

**2018 NASCIO Award Submission  
Category:**

**Information Communications Technology Innovations**

**Project Title:  
“Elevating Tennessee” Through LiDAR Data Innovations**

**State of Tennessee, Department of Finance and Administration, Strategic  
Technology Solutions, GIS Services**

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**State:  
Tennessee**

**Project Initiation:  
December 1, 2015**

**Project Completion:  
December 31, 2017**

## **Executive Summary**

At all levels of government, geography, and more specifically geospatial data, often plays a significant role in business decisions that make government work more effective and efficient. With this in mind, the State of Tennessee, STS GIS Services developed an enterprise/multi-agency approach for funding the development of a new and innovative technology, LiDAR (Light Detection and Ranging) , that is used to create digital elevation data in support of federal, state, and local government agencies.

Working through the US Geological Survey's 3D Elevation Program (3DEP), the State of Tennessee has completed LiDAR data collection for approximately two thirds of the state. Since December of 2015, the USGS awarded Tennessee with funding for three separate LiDAR projects. Each award is based on a proposal submitted to the USGS that identifies several funding partners and associated benefits of how LiDAR data will leveraged in support of agency business needs. On average, each of the three Tennessee proposals identified approximately 70% of the funding and the USGS funded the remaining 30%. Through this coordinated effort, agencies are able to obtain the LiDAR data for pennies on the dollar. The goal is to complete statewide LiDAR collection by 2020.

In addition to the coordinated funding efforts, the LiDAR data has revolutionized the way in which many agencies view, manage, and analyze digital elevation data, saving time and money. Overall, having a statewide elevation LiDAR dataset will improve flood risk mitigation, transportation planning, environmental management, navigation, natural resources conservation, precision farming, hazard mitigation, and many others.

## **Exemplar**

The initial business driver and vision for developing statewide LiDAR elevation data was based on the flooding that hit the middle of Tennessee in 2010 and which struck again in west Tennessee in 2011. These flood events caused billions of dollars in damage. The flood maps throughout most of the State were old paper maps that were out of date and based on outdated technology that developed elevation data from 30 years ago. Significant land development and other natural impacts on the land modified the terrain throughout Tennessee resulting in the need for new, modern, digital flood maps to support flood insurance programs and related flood risk mitigation efforts. Ultimately, the State needed better data before the next disaster.

LiDAR (Light Detection and Ranging) technology was identified as a new, cost effective, and very accurate method for developing new digital elevation data to support flood mapping efforts and a wide range of other State agency needs.

To help build the business case for why Tennessee should invest in LiDAR, STS GIS Services set out to develop a business plan. STS GIS Services held workshops and conducted interviews with key stakeholders in State government, as well as engaging the federal and local government community in Tennessee. The final plan included several key benefits for State government and its citizens, including:

- Predicting the extent and impact of flood events
- Facilitating emergency management and public safety
- Ensuring fairness in code enforcement and property assessment
- Improving natural resource management and agriculture
- Discovering and preserving cultural resources
- Making decisions about flood insurance, damage mitigation measures, and public policy
- Site selection for new factories and industrial development
- Route planning and corridor management for transportation and utilities
- Promoting new skill development through the use of modern technology (i.e. LiDAR) to make Tennessee a center of excellence for such knowledge and related jobs

At the conclusion of the State business plan, the US Geological Survey (USGS) developed their own LiDAR program branded as 3DEP (3D Elevation Program) with the goal of developing LiDAR elevation data for the nation. Aligning these two initiatives gave STS GIS Services hope of realizing the vision and assistance with funding the effort.

## **Concept**

As the USGS began their 3DEP program, they solicited applications from States to participate in a collaborative effort to bring LiDAR to the nation. Tennessee was fortunate to receive three separate financial awards from the USGS that corresponds to

the LiDAR projects funded from 2015-2017. Each project collected LiDAR data for about 20 counties on average. Having implemented and proven the benefits of LiDAR, the State is now completing the rollout in remaining counties. Through December of 2017, Tennessee has collected LiDAR data in 56 of the 95 counties.

Funding for Tennessee LiDAR Projects 2015-2017

	Federal	State	Local	USGS	Total
2015	\$390,000 (3 Agencies)	\$643,000 (2 Agencies)	\$377,000 (8 City/County)	\$600,000	\$2,010,000
2016	\$350,000 (2 Agencies)	\$582,000 (2 Agencies)	\$0	\$502,000	\$1,434,000
2017	\$350,000 (2 Agencies)	\$818,000 (2 Agencies)	\$190,000 (2 Counties)	\$731,000	\$2,089,000
Total	\$1,090,000	\$2,043,000	\$567,000	\$1,833,000	\$5,533,000

One of the benefits of leveraging the USGS funding is that the LiDAR data must be in the public domain. So, although many state agencies that couldn't assist with funding, they were still able to acquire the data to support their internal business needs.

In addition to addressing the need for better flood maps across the state, many state agencies found value in the LiDAR data that addressed specific issues or agency dilemmas. A key example is the Tennessee Department of Environment and Conservation (TDEC), Division of Water Resources, Land Reclamation section.

TDEC administers an Abandoned Mine Lands (AML) program, with the goal of transforming old, scarred strip mines into manageable land. Prior to the Surface Mining Control and Reclamation Act (SMCRA) of 1977, it was legal for strip miners to leave a site un-reclaimed, creating dangerous public health and safety hazards characterized by high walls, pits and uneven, irregular terrain. Traditional aerial photogrammetry formerly used to assess the condition of abandoned mine sites did not sufficiently reflect their condition and terrain. AML Program Manager Trevor Martin indicates, "With aerial photography, the contours and spoils were obscured by pine tree cover...but with LiDAR data that tree cover goes away, and you can get good ground penetration through the terrain to generate a very accurate bare earth surface model."

With an accurate view of the landscape, TDEC is able to evaluate the actual condition of the site, assess the yardage of spoils, reestablish surface drainage patterns to boost water quality, and prioritize projects based on need and which pose the highest risk to the public.

### Significance

The LiDAR data has proved to be both significant and revolutionary for an array of state government agencies. The agencies using the data include but are not limited to TDEC,

the Department of Transportation (TDOT), the Department of Agriculture, the Comptroller of the Treasury's Office of Local Government, and the Department of Finance and Administration. Not only do state agencies benefit from this accurate elevation data, but the citizenry, local governments, and federal government agencies have found the data to be very valuable in a broad range of use cases. As the coordinator for this project, STS GIS Services has been able to both educate through a training program and also gauge the significance of the data to state constituents.

In state government, the two primary users of LiDAR data are TDOT and TDEC. The Department of Transportation has been a significant funding partner as well as advocate for future updates to the project. Their uses of the data are wide reaching within the department. TDOT has been able to use the data to improve workflows in hydrologic and flood modeling for culvert and roadway design. At a recent GIS user's group forum, TDOT presented an impressive process for modeling flood water flow through a culvert and how they are using the flow models to design safer more effective culverts. The data provides accurate Digital Elevation Models (DEMs) that have been used to generate slope maps for planning and hazard prediction. In addition, the LiDAR has been transformational by minimizing field surveys to plan for construction.

Within TDEC there are separate departments that have been leveraging the new and improved elevation data. The use cases vary within these departments and the project has proved to be transformational in their workflows. State Parks for example is using the elevation data for archeological site identification, trail elevation mapping, site planning for new trails and construction, and land acquisition planning. A recent project by State Parks has been the study of Native-American burial mounds at Pinson Mounds State Park, and they have been able to identify and map previously undiscovered mounds. Additionally within the Water Resources Division they have discovered the data to be very important using it for environmental impact studies, groundwater modeling, wetland delineation, hydrologic modeling, and stream channel identification. As mentioned, the Water Resources AML program has been a large user providing the program with better ways to initiate and complete mine reclamation.

State agencies have not been the only group to improve workflows and create new projects with the availability of this data. Surveyors and engineers have found the elevation data significant for site planning and topography generations. Local governments are discovering the significance of good elevation data as well. Regional Development districts are leveraging contours generated and provided by the State to make industrial site planning easier and cheaper. The United States Department of Agriculture – Natural Resources Conservation Service who has been a great funding partner and advocate for the project has used the data to easily provide farmers and landowners across the state with soil erosion control solutions.

STS GIS Services has witnessed the extensive uses and seen how the significance of this data has been discovered by so many different agencies, departments, and groups and thus making the citizens of Tennessee the ultimate beneficiaries.

Information on the importance of this project has been shared with the public via the STS GIS Services' projects web page. This allows state agencies as well as citizens to become educated on the project.

Project page link: <https://www.tn.gov/finance/sts-gis/gis/gis-projects/gis-projects-elevation.html>

The LiDAR point cloud data, as well as the derivative products; digital elevation models, building footprints, contour data and breaklines have been shared to the public via the STS GIS Services' data web page and through the employment of Google Drive cloud storage.

Data page link: <https://www.tn.gov/finance/sts-gis/gis/data/>

## **Impact**

As the project has been developed and completed, the impacts to the state of Tennessee have been more and more apparent. STS GIS Services is actively partnered with the state Geographic Information Systems (GIS) users group. Through this partnership and through the coordination of state government, STS GIS Services has seen the data appreciated and used for so many applications. Simplified, the impacts observed have been savings in both time and money, improvements in the environment and safety of the citizens of the state.

Both TDOT and TDEC have presented at local user forums the time savings they have seen from using the new improved elevation information. For example, a recent TDEC-AML presentation showed how LiDAR has impacted their project design by "improving initial site scouting from the office, better targeting limited resources and eliminating unnecessary trips to the field." Additionally, the TDOT Hydraulic Design group has seen improvements in the quality of their models, ability to schedule more efficiently, cost savings by cutting field time, and the ability to study a larger area of interest with the onset of the elevation data. Local governments have also communicated the time saving impacts of the states project. The City of Chattanooga Land Development Office has been utilizing the new technology on a daily basis and it has "opened a new world" commenting on the speed in which they can now complete site surveys. These examples show the direct impact in cost savings that are ultimately passed on to the tax payers of Tennessee.

Environmental improvements to the state have also been greatly impacted by LiDAR technology. Both state and federal agricultural departments have been employing the data to improve wetland conservation, stream conservation, and environmental planning. One such example is from the Water Resources Division at TDEC where they

are using the LiDAR technology to accurately measure ground water levels from the surface around landfill sites where hazardous chemicals can enter the water table. The data is improving measurements at well locations and thus impacting how the state is responding to this environmental threat.

As mentioned, one of the initial drivers to pursue this technology was in response to flooding. Preparation for natural disasters has been greatly improved with Lidar technology making Tennessee a safer place. Better flood maps are being developed and utilized by TDOT designers, waste water management, flood responders, and local flood plain managers to make safer decisions in regards to flood control and residential location. Another benefit to emergency response using this technology was in the devastating wildfires in the Smoky Mountains area in November and December of 2016. STS GIS Services was able to coordinate with State Forestry, local government, and responders to the fire and provide the LiDAR derived building footprint data as well as digital elevation models. This data was used in both the first response and post fire studies that will help future fire response and fire risk assessments.

Overall, the effect of the State's LiDAR collection project has made State government work more effective and efficient and provides Tennesseans with improvements in environmental quality and public safety, among others. Through the coordination of STS GIS Services, more LiDAR projects are anticipated and supported by more State agencies and other levels of government as they have seen the return on investment of the existing LiDAR projects.