identified:

- Program Executive Oversight, Chair, Nebraska GIS Council
- Program Direction – Nebraska GIS Council
- Program Technical Support: Nebraska GIS Council Elevation Workgroup
- Program Administrative Support: State Agency Director such as the Chief Information Officer
- Stakeholder Outreach and Support: Nebraska GIS Council Elevation Workgroup
- Federal Program Coordination: USGS National Map Liaison for Nebraska

4.7 Costs

The Elevation Workgroup posted a 22 question RFI designed to update and refine our estimate of costs for future LiDAR acquisitions.
Cost information was being sought regarding:

- Acquisition and Classification
- DEM processing
- QAQC
- Breakline development Contours

The NEEA describes 5 Quality Levels (QLs). Generally, the resolution and accuracy of the elevation products decrease as the QL increases. The two QLs most relevant to Nebraska are:
QL2 – 0.7 meter NPS, 9.25 cm RMSE, 1 meter DEM
QL3 – 1.4 meter NPS, 18.5 cm RMSE, 2 meter DEM

LiDAR vendors were asked to provide an estimate of costs based upon their optimal project size and shape. They were given a certain amount of leeway with respect to project size and shape when responding to this RFI. These numbers are considered suitable for planning purposes.

Results: The cost of acquiring the standard LiDAR product for Nebraska over all vendors and over 2 quality levels per square mile is as follows; Acquisition $112, Classification $64, DEM processing $6, QA/QC $14, for a total of $197. A rough estimate of data management costs was calculated based upon prior Nebraska projects (5% of the costs of acquisition, post-processing, classification of point cloud, and DEM processing). This cost does not include stewardship of the data. Average cost for producing breaklines is $23 per square mile and the average cost for producing contours is $19 per square mile. Total average costs including management of the data and the value-added products is approximately $249 per square mile. Costs varied widely ranging from a low of $86 for a QL 3 Nebraska product to $585 per square mile for a QL 2 product with the value-added products.
The unit cost of LiDAR varied widely by vendor. Average costs to produce a product ranged from a low of $119 for a Nebraska standard LiDAR product ($145 for all value-added products) to a high of $440 ($488).
The unit cost LiDAR varied by QL. Average costs to produce a product at the two different QLs (including data handling) are:

	NE Standard Product	With Value-Added Products
QL 3	$168	$208
QL 2	$251	$296

4.8 Recommendations

The GIS Council recommends that LiDAR be acquired for the remainder of the state and has identified the following recommendations in pursuit of that goal:

1. Develop a detailed Acquisition Plan identifying project areas, timelines, and partners by 6/2015
2. Develop a detailed Marketing and Outreach Plan by 6/2015
3. Develop a detailed Stewardship Plan identifying a single Nebraska LiDAR Steward and outlining stewardship responsibilities by 6/2015
4. Develop a detailed Distribution Plan identifying products to be distributed and the various distribution mechanisms by 6/2015
5. The Nebraska State Legislature authorizes a state LiDAR program and assigns responsibility to a state agency and provides the necessary funds by 1/2017

5.0 Implementation Plan

Federal agencies have needs for elevation data and most of the LiDAR collected to date is due to leadership of a federal agency pursuing a LiDAR project. The state generally does not have the resources to collect LiDAR independently. The state can facilitate federal collection effort through coordination of state resources. Coordinating state and local support of federal LiDAR projects would accelerate the acquisition of, and facilitate the maintenance and distribution of a current, consistent, accurate statewide elevation dataset. The

state does not have program in place with which to coordinate with federal efforts. An important recommendation of this plan is that a state agency be authorized and resourced to coordinate the state's interest in LiDAR acquisition, stewardship, and distribution. This authorization process will take approximately 3 years. An ad hoc management team will be identified to coordinate these activities in the interim.
The following implementation plan is divided into two phases based upon the assumed authorization: Phase 1 includes the activities that must take place in the 3 years until the program can be implemented, Phase 2 would be the continuation of LiDAR activities under the program.

5.1 Phase 1. Pre LiDAR Program Tasks:

1. GIS Council develops standards and guidelines
2. GIS Council identifies Core Requirements
3. GIS Council identifies program management team & petitions for legislative authorization and funding
    a. State lead to coordinate with Federal projects
4. Write Procurement and Acquisition plan
    a. Geographic extent
    b. Costs
    c. Collaborators
    d. Funding
5. Write Marketing and Outreach plan
6. Write Stewardship plan
    a. Storage and management strategies
    b. Development of derivatives
    c. Update process
    d. Develops costs estimates and proposes funding scenarios
7. Write Distribution plan
    a. Identifies who is responsible for publishing and access
    b. Identifies products for distribution
    c. Identifies required resources for stewardship
8. Implement Interim Procurement and Acquisition plan
9. Implement Interim Marketing and Outreach plan
10. Implement Interim Stewardship plan
11. Implement Interim Distribution plan

5.2 Phase 2. Post LiDAR Program Authorization

The state lead is authorized by legislature to coordinate the state's role in LiDAR acquisition, maintenance, and distribution as a function of a state LiDAR Program.
Tasks:

12. Implement Procurement and Acquisition plan
13. Implement Marketing and Outreach plan
14. Implement Stewardship plan
15. Implement Distribution plan
16. Coordination and Management

5.3 Implementation Details

LIDAR IMPLEMENTATION PLAN

Task	Responsible	YEAR 2014	2015	2016	2017	2018	2019	2020	2021	---	2030
Write P&A plan	GIS_C, Coord.										
Write M&O plan	GIS_C, Coord.										
Write Stewardship plan	GIS_C, Coord.										
Write Distribution plan	GIS_C, Coord.										
Leg. Authorization of LiDAR Program	GIS_C, Coord.										
Implement Interim P&A plan	GIS_C, Coord.										
Implement Interim M&O plan	GIS_C, Coord.										
Implement Interim Stewardship plan	GIS_C, Coord.										
Implement Interim Distribution plan	GIS_C, Coord.										
Implement P&A plan	LiDAR Program										
Implement M&O plan	LiDAR Program										
Implement Stewardship plan	LiDAR Program										
Implement Distribution plan	LiDAR Program										
Coordination and Management	LiDAR Program										

5.4 Milestones

1. Procurement and acquisition plan – Opportunities to collaborate on Federal projects arise most years and the sooner a procurement and acquisition plan is done, the better we are able to respond to these opportunities
2. Marketing and outreach plan – Marketing and outreach are important components to implementing the procurement and acquisition plan. This must be done concurrently with the P&A plan
3. Stewardship plan – Nebraska has a substantial collection of LiDAR and derivatives which must be stewarded and could be enhanced and anticipates the acquisition of additional data in the future.
4. Distribution Plan – There is only a return on LiDAR investments if the LiDAR data is actually used. The more use, the more return. LiDAR is available to potential users but may not be as robustly available as it could be.

5. Legislative authorization of state LiDAR program – Nebraska should finish acquiring LiDAR for the state in approximately 6 years. Responsibility for LiDAR planning will shift to development of the data that has been acquired and for collaborating with 3DEP as LiDAR becomes dated and must be replaced.
6. Completion of once-over acquisition
7. Stewardship implementation
8. Distribution implementation

5.5 Budget and Finance Strategy

5.5.1 Funding Option 1, Nebraska Standard Product (QL3)
Historically, LiDAR projects conducted in a collaborative approach were initiated by the availability of (usually federal) funds. Using the funds as seed money, collaborators were sought to expand the area collected as much as possible. This is one possible strategy for moving forward however; previously there was often inadequate time available for state and local agencies to participate. This option includes the development of a procurement process that will allow state and local agencies to pre-plan and pre-invest their dollars in anticipation of a last-minute NRCS LiDAR project. The money invested would be immediately available for NRCS and the planning committee when, and if, money becomes available to NRCS. Based upon historical spending averages, the goal of this strategy is to collect $302,500 per year from state and local sources to augment federal LiDAR acquisition efforts.

Points to consider:

- Assumes a continued interest from federal agencies to pursue LiDAR in Nebraska
- Assumes a 6-year acquisition to finish state
- Funding is solicited from partners in anticipation of seed funding from Federal agencies and according to Procurement and Acquisition plan
- Procurement mechanism is available to manage these funds
- Distribute to lead agency as their funding permits a LiDAR project to be implemented.

LIDAR ACQUISITION COSTS @ $168/Square Mile ACQUISITION

Year	**Federal**	**State**	**NRD**	**Other**	**Annual Total**
2015	$505,620	$173,571	$45,279	$30,186	$754,656
2016	$789,946	$271,176	$70,741	$47,161	$1,179,024
2017	$352,650	$121,059	$31,581	$21,054	$526,344
2018	$663,429	$227,744	$59,412	$39,608	$990,192
2019	$674,572	$231,570	$60,409	$40,273	$1,006,824
2020	$690,668	$237,095	$61,851	$41,234	$1,030,848
Totals	**$3,676,885**	**$1,262,214**	**$329,273**	**$219,516**	**$5,487,888**

FINAL COST ESTIMATES BY GOVT.

AGENCY	**COST / AGENCY**	**Pct. TOTAL COSTS**
Federal	$3,676,885	**67.00%**
State	$1,262,214	**23.00%**
NRD	$329,273	**6.00%**
Local	$219,516	**4.00%**
Totals	5,487,888	**100.00%**

5.5.2 Funding Option 2. USGS 3DEP
A second possible strategy moving forward is to work with USGS and other collaborators under the 3DEP program. This option also includes the development of a procurement process that will allow state and local agencies to pre-plan and pre-invest their dollars in anticipation of a last-minute NRCS LiDAR project. This option is based on average of costs submitted in response to RFI.

Points to consider:

- Assumes a continued interest from federal agencies to pursue LiDAR in Nebraska
- Assumes a 6-year acquisition to finish state
- Funding is solicited from partners in anticipation of seed funding from Federal agencies and according to Procurement and Acquisition plan
- Procurement mechanism is available to manage these funds
- Distribute to lead agency as their funding permits a LiDAR project to be implemented.

LIDAR ACQUISITION COSTS @ $297/Square Mile ACQUISITION

Year	USGS	Other Fed	State	NRD	Local	Annual Total
2015	667,062	400,237	186,777	53,365	26,682	**$1,334,124**
2016	1,042,173	625,304	291,808	83,374	41,687	**$2,084,346**
2017	465,251	279,150	130,270	37,220	18,610	**$930,501**
2018	875,259	525,155	245,073	70,021	35,010	**$1,750,518**
2019	889,961	533,976	249,189	71,197	35,598	**$1,779,921**
2020	911,196	546,718	255,135	72,896	36,448	**$1,822,392**
Totals	**4,850,901**	**2,910,541**	**1,358,252**	**388,072**	**194,036**	**$9,701,802**

FINAL COST ESTIMATES BY GOVT.

AGENCY	COST / AGENCY	Pct. TOTAL COSTS
USGS	4,850,901	**50.00%**
Other Fed	2,910,541	**30.00%**
State	1,358,252	**14.00%**
NRD	388,072	**4.00%**
Local	194,036	**2.00%**
Totals	9,701,802	**100.00%**

A Request for Proposal (RFP) with clear specifications is required for more accurate costs.

LiDAR Stewardship and Distribution Program Costs (*State Agency Program only)*

ANNUALIZED COSTS

	STEWARDSHIP			DISTRIBUTION	
Program Year	**1 FTE**	**Hardware, Software Maintenace, Backups**	**Total Stewardshp**	**-**	**Total Distribution and Stewardship**
2014		$8,330	$8,330		$8,330
2015		$8,330	$8,330		$8,330
2016		$8,330	$8,330		$8,330
2017	$85,575	$8,330	$93,905	$20,000	$113,905
2018	$85,575	$8,330	$93,905	$20,000	$113,905
2019	$85,575	$8,330	$93,905	$20,000	$113,905
2020	$85,575	$8,330	$93,905	$20,000	$113,905
2021	$85,575	$8,330	$93,905	$20,000	$113,905
2022	$85,575	$8,330	$93,905	$20,000	$113,905
2023	$85,575	$8,330	$93,905	$20,000	$113,905
2024	$85,575	$8,330	$93,905	$20,000	$113,905
2025	$85,575	$8,330	$93,905	$20,000	$113,905
2026	$85,575	$8,330	$93,905	$20,000	$113,905
2027	$85,575	$8,330	$93,905	$20,000	$113,905
2028	$85,575	$8,330	$93,905	$20,000	$113,905
2029	$85,575	$8,330	$93,905	$20,000	$113,905
2030	$85,575	$8,330	$93,905	$20,000	$113,905
TOTALS	**$1,198,050**	**$141,610**	**$1,339,660**	**$280,000**	**$1,619,660**

5.5.3 Potential sources of funds.

Federal Agencies that might potentially contribute to a Nebraska LiDAR project include US Geological Survey, Natural Resources Conservation Service, US Army Corps of Engineers, and Federal Emergency Management Agency. These agencies have contributed substantially to Nebraska projects in the past. State Agencies that have participated in LiDAR projects in the past include Nebraska Department of Roads, Nebraska Department of Natural Resources, Nebraska Game and Parks Commission, Nebraska Department of Environmental Quality and others.

Natural Resources Districts have participated in a number of LiDAR projects and have an interest in pursuing additional LIDAR projects in those areas that do not currently have recent elevation data. County and city governments have contributed as well.

5.5.4 Potential risks.

These potential partners have different budget processes. The Federal Fiscal year runs from October 1st until September 30 of the following year. Budgets are for one fiscal year. State Agencies maintain a two-year budget cycle and the state fiscal year runs from July 1st until June 30th of the following year. NRDs and counties run similar fiscal years as the state but budget for one year at a time. Counties and cities may have similar or different budget processes. Funds may become available from one source as the opportunity for funding from another source closes. Coordinating funding under these conditions can be challenging and must be proactive to be effective.

5.5.5 Fiscal Management

A coordinated procurement process will cut down on the inefficiency of multiple procurements for the same type of data and services within a jurisdiction and across jurisdictions. To achieve this efficiency, it is recommended that the fiscal authority and management of funds for procuring elevation services will be supported within a state agency.

This state agency will be responsible for coordination of funds, facilitating procurement and participate in management of programs to assure deliverable products meet procurement requirements. Other state agencies and partners will participate in the management and decisions made for fund allocations towards the statewide elevation program.

GIS Shared Services, an OCIO cost sharing unit has authority to coordinate statewide geospatial data and service oriented programs. This unit, located within the Department of Administrative Services, can provide the necessary administrative support to handling contracts, procurement and follow through on acquisition products and services.

Once initial steps are in place for identifying partners and source of funds, the OCIO GIS Shared Services unit can initiate the process for coordinating funds and initializing the acquisition process of services.

Should the State choose to partner with USGS through 3DEP, funds may be contributed toward a LiDAR data acquisition via the Geospatial Products and Services Contracts.

6.0 Marketing and Outreach

LiDAR has benefits to decision makers at all levels of government and in the private sector. Yet it can be difficult to understand the full return on investment that contributing to a statewide elevation program provides. The value of the data and the program are better understood when additional uses to improve public and private decisions at all levels are communicated. Raising awareness of the benefits of LiDAR, providing educational opportunities and technical support in the use of this data, and advocating for its development, maintenance and distribution will provide real and tangible benefits to Nebraskans. These activities allow for better understanding of what the data provides, builds confidence in decision making, and enhances the overall partnership aspects to this program.

The marketing and outreach goal of this program is to raise awareness of the statewide elevation program and increase knowledge on the use and value of how elevation data is used for decision making.

6.1 Communications

Develop a communications plan through the program management team by incorporating some of the following objectives:

- Establish necessary branding and overall message that can be presented to a wide variety of audiences at the local, state and federal levels.
- Maintain a comprehensive contact database of partners including government, associations and industry that may benefit from LiDAR products.
- Develop a web-based coverage map through NebraskaMAP.gov showing LiDAR data availability across the state.
- Share impact statements aimed at key decision makers who are managers, directors and elected officials at the federal, state and local levels showing impact and uses of the data through the program and how benefits outweigh program costs.

- Develop other explanatory and promotional materials that provide information on needs, applications, and benefits of the program to users of the data.
- Provide timely face-to-face meetings, webinars, and teleconferences for partners to respond to and provide input on LiDAR acquisition opportunities as they become available.
- Maintain a statewide electronic mailing list for emailing frequent communication, news, and updates about LiDAR acquisition among partners. Use other electronic social media and web sites to also communicate information.
- Conduct presentations, seminars, lectures, posters and displays at various statewide association and other meetings where appropriate. A few example meetings and conferences can include:
    - Nebraska GIS LIS Association Biennium Symposium
    - Annual Water Symposia conducted by the Nebraska Water Center
    - Annual meetings and conferences for Nebraska Association of Resource Districts (NARD), Natural Resource Districts, Soil and Water Conservation Society, Water Resources related associations, United States Geological Survey, Natural Resources Conservation Service, Federal Emergency Management Agency, and Army Corp of Engineers.

6.2 Technical Assistance and Education Outreach

Develop a technical assistance and education outreach plan through the program management team by incorporating some of the following objectives:

- Identify appropriate target audiences and package promotional, educational, and technical assistance materials to support their needs.
- Develop illustrative content for use in both printed and web based media.
    - Fact sheets
    - Technical “How-To” guides
    - Electronic presentations made available as either stand alone or through web-based communication such as webinars.
- Partner with Land Grant University of Nebraska entities that are in line with our program goals to assist in facilitating and conducting educational activities across the State. For example, leverage groups such as NebraskaView, Center for Advanced Land Management Information Technology (CALMIT), and the University of Nebraska Extension Service.
- Develop and implement hands-on workshops on how to use LiDAR data through various applications such as GIS and other mapping and interpretive software.
- Support technical assistance needs of users by providing them connectivity to a statewide expert list of volunteers who manipulate and use LiDAR data for a variety of applications. This group would be listed as a contact list on the NebrakaMAP.gov web site for assistance.

7.0 Measuring Success and Feedback for Recalibration

Generally speaking, successful implementation of this business plan should manifest itself in realization of a statewide elevation dataset of sufficient quality to support the majority of Nebraska’s elevation needs. As the most current and the most accurate elevation dataset, it would constitute the authoritative elevation dataset for Nebraska. As such, it would be carefully managed, systematically improved, and widely distributed. To ensure that elevation efforts are bearing fruit, the elevation project management team would assemble and evaluate the following specific elements of success:

1. State standards and guidelines are developed for Nebraska elevation products and adopted by the NITC
2. Core elevation requirements are identified and documented to aid in the selection of LiDAR products to pursue

3. Awareness of the importance of elevation data in local, regional, state, and federal activities and in the activities of private concerns is elevated resulting in an increase in appreciation and support of state LiDAR efforts.
4. A state LiDAR program is authorized and funded by the legislature.
5. Acquisition, Marketing and Outreach, Stewardship, and Distribution plans are written to guide the LiDAR program into the future.
6. LiDAR projects resulting in a statewide LiDAR coverage are systematically and efficiently executed.
7. Elevation investments are leveraged by stewardship and distribution of the data.

The elevation management team would identify specific actions for recalibration of the implementation of this plan as needed.

Appendix I – Source Documents

Applied Geographics, Inc. September 2012. Geospatial Strategic Plan for the State of Nebraska. Available at: http://nitc.nebraska.gov/gis_council/archived_initiatives/strategicplan_2012/documents/NEStrategicPlan2012Final.pdf

Craun, Kari U., 2010. Creation of Next Generation U.S. Geological Survey Topographic Maps. http://www.isprs.org/proceedings/XXXVIII/part4/files/Craun.pdf

Dewberry, 2011, Final Report of the National Enhanced Elevation Assessment (revised 2012): Fairfax, Va., Dewberry, 84p. Plus appendices.

Heidemann, Hans Karl, 2012, Lidar base specification version 1.0, U.S. Geological Survey Techniques and Methods,book 11, chap. B4, 63 p.

Heidemann, Hans Karl, 2014, Lidar base specification (ver. 1.2, November 2014): U.S. Geological Survey Techniques and Methods, book 11, chap. B4, 67 p. with appendixes, *http://dx.doi.org/10.3133/tm11B4*.

Carswell, W.J., Jr., 2015, The 3D Elevation Program—Summary for Nebraska: U.S. Geological Survey Fact Sheet 2014–3112, 2 p., http://dx.doi.org/10.3133/fs20143112. ISSN 2327–6932 (online)

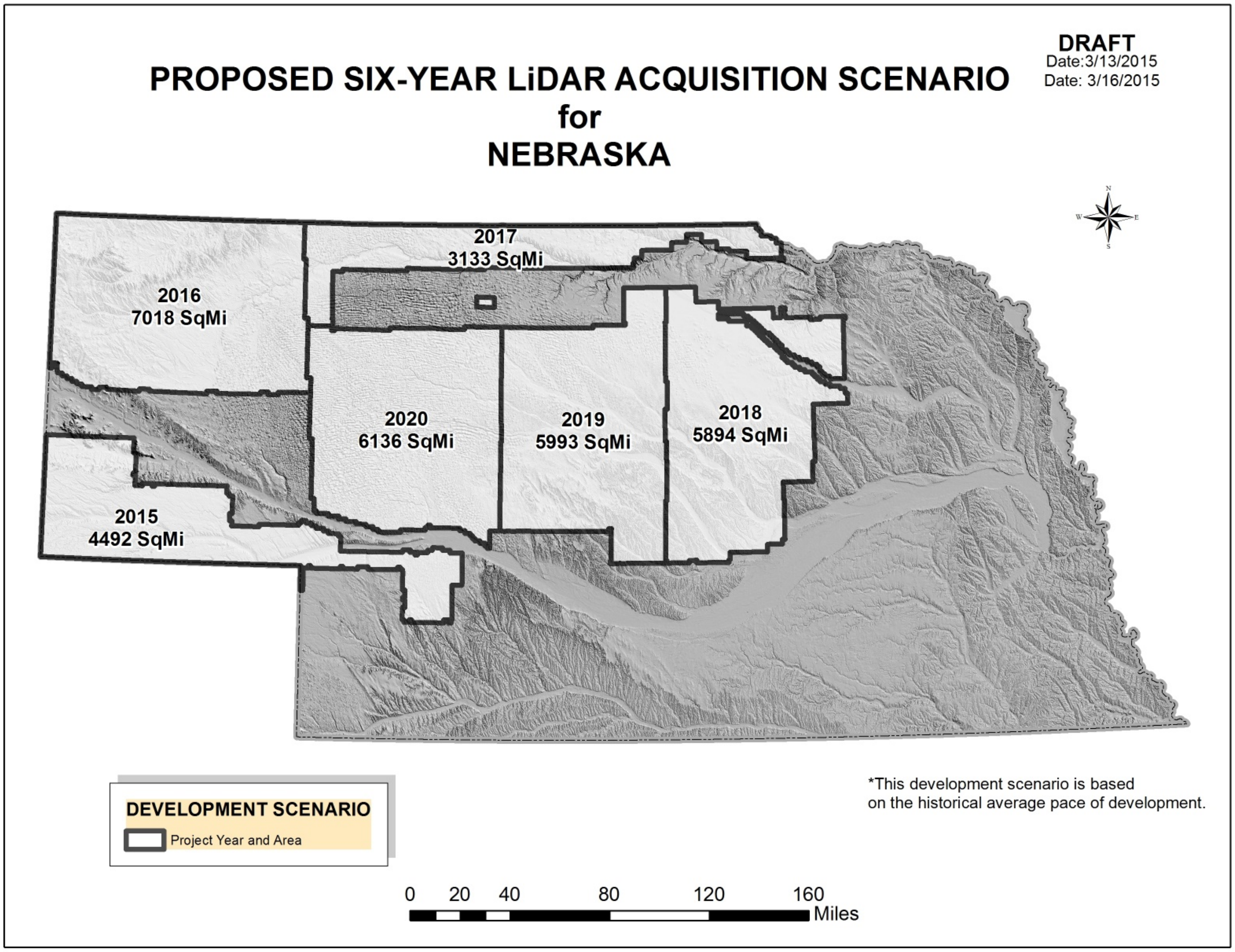
Snyder, G.I, 2012. The 3D Elevation Program – Summary of Program Direction: U.S. Gelolgical Survey Fact Sheet 2012-3089, 2 p., available at http://pubs.usgs.gov/fs/2012/3089/pdf/fs2012-3089.pdf

Sugarbaker, L.J., Constance, E.W., Heidemann, H.K., Jason, A.L., Lukas, Vicki, Saghy, D.L., and Stoker, J.M., 2014, The 3D Elevation Program initiative—A call for action: U.S. Geological Survey Circular 1399, 35 p., *http://dx.doi.org/10.3133/cir1399*.

Appendix II - LiDAR Standards

Nebraska Elevation Acquisition using LiDAR Standard
http://nitc.ne.gov/standards/3-203.html

LiDAR Base Specification Version 1.2
http://dx.doi.org/10.3133/tm11B4.


DRAFT
Date:3/13/2015
Date: 3/16/2015
PROPOSED SIX-YEAR LiDAR ACQUISITION SCENARIO
for
NEBRASKA
2017
3133 SqMi
2016
7018 SqMi
2020
6136 SqMi
2019
5993 SqMi
2018
5894 SqMi
2015
4492 SqMi
DEVELOPMENT SCENARIO
Project Year and Area
*This development scenario is based
on the historical average pace of development.
0 20 40 80 120 160
Miles

Appendix IV - Estimated Costs for a six-year LiDAR acquisition

Estimated LiDAR Acquisition Costs to Finish Nebraska (Level 3)

Project Year		1	2	3	4	5	6	**Totals**
	Share\Area	4492	7018	3133	5894	5933	6136	**32606**
Federal	0.67	$505,620	$789,946	$352,650	$663,429	$667,818	$690,668	**$3,670,131**
State	0.23	$173,571	$271,176	$121,059	$227,744	$229,251	$237,095	**$1,259,896**
NRD/Local	0.1	$75,466	$117,902	$52,634	$99,019	$99,674	$103,085	**$547,781**
	Subtotal	**$754,656**	**$1,179,024**	**$526,344**	**$990,192**	**$996,744**	**$1,030,848**	**$5,477,808**

Mean Annual Investment

Federal	$611,689
State	$209,983
NRD	$91,297
	$912,968

***This scenario includes the costs to fly and process level 3 LiDAR for the remainder of the state over a 6-year period. This assumes that NRCS, and state and local agencies fund the project outside of the 3DEP. Est. Cost = $168 / Sq. Mile**

Estimated LiDAR Acquisition Costs to Finish Nebraska @ 3DEP (Level 2)

Project Year		1	2	3	4	5	6	**Totals**
	Share\Area	4492	7018	3133	5894	5933	6136	**32606**
Federal	0.8	$916,368	$1,431,672	$639,132	$1,202,376	$1,210,332	$1,251,744	**$6,651,624**
State	0.14	$160,364	$250,543	$111,848	$210,416	$211,808	$219,055	**$1,164,034**
NRD/Local	0.06	$68,728	$107,375	$47,935	$90,178	$90,775	$93,881	**$498,872**
	Subtotal	**$1,145,460**	**$1,789,590**	**$798,915**	**$1,502,970**	**$1,512,915**	**$1,564,680**	**$8,314,530**

Mean Annual Investment

Federal	$1,108,604
State	$194,006
NRD	$83,145
	$1,385,755

This scenario includes the costs to fly and process level 2 LiDAR for the remainder of the state over a 6-year period (3DEP Model). This assumes that USGS will cost share to the full 50% and that NRCS, State agencies, NRDs, Counties, and cities will fund 50%. Est. Cost = $255 / Sq. Mile

*The $255 / mi^2 estimated costs for acquiring LiDAR under 3DEP are based on information developed by USGS in planning 2015 LiDAR acquisitions.

Appendix V - NITC Elevation Request for Information

https://portal.nebraska.gov/sites/ocio/nitc/gis/elevation/default.aspx

Appendix VI - Activities and Milestones

Activities and Milestones	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019	FY 2020
Objective 1: Gather core requirements and stakeholder expectations								
1.1 Meet with user community to identify current and near-term uses and requirements	X							
1.2 Develop a LiDAR survey instrument	X							
1.2 Review industry standards	X							
Objective 2: Identify a standard that will meet the majority of these requirements and expectations in a cost-effective manner								
2.1 Identify a standard state-wide product (deliverables)	X							
2.2 Identify buy-up alternatives	X							
Objective 3: Define an elevation program management team								
3.1 Identify and define program management tasks		X						
3.2 Identify prospective team members and get commitments			X					
3.3 Obtain authorization for a state agency program					X			
Objective 4: Identify elevation data steward and responsibilities including storage and management strategies								
4.1 Identify and define stewardship responsibilities			X					
4.2 Inventory of "in-house" capabilities and expertise			X					
Objective 5: Identify and pursue program funding sources(s) and encumber funds. Market Business Plan								
5.1 Develop short, medium, and long term coordination and planning objectives		X						
Objective 6: Request program cost estimates from solution / data providers								
6.1 Develop and implement RFI	X							
Objective 7: Develop alternative scenarios for completing "standard product" LiDAR coverage for the state (see "LiDAR Statewide Acquisition Project" map)								

	X						
Objective 8: Identify and evaluate providers							
8.1 Send out RFPs for elevation projects	X						
Objective 9: Implement the project							
9.1 Develop procurement plan		X					
9.2 Acquisition projects		X	X	X	X	X	X
9.3 Stewardship plan		X					
9.4 Distribution plan		X					
Objective 10: Advertise and publish data							
10.1 Identify elevation data format(s) for NebraskaMap		X					
10.2 Create and deploy NebraskaMap elevation datasets		X					
Objective 11: Conduct post-project review							
11.1 Evaluate specific elements of success			X				
11.2 Identify specific actions for recalibration			X				