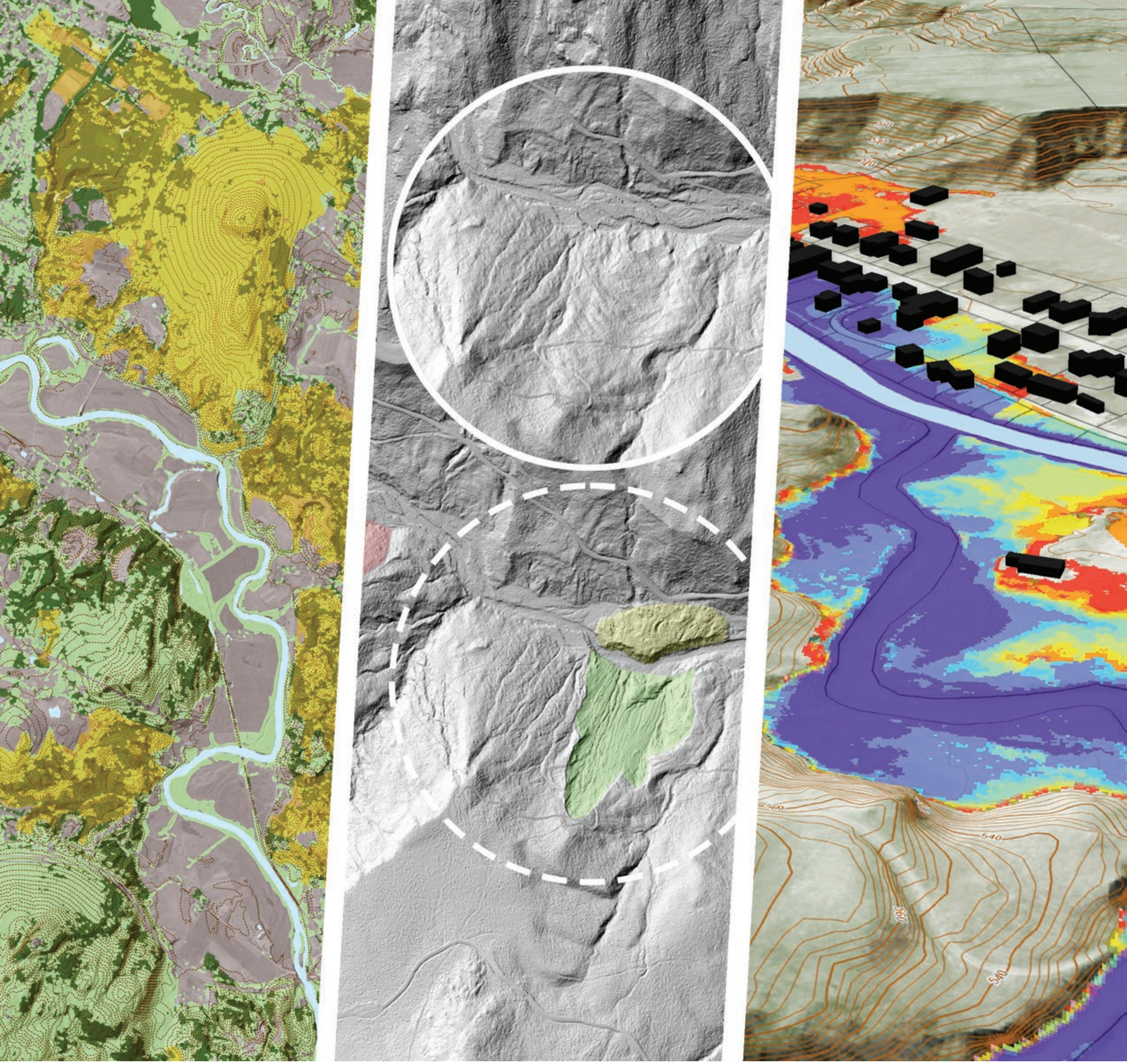

Vermont Lidar Plan

2023

Prepared by the
Vermont Center for Geographic Information
Agency of Digital Services

VERMONT
LIDAR PARTNERSHIP

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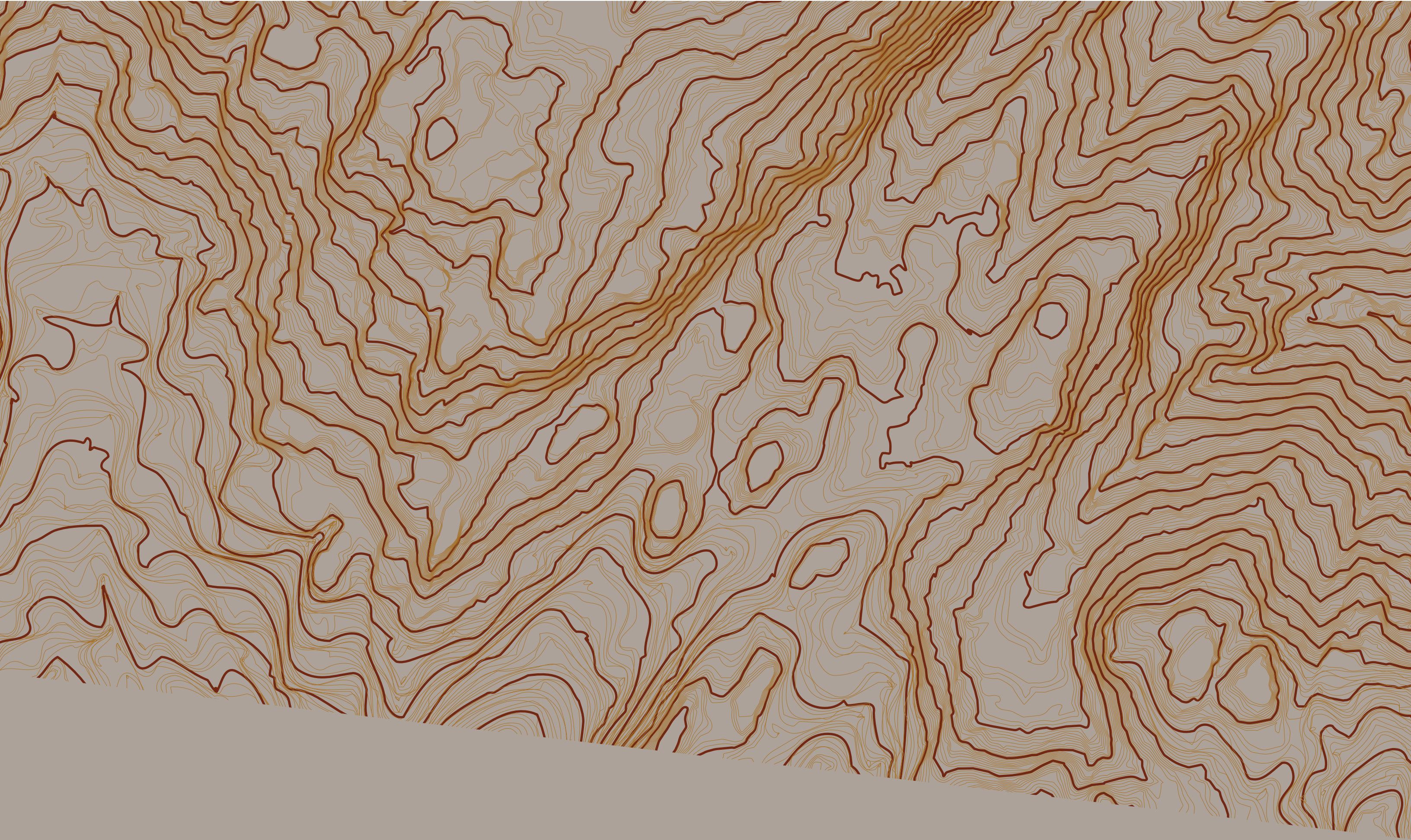


Contents

All images by VCGI unless noted in caption.

VERMONT LIDAR PARTNERSHIP

Summary

Vermont Lidar Plan 2023

This plan conveys the State of Vermont's intention to obtain statewide Quality Level 1 (QL1) airborne lidar data for supporting activities across all sectors of Vermont's Strategic Plan as well as core functions of government throughout State Agencies and Departments.

Lidar-derived elevation data represent a consistent and seamless statewide topographic framework that supplants a traditionally time-consuming and costly approach of extensive field data collection. Instead, these remotely-sensed data save time and money many times over, accumulating benefits with each additional use. Based on the National Enhanced Elevation Assessment commissioned by the United States Geological Survey (USGS), the 8-year minimum ROI for Vermont's investment is expected to be nearly 10:1.

The plan focuses on the common needs highlighted by partners across all levels of government, academia, and the private sector: 1) Vermont needs updated topographic data, which is now on average 8 years old and older than 10 years in parts of the state; 2) higher resolution data QL1 is needed to meet most use cases, and 3) a consistent single year collection would simplify use of the data and leverage economies of scale. The Vermont Lidar Plan provides a framework and timeline to meet these needs and **charts a path towards a goal of Quality Level 1 lidar data collected statewide in the Spring of 2023 during leaf-off conditions.**

Federal partners have identified Vermont as a priority for data collection and the USGS 3D Elevation Program (3DEP) in December 2022 committed matching funds towards the project. State matching funds are anticipated to come from the FY23 budget adjustment, pending inclusion of the funds in the Governor's forthcoming budget and subsequent approval by the legislature.

Whether by supporting informed housing development, protecting the vulnerable by improving the accuracy of mapped areas prone to flooding and natural hazards, reducing the need for intensive field data collection, or improving the effectiveness of government across jurisdictions, lidar-derived elevation data promoted by this plan remains an essential information resource supporting these tasks and many more in the years to come.

The Vermont Center for Geographic Information
January 2023

Figure 1 (Below): A sample of lidar-derived elevation data products' uses in supporting the four sectors of Vermont's Strategic Plan

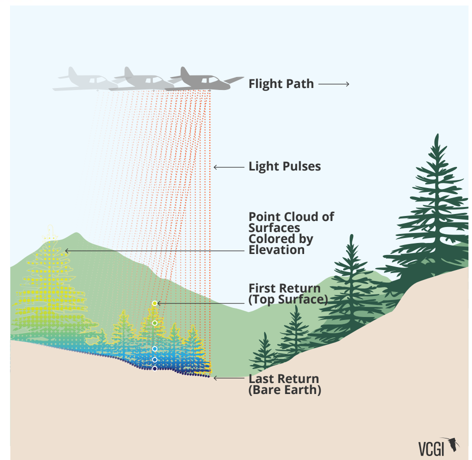
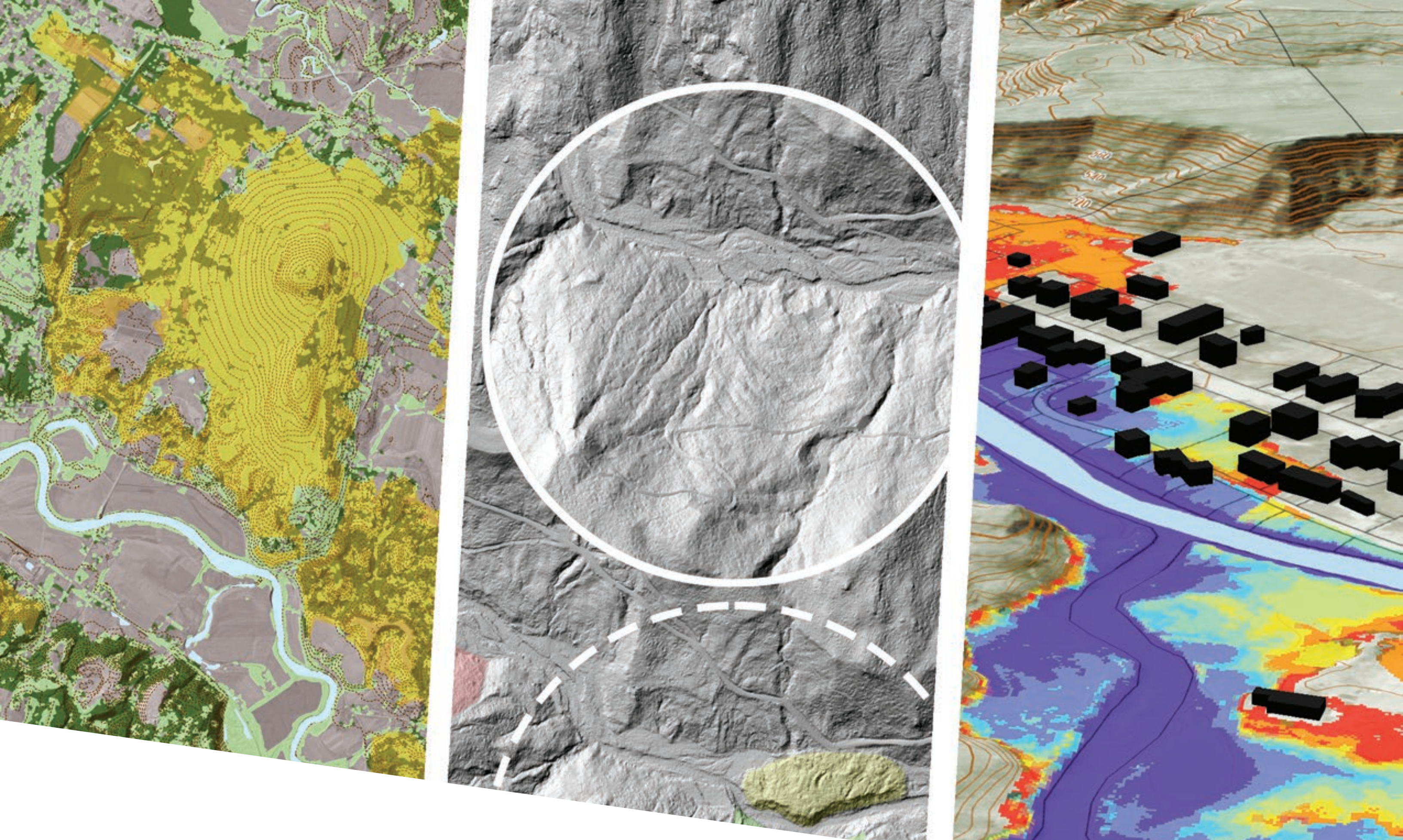


Figure 2 (Above): Light Detection and Ranging (lidar) is a technology used to create high-resolution models of ground and surface elevation. Airborne lidar is collected using sensors that detect the reflections of a pulsed laser beam. Reflections are recorded as billions of individual points, which are processed into digital three-dimensional models of Vermont in formats readily accessible for use by state agencies, partners, and the public.

Figure 3 (Left): The plan proposes to captue the entire state in one collection season during 2023 at Quality Level 1 (QL1), 4 times the resolution of Vermont's existing data which is over a decade old in parts of the state.



3D Elevation Program

Supporting Vermont's Economy and Environment

Introduction

The Vermont GIS community has a history of cross-disciplinary and cooperative projects that involve both the capture and use of geospatial data across the State. One such example is Vermont's achievement of statewide quality level 2 coverage of inland topographic light detection and ranging (LiDAR) data in 2017 (see table 1). Far more accurate than what was available, obtaining this high-quality elevation data enabled GIS professionals to support decision makers in important efforts such as economic development, environmental protection, public safety, watershed management and water quality, geology, transportation planning, forest and wildlife management, local planning, and floodplain management as these data permit visualization of the Vermont landscape in ways previously unavailable while serving as a common foundation for decision making across sectors.

Presented here are examples of the State of Vermont's effective stewardship of lidar-derived elevation data as we look to update them to provide continued support of initiatives that now depend on such data.

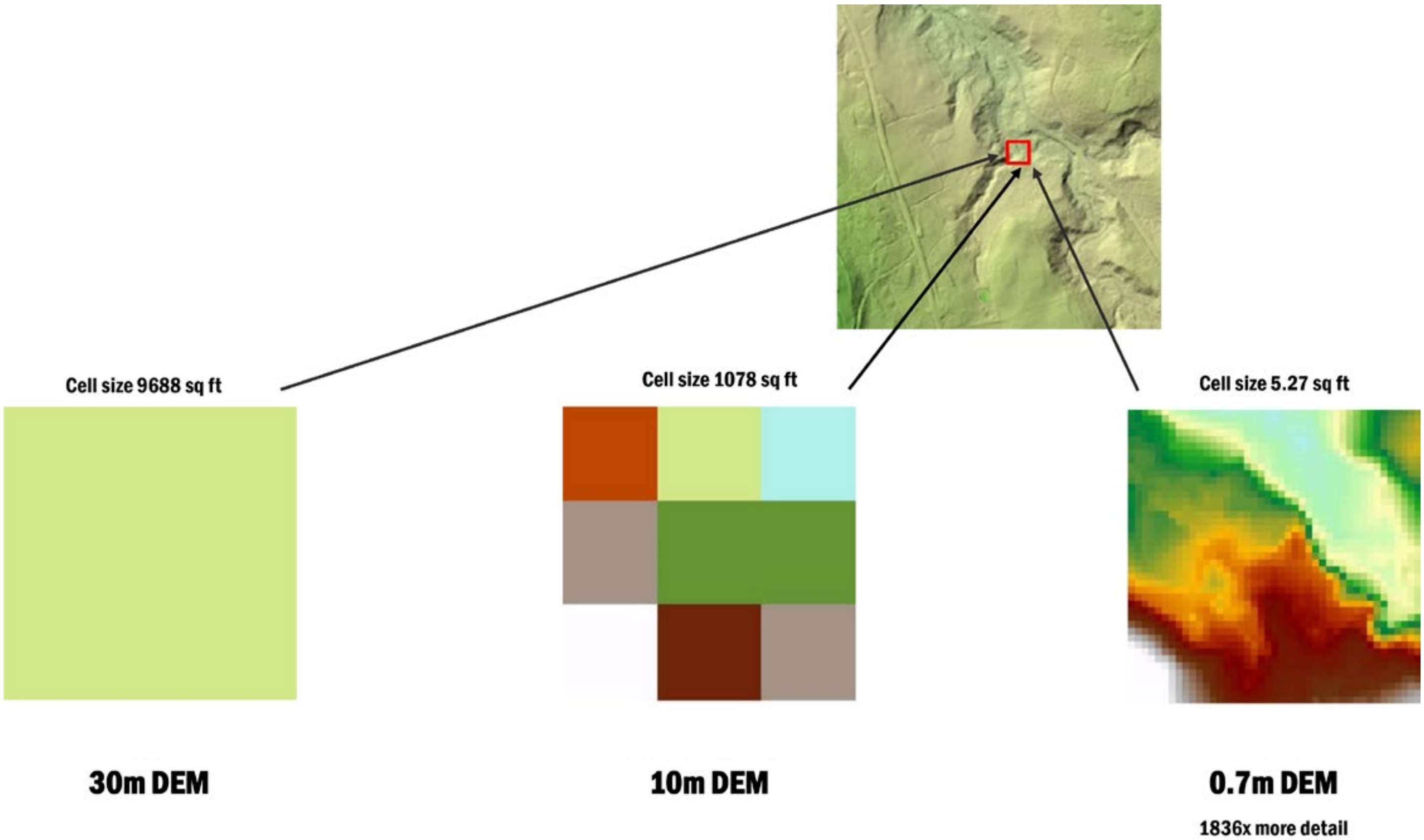


Figure 4 (Above): Evolution of the resolution of Vermont's available elevation data. Note: Vermont's QL2 data differ slightly from USGS specifications of 1.0m cell size in that they are 0.7m cell size.

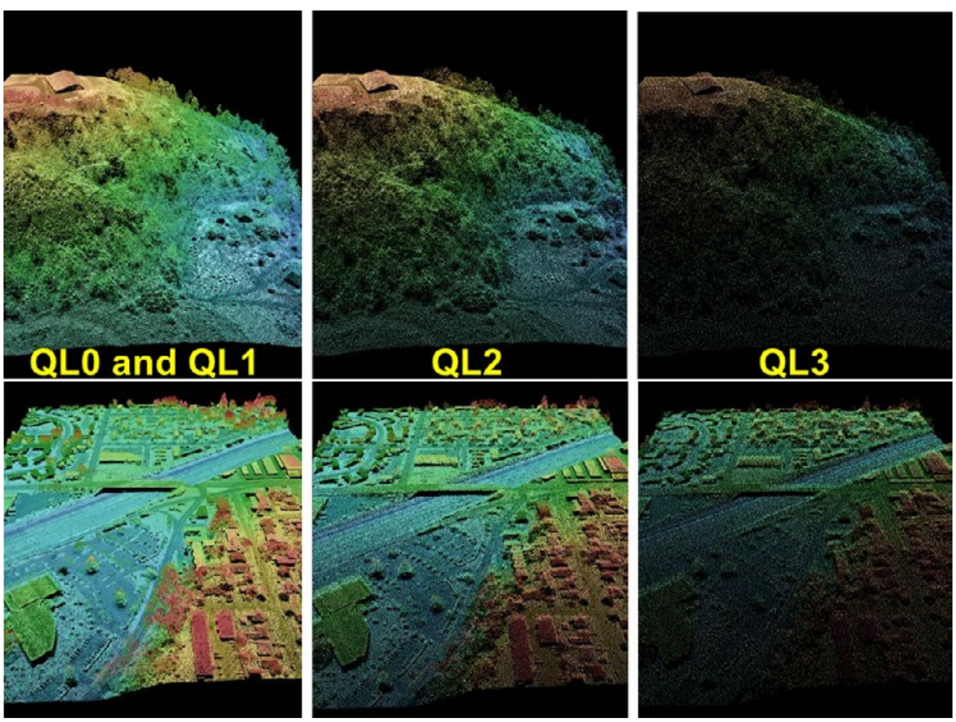


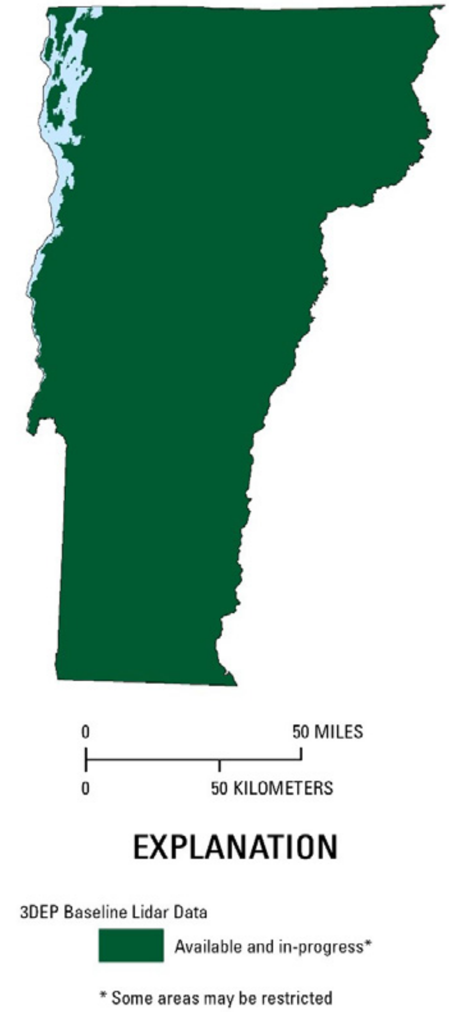
Figure 5 (Left): 3D view of lidar point clouds demonstrating differences in point density at each lidar quality level (QL). This proposal is to move from currently available QL2 to QL1 data for Vermont. Source: USGS

Status of 3DEP in Vermont

The 3D Elevation Program (3DEP; see sidebar) is managed by the U.S. Geological Survey (USGS) in partnership with Federal, State, Tribal, U.S. territorial, and local agencies to acquire consistent lidar coverage at quality level 2 (QL2) or better to meet many needs of the Nation. For Vermont, the entire state is 3DEP baseline lidar data-compliant in that it meets QL2 and reflects the Lidar Base Specification (https://www.usgs.gov/3dep/lidarspec) requirements.

Ten years ago, The National Enhanced Elevation Assessment (NEEA) (Dewberry, 2012) identified user requirements and estimated that availability of such lidar data would result in at least $1.63 million in new benefits annually to the State. In that report, the top ten Vermont business uses for 3D elevation data based on the estimated annual conservative benefits of 3DEP are shown in table 2. A subsequent report suggests that lidar brings a nearly 5:1 return on investment in supporting public policy, safety, planning, and infrastructure decisions that depend on high-quality elevation data (Sugarbaker et al., 2014). Yet more recent studies continue to detail the public benefits of regularly updated high-resolution lidar elevation capture, emphasizing a collect "sweet spot" that balances benefit-cost ratio and translates to a roughly 5-year update cycle at resolutions greater than QL2 (Dewberry, 2022).

Consistent with this recent finding, and perhaps a consequence of the acquisition of and ease of access to statewide QL2 elevation data across Vermont, there is now an emerging need for more recent lidar data at higher resolution. Use of existing Vermont QL2 data suggest that the annual benefits will increase if up-to-date, quality level 1 (QL1) lidar data were available statewide. The following sections list several existing and potentially expanded Vermont use cases that would benefit from the availability of QL1 inland topographic and bathymetric lidar-derived elevation products.



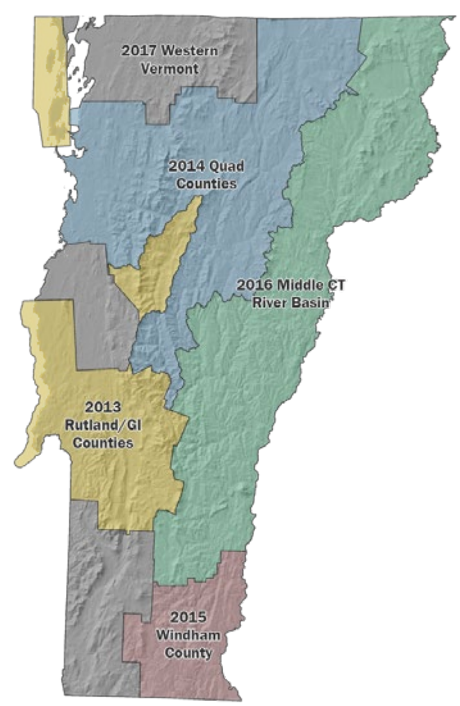


Figure 6 (Top Right): USGS 3DEP data at QL2 is available statewide in Vermont. Source: USGS.

Figure 7 (Bottom Right): Although QL2 data are available statewide, it is a composite layer reflecting 5 separate collections spanning 5 years, from 2013 to 2017. In other words, the oldest component collection is nearly 10 years old.

Table 1 (Opposite): Data quality levels. QL 0 represents the highest quality. RMSE is Root Mean Square Error in the elevation (z) dimension. Pulse spacing and pulse density are measured in meters and pulses per square meter, respectively. Source: Sugarbaker et al. 2014.

USGS 3D Elevation Program (3DEP)

The 3D Elevation Program is managed by the U.S. Geological Survey (USGS) on behalf of the community of Federal, State, local, and other partners and users of elevation data. In response to growing needs for high-quality elevation data, the goal of 3DEP is to complete acquisition of nationwide light detection and ranging (lidar) data (interferometric synthetic aperture radar [IfSAR] data in Alaska) to provide the first-ever national baseline of consistent high-resolution topographic elevation data – both bare earth digital elevation models and 3D point clouds.

Benefits

- Economies of scale by acquiring data for larger areas.
- Predictable and flexible Federal investments that reduce costs and allow better planning.
- Consistent national coverage that provides data for applications that span project, jurisdictional, and watershed boundaries.
- Simplified data acquisition that provides contracts, project management, quality assurance, and published data specifications.
- National benefits of $690 million per year conservatively, with the potential to generate $13 billion per year in additional benefits through applications that span the economy (Dewberry, 2012).

High-Quality Data and Products

3DEP lidar provides coverage with a minimum of two points per square meter and a vertical error not to exceed 10 centimeters, measured as root mean square error in the elevation (z) dimension (RMSEz) (see table 1). 3DEP baseline lidar data products include all data points collected (point clouds) and bare-earth digital elevation models with a 1-meter or better resolution. The USGS integrates the elevation data into The National Map. Data are available free of charge and without use restrictions. To download 3DEP products visit https://apps.nationalmap.gov/downloader/.

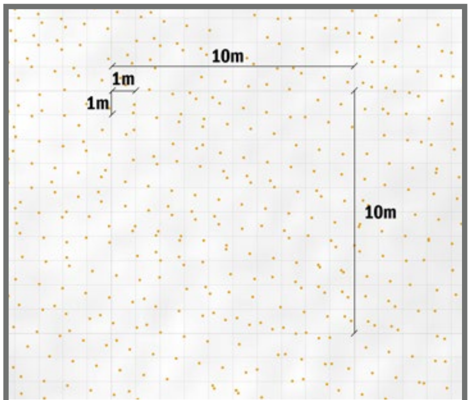
Ways to Participate

3DEP participation is open to Federal, State, Tribal, U.S. territorial, and local government partners, as well as private sector partners, and offers the option to acquire higher quality data. Partners may contribute funds toward projects managed by the USGS, or they may receive cooperative funds to manage their own projects. An annual Broad Agency Announcement (BAA) is the mechanism used to establish partner agreements. Organizations and the private sector may contribute existing data that meet 3DEP requirements. For more information see the 3DEP website at https://usgs.gov/3DEP/collaborate.

Table 1 (see description opposite page):

Quality Level	Absolute Vertical Accuracy RMSEz (cm)	Aggregate Nominal Pulse Spacing (m)	Aggregate Nominal Pulse Density (pls/m^2)
QL 0	≤ 5	≤ 0.35	≥ 8.0
QL 1	≤ 10	≤ 0.35	≥ 8.0
QL 2	≤ 10	≤ 0.71	≥ 2.0

Pulse Density



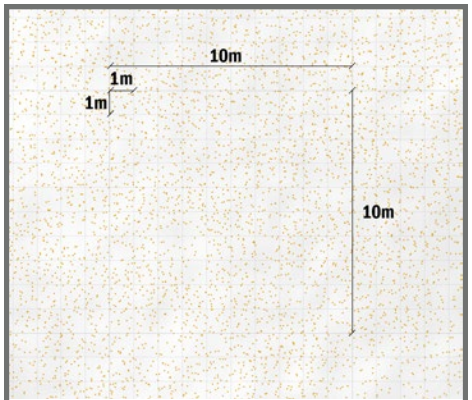
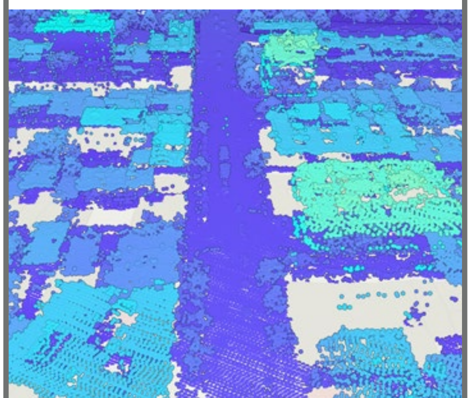


Figure 8 (Left): Quality level 2 / "QL2" pulse density at ~2 points per square meter.

Figure 9 (Right): Quality level 1 / "QL1" pulse density at ~8 points per square meter.

Elevation



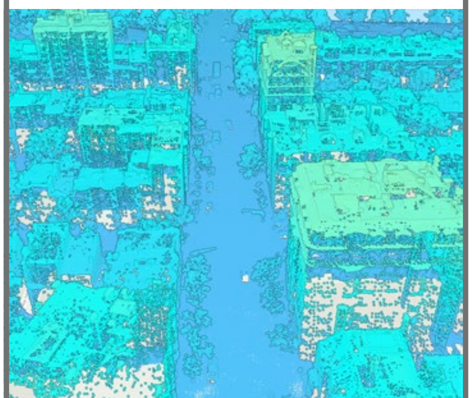


Figure 10 (Left): 3D view of QL2 / 2pts/sq.m point cloud colorized by elevation.

Figure 11 (Right): 3D view QL1 / 8pts/sq.m point cloud for the same location (Boston's Back Bay) colorized by elevation.

Classification

Figure 12 (Left): QL2/2pts/sq.m point cloud colorized by classification. Brown points are ground, grey are unclassified.

Figure 13 (Right): QL1/8pts/sq.m point cloud colorized by classification. Brown points are ground, red are buildings, greens are vegetation, and grey are bridge deck.

Intensity

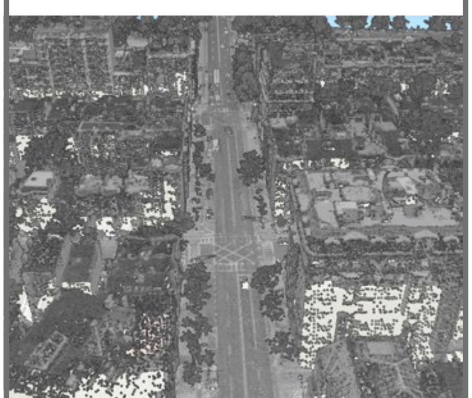


Figure 14 (Left): QL2/2pts/sq.m point cloud colorized by intensity, which is the return strength of the laser pulse.

Figure 15 (Right): QL1/8pts/sq.m point cloud colorized by intensity, Readily identifiable features are visible as this quality level.

"QL2"Capture

~2 points per sq. meter
Existing VT Lidar-derived Elevation Resolution

"QL1"Capture

~8 points per sq. meter
Proposed VT Lidar-derived Elevation Resolution

Data source for all on this page: USGS Project ID [218602](218602) (QL1) and USGS MA NE CMGP Sandy Z19 2013 [19TCG270905](19TCG270905) (QL2)

Elevation Classified

Figure 16 (Top): 3D view of QL2 / 2pts/sq.m point cloud colorized by elevation classification, with blue values lower in elevation and red values higher.

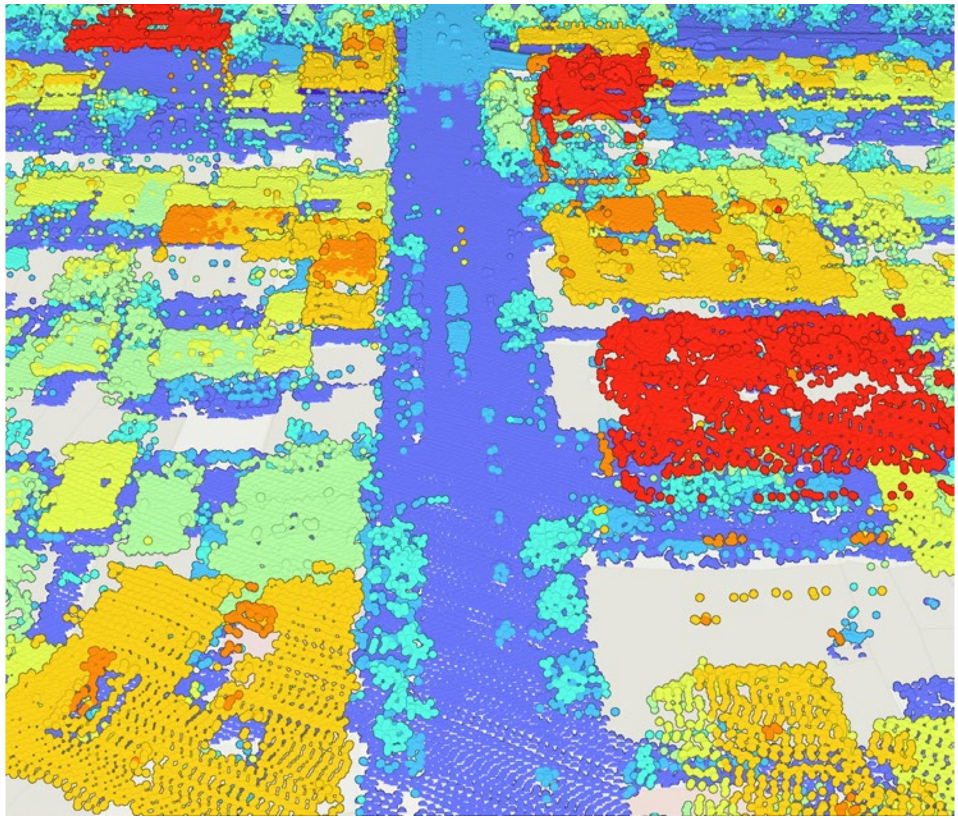
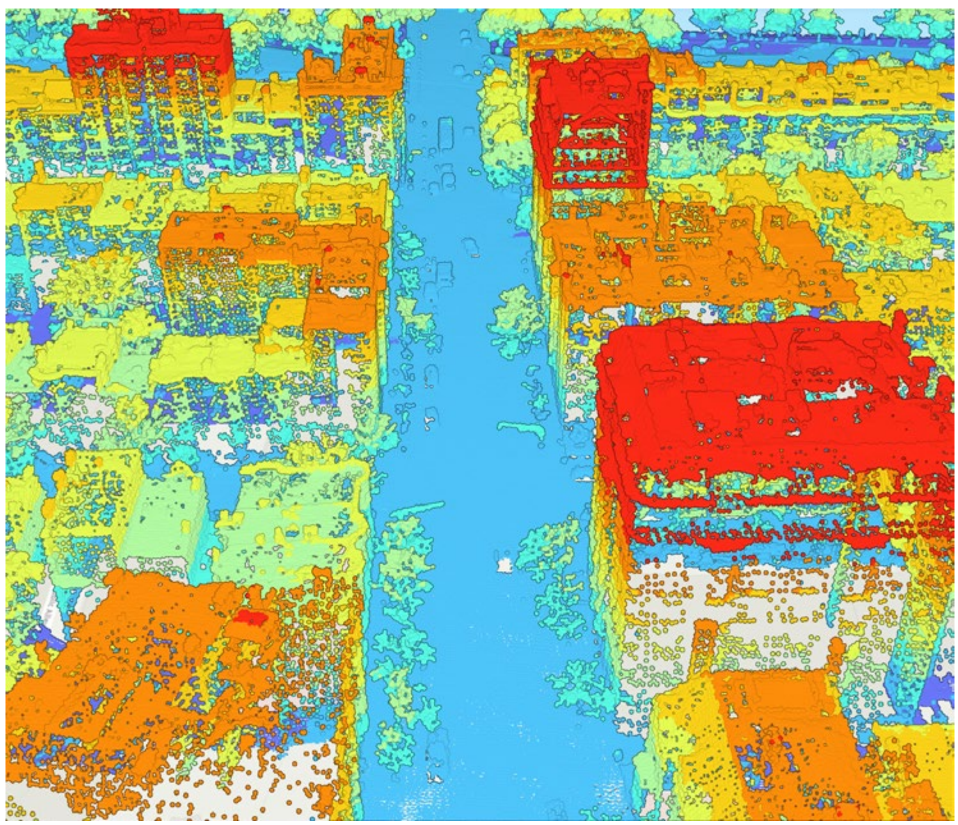


Figure 17 (Bottom): 3D view of QL1 / 8pts/sq.m point cloud colorized by elevation classification for the same location (Boston's Back Bay). QL1's increased pulse density relative to QL2 as well as overall improvements in sensing technology permit higher-resolution depiction of objects and surfaces, enabling higher-resolution lidar-derived elevation products.



Data source for all on this page: USGS Project ID [218602](#) (QL1) and USGS MA NE CMGP Sandy Z19 2013 [19TCG270905](#) (QL2)

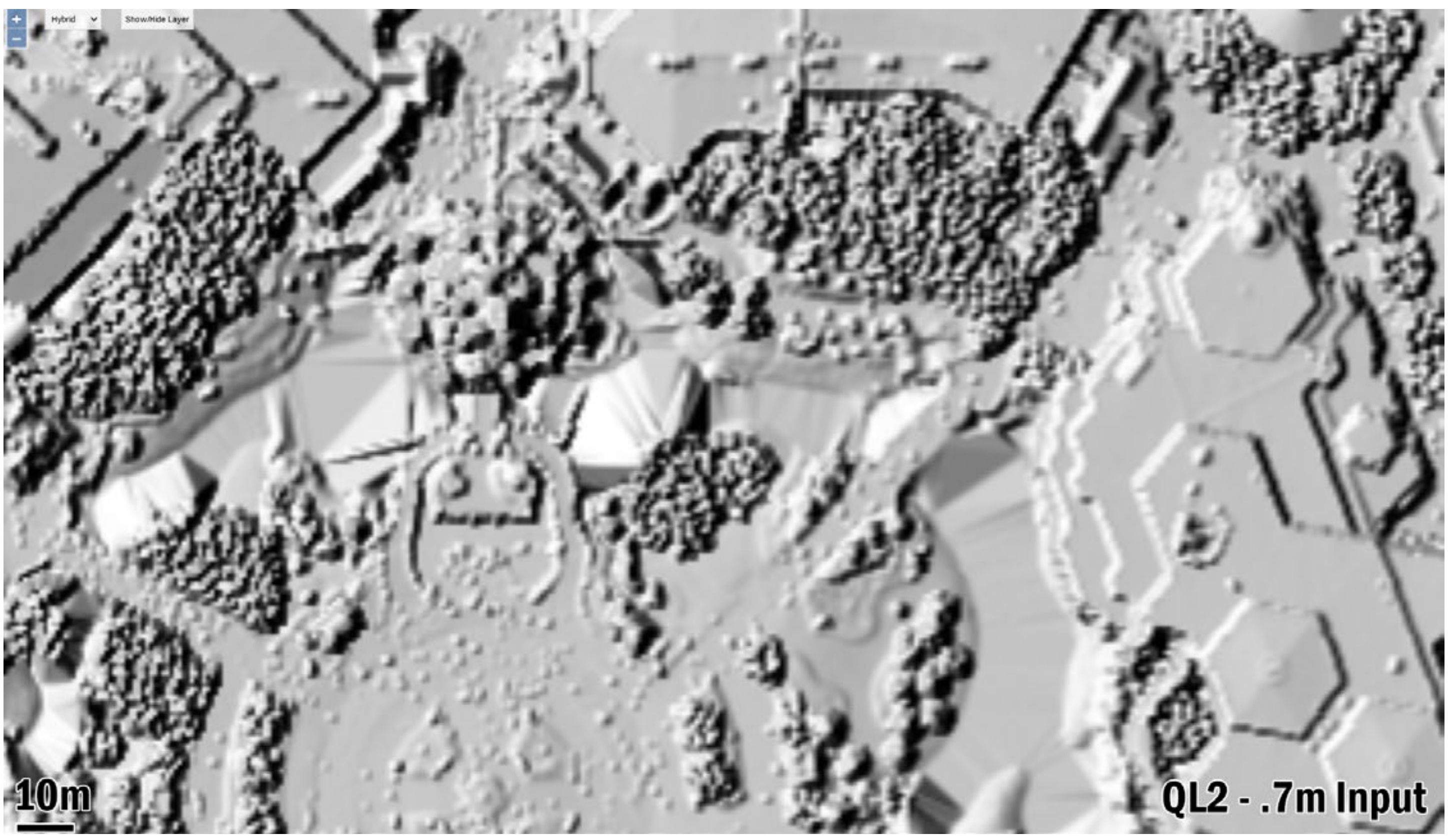
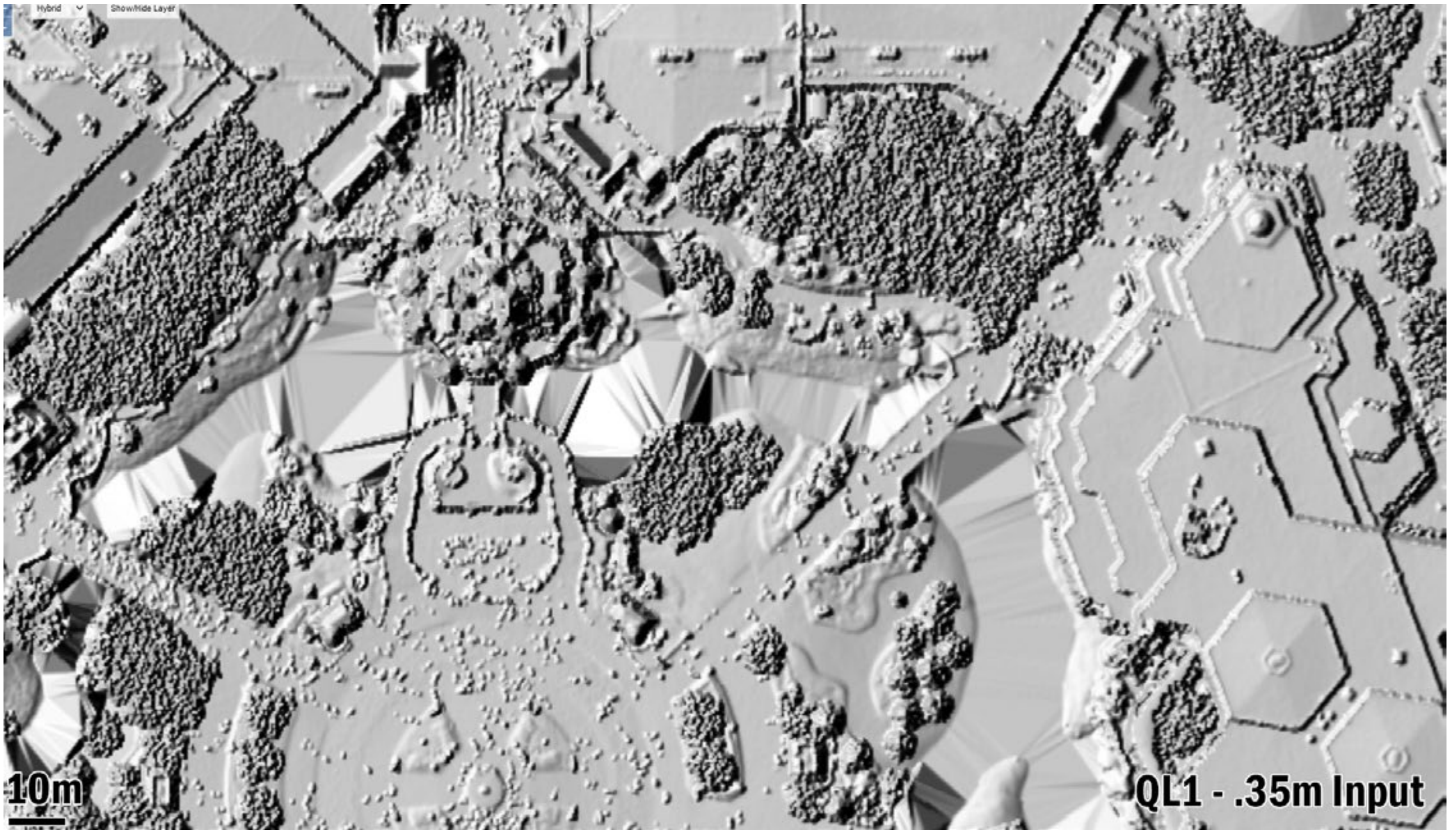


Figure 18 (Top): Orthoimage of the Magic Kingdom, Orlando, Florida. This area was captured with QL1 lidar data capable of producing a .15m Digital Elevation Model (DEM). Data Source: USGS/opentopography.org

Figure 19 (Bottom): Hillshade derived from .7m DEM input, simulating QL2 source data. Data Source: USGS/ opentopography.org



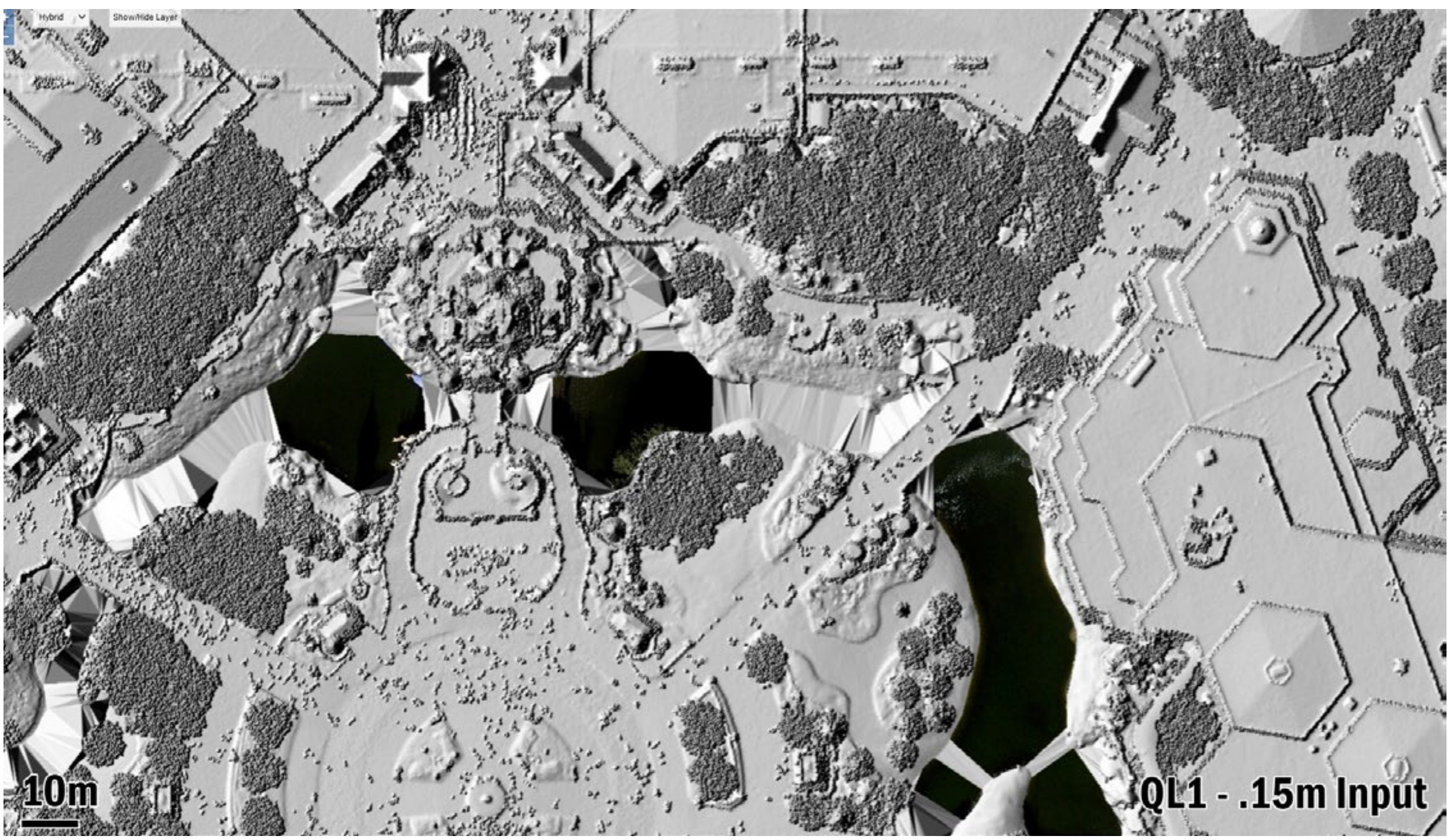


Figure 20 (Top): Hillshade derived from .35m DEM input, simulating QL1 source data. Data Source: USGS/ opentopography.org

Figure 21 (Bottom): Hillshade derived from .15m DEM input, simulating QL1HD source data at >8 pts/sq.m. Data Source: USGS/opentopography.org

Applications and Uses

Existing and Potentially Expanded Uses of High-Resolution Lidar-Derived Elevation Data in Vermont

Geological Resource Assessment and Hazard Mitigation

As a headwater State, Vermont experiences landslides throughout all its physiographic regions. Existing lidar provides detailed bare earth elevation data, even in heavy vegetation areas, that enhances surficial geologic mapping used for the identification of landslides, sinkholes, blind valleys mapping, monitoring and analysis, as well as assists with geologic resource assessments such as the identification of sand and gravel deposits. A recent example involved State geologists assessing a 2020 landslide at Cotton Brook employing existing lidar-derived elevation products to understand the scope of impacts and geological context of the event (see Figure 5). More current and higher-resolution data would further aid this kind of work.

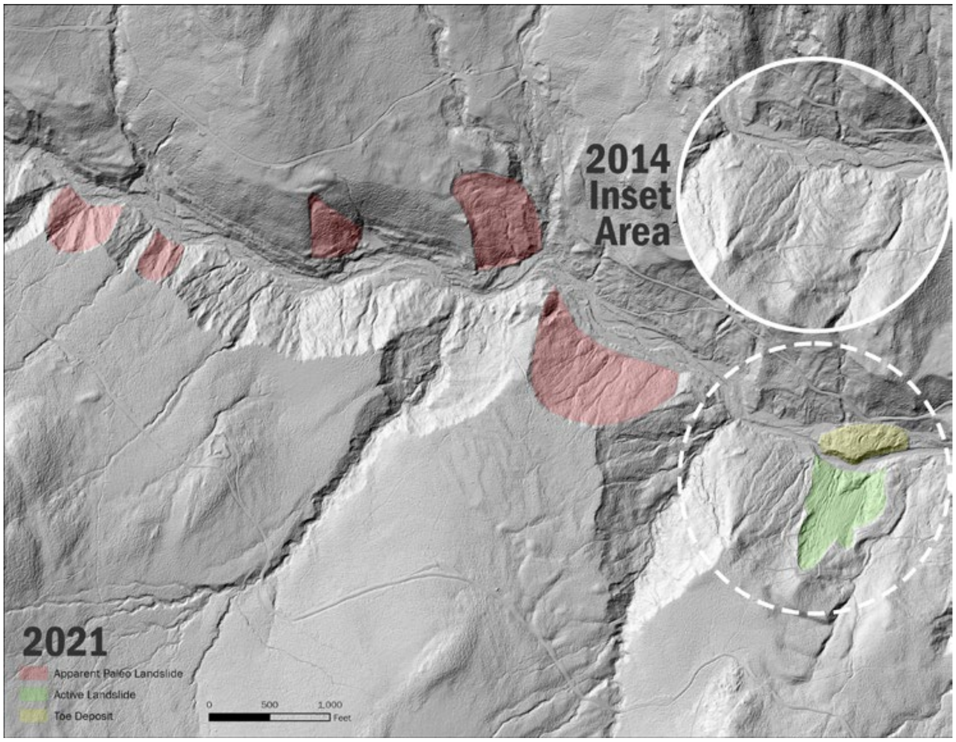


Figure 22 (Top): Active and apparent paleo landslides along the Cotton Brook, Mount Mansfield State Forest, VT, as seen in 2014 and 2021, used to understand the 2020 Cotton Brook Landslide. Source: Tim Terway/VCGI and Julia Boyles/VGS

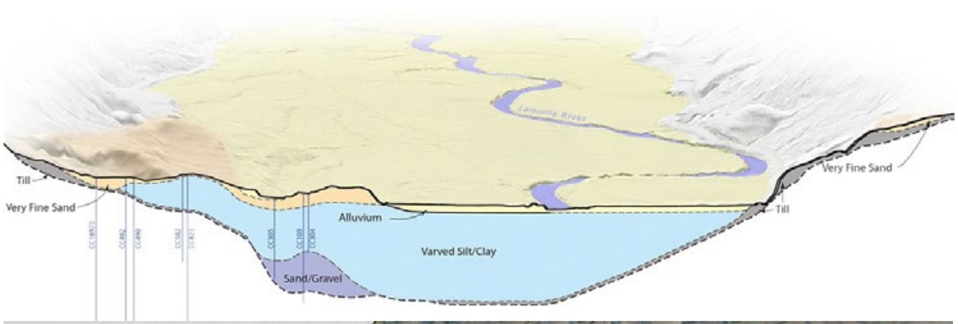


Figure 23 (Center): Cross Section at Jeffersonville, VT utilizing lidar hillshade to visualize geological conditions. Source: Colin Dowey/ ANR

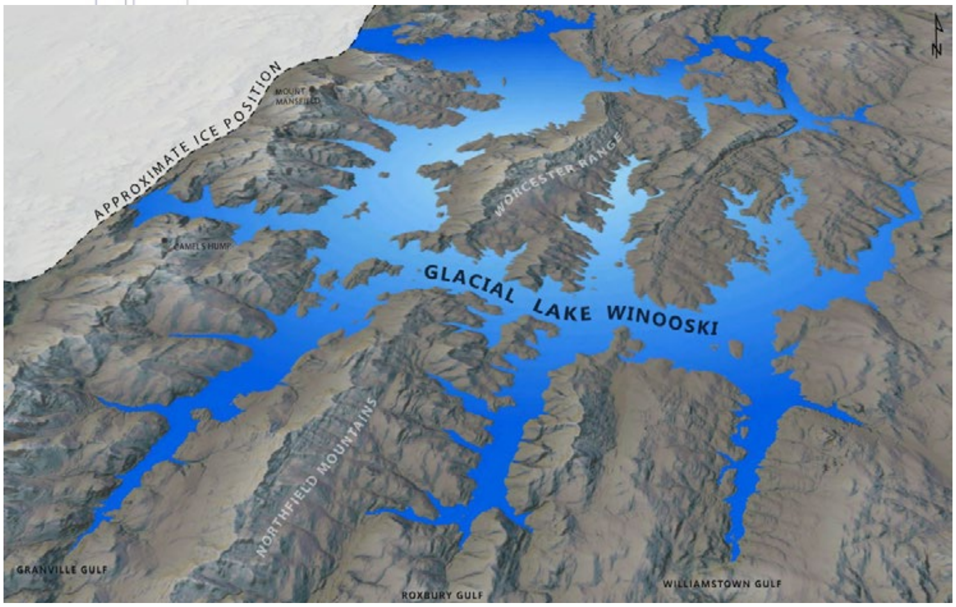
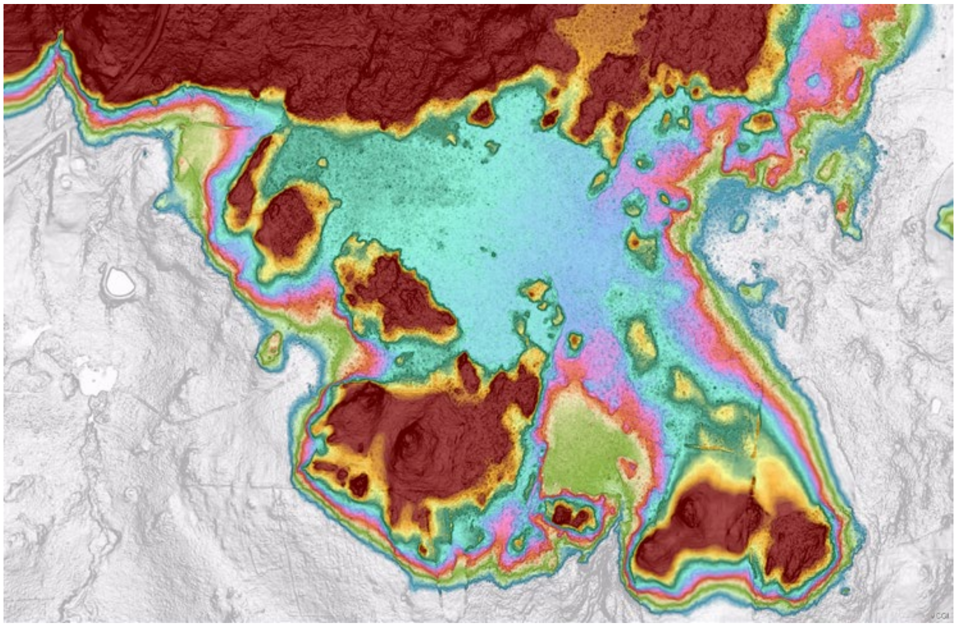


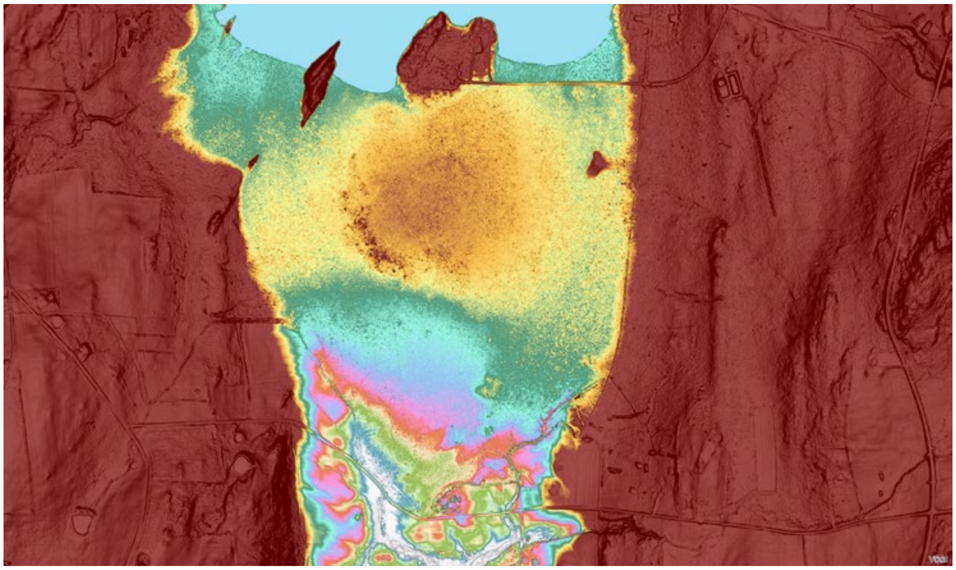
Figure 24 (Bottom): Lidar elevation data has helped researchers accurately estimate and visualize the extent of glacial lakes in Vermont. Source: Colin Dowey/ANR

Natural Resources Conservation

High resolution elevation data enables State, regional, and local governments to implement natural resources conservation practices. These activities include grade stabilization, dam safety, habitat easements, pipelines, terracing, wetland restoration, and identifying historic wetlands (drained) and cultural features.

Lidar-derived elevation represents a consistent and seamless statewide topographic framework that supplants a traditionally time-consuming and costly approach of extensive field data collection. Instead, these remotely-sensed data save time and money many times over, accumulating benefits with each additional use.





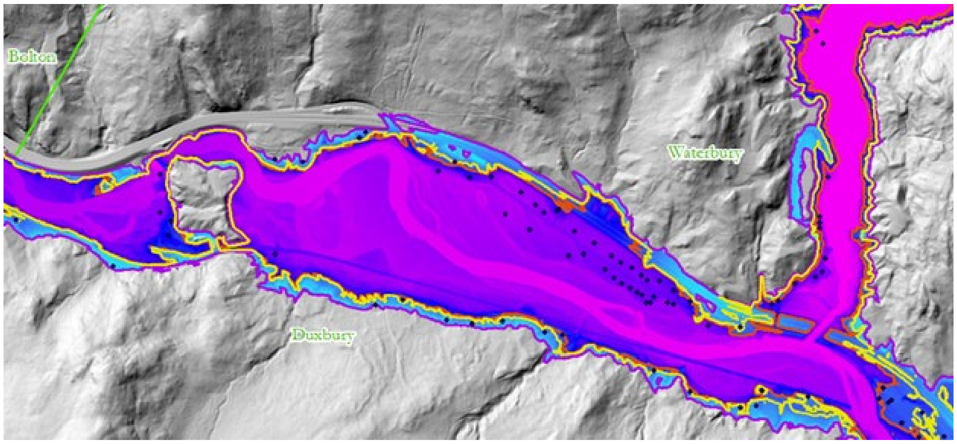


Figure 25 (Top): ANR wetland ecologists use lidar-derived elevation data to observe variations in wetlands remotely in conjunction with intensive field work. Source: Charlie Hohn/ANR

Figure 26 (Center): Another example of wetland analysis utilizing lidar-derived elevation data. Source: Charlie Hohn/ANR

Figure 27 (Bottom): ANR uses lidar-derived elevation data to assess the flooding impacts of areas downstream of dams as part of their dam safety program. Source: Ryan Knox/ANR

Agriculture and Precision Farming

High-resolution elevation data can provide a more accurate depiction of the terrain and dramatically improve precision farming activities. Benefits include helping to improve crop yields, prevent soil degradation, minimize groundwater usage, and reduce agricultural chemical runoff—all factors that help farmers realize a larger return on their investments. Digital elevation models (DEMs) derived from lidar help with hydrologic and hydraulic modeling to identify fields that frequently flood and require extra care to avoid manure and fertilizer runoff into fields. Related datasets such as high-resolution land cover can be used in tandem with elevation data to better understand all of the above factors.

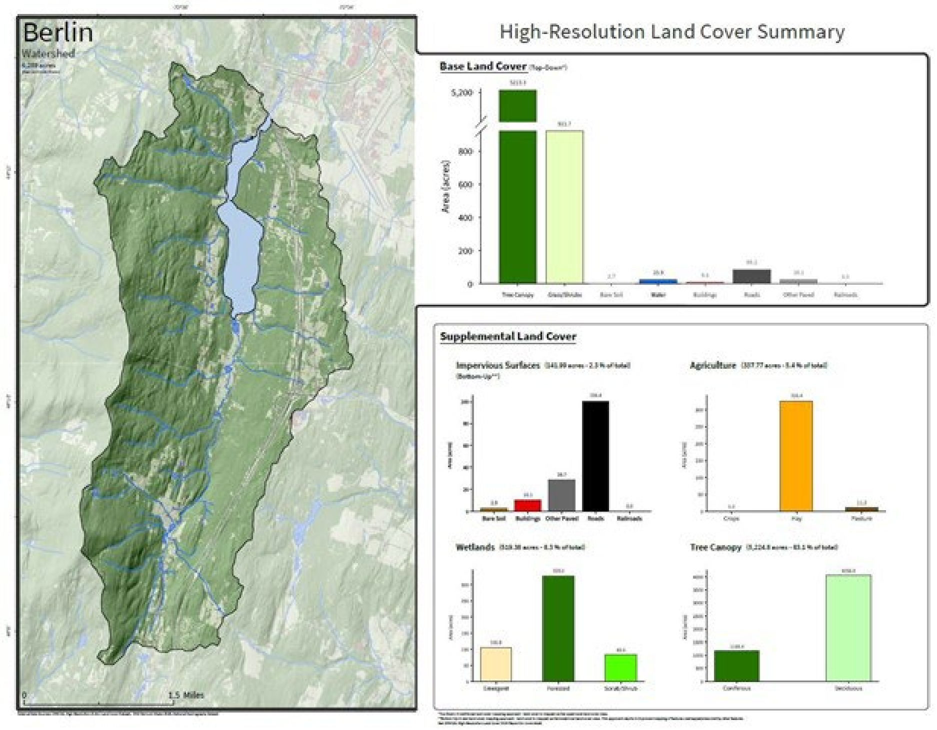
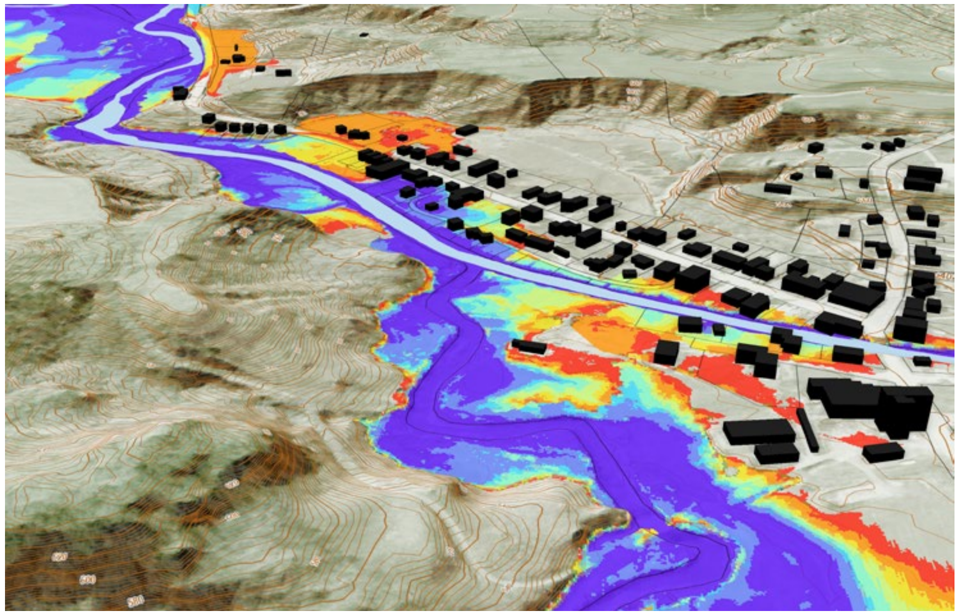


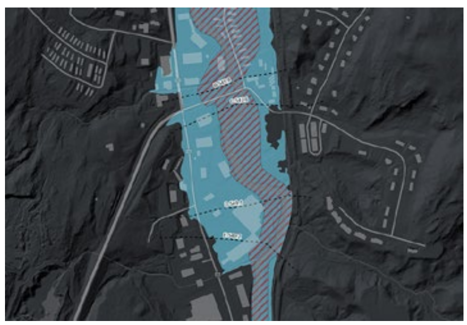
Figure 28 (Top): Lidar-derived elevation data is used to help create high-resolution land cover data which in turn is used to help analyze the impacts of agricultural and other land uses on Vermont waterbodies. Source: Colin Dowey/ANR

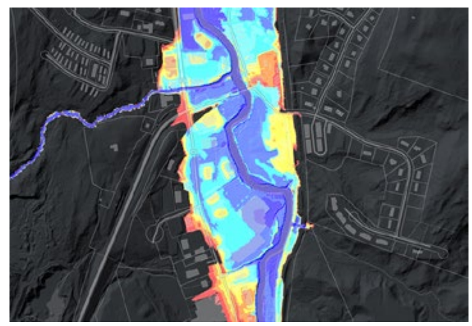
Figure 29 (Bottom): Another example of derivative products created from lidar-derived elevation data: high-resolution land cover, with respective agricultural classifications. Source: UVM Spatial Analysis Lab

Flood Risk Management

Lidar data provide high-quality terrain information as input for more accurate and less expensive hydro¬logic and hydraulic modeling for flood studies, retention dam design, dam breach studies, and stormwater management and engineering. Identification of vulnerable properties within a floodplain, facilitating better floodplain-management decisions and education of the public on true flood risks are further uses of lidar-derived elevation products. Dynamic three-dimensional models are also available to show the potential impact of flooding, while the value of extracting building height information from lidar data becomes readily apparent in mapping flood impacts.







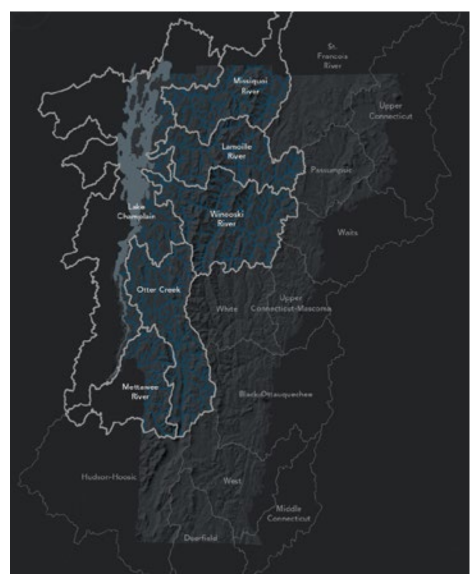


Figure 30 (Top): UVM-produced flood inundation layer using VT's QL2 lidar data that depicts the lateral extent of flooding at 8 modeled storm sizes of recurrence intervals ranging from 2 to 500 years for rivers that drain more than 2 square miles.

Figure 31 (Center Left): Existing, non-lidar informed DFIRM flooding layer in Berlin, VT.

Figure 32 (Center Right): The same location as in Figure 31, viewed with the lidar-informed, detailedflood layer.

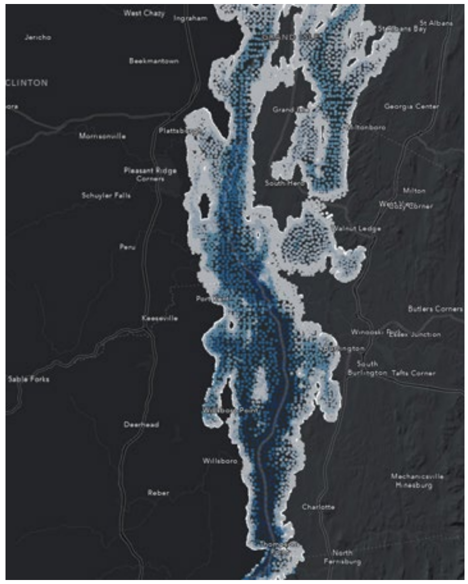
Figure 33 (Bottom Left): Data are classed and symbolized by the eight modeled storm sizes reflecting 2, 5, 10, 25, 50, 100, 200, and 500 year peak floods.

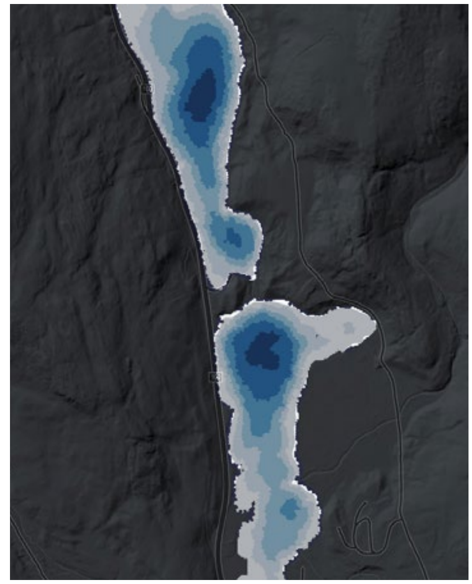
Figure 34 (Bottom Right): The lidar-informed flood data reflect the above modeled reaches within the Vermont portion of the Lake Champlain Basin watershed, as shown along with HUC8-level hydrological boundaries.

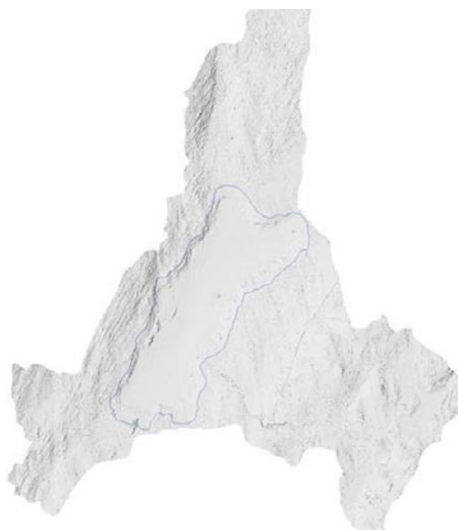
Bathymetric Data and Watershed Management

High resolution bathymetric lidar data is important for managing Vermont waterways. With a surface area of just over 500 square miles and nearly 600 miles of shoreline in New York, Quebec, and Vermont, Lake Champlain stands out as the most important surface water feature in Vermont. The Connecticut River and the many other lakes and ponds in Vermont will also benefit from high resolution bathymetry coupled with the existing statewide quality level 2 lidar foundation for many of the same reasons.

"Collecting shallow-water lidar data in Lake Champlain is very important for development of more accurate hydrodynamic and wave models used in forecasting of hazardous lake conditions and informing future shore protection projects. For example, in the flood forecasting model under development many of the tributary connections at the shoreline are not very well defined in the current bathymetry data, so lidar data could help with grid development and coastal coupling of hydrodynamic and hydrologic models in those areas. New bathymetric data will also improve ice, sediment, and pollutant transport modeling in the lake." [written comm., Dmitry Beletsky, Research Scientist, Cooperative Institute for Great Lakes Research (CIGLR), University of Michigan, April 20, 2021.]







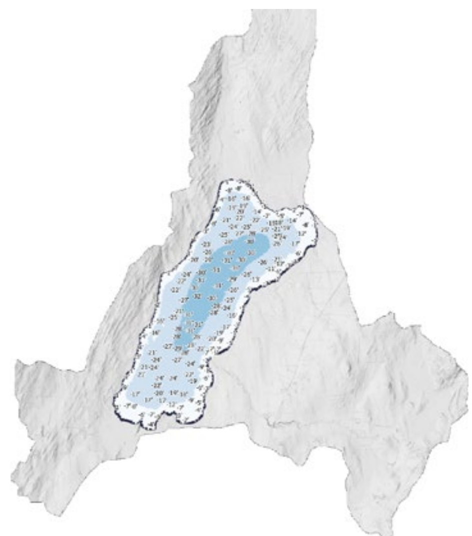


Figure 35 (Top Left): Currently available bathymetric data for Lake Champlain and its nearshore terrestrial zone are not lidar-derived and of comparatively poor resolution.

Figure 36 (Top Right): In absence of available high-resolution bathymetry, Agency of Natural Resources' (ANR) programs have sought to obtain sonar bathymetry data for select lakes and ponds, showcasing demand.

Figure 37 (Bottom Left): Example of ANR test to merge sonar-derived bathymetry with existing QL2 terrestrial lidar. Source: Colin Dowey/ANR

Figure 38 (Bottom Right): The same lake as in Figure 37 shown with sample bathymetric sonar-derived point data as a proof of concept.

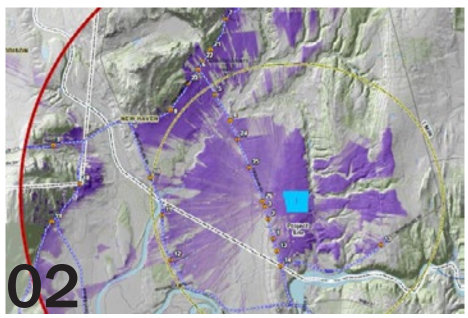
Additional Uses

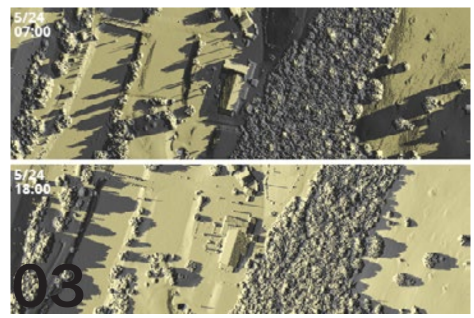
Image 01: Lidar-derived Digital Surface Model and other data are used to estimate solar energy generation potential as in this South Burlington example.

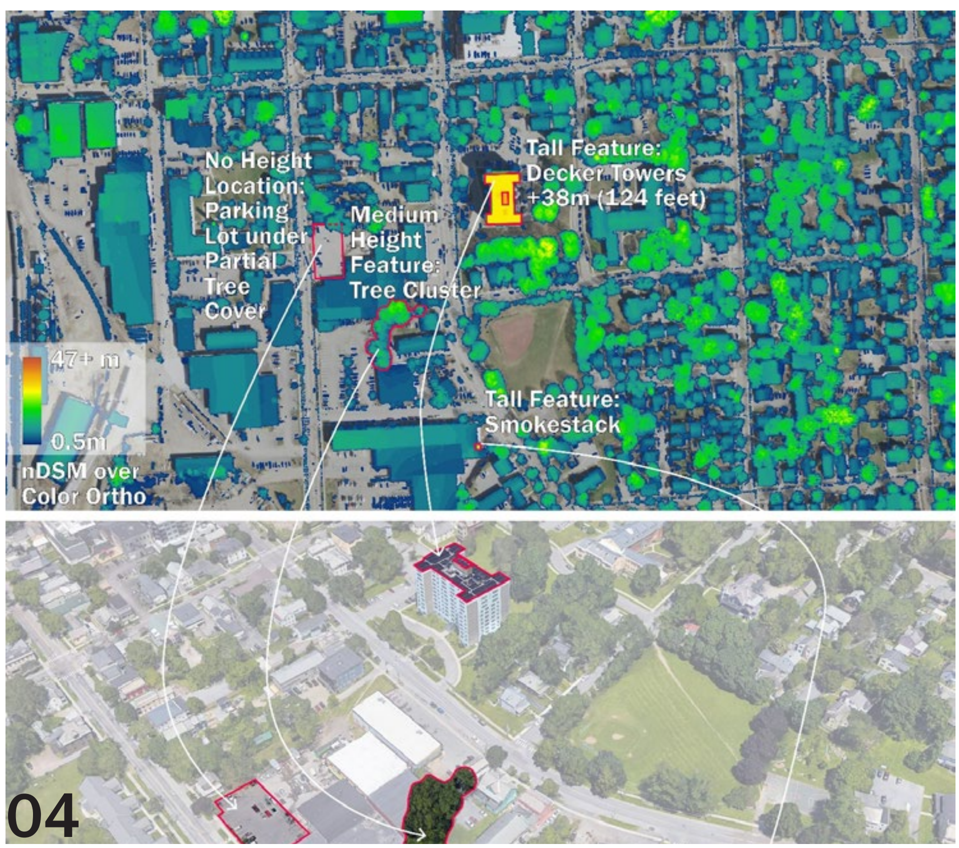
Image 02: Estimating the potential viewshed/visual impacts of siting renewable enegy infrastructure near New Haven, VT using bare earth hillshade and other lidar derived elevation data.

Image 03: Detailed sun/shade studies for renewable energy potential assessment are enabled with use of lidar-derived digital surface models and other data.

Image 04: "Normalized" digital surface model creation based on existing QL2 data has enabled the depiction of height of feature information, be they structures or vegetation. This is useful for remote assessment of conditions for forestry and planning/design purposes alike.







Additional Uses

Image 05: Ancillary benefits of lidar-derived elevation include the ability to extract building height information, which when coupled with surface elevation products, help visualize areas impacted by local zoning regulations as seen here.

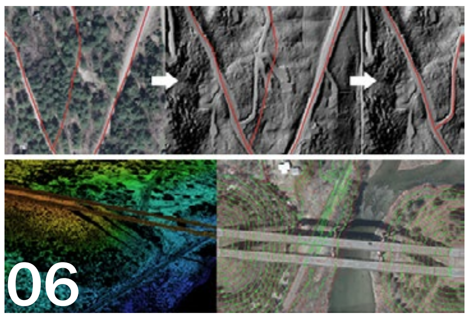
Image 06: Vermont's Agency of Transportation has used existing QL2 data to improve the mapped accuracy of their statewide road centerline dataset, as well as the accuracy of mapped structures such as bridges and culverts. Source: Johnathan Croft/VTrans

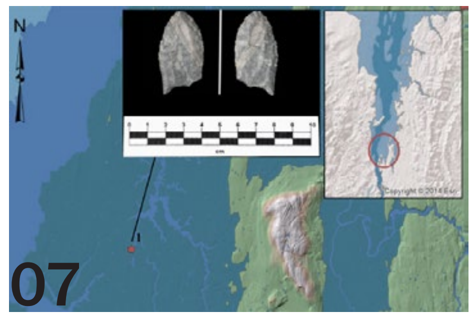
Image 07: State archeologists have used existing QL2 lidar data to put discovered artifacts in context, as well as aid in their discovery in the first place. Source: Jess Robinson/ ACCD

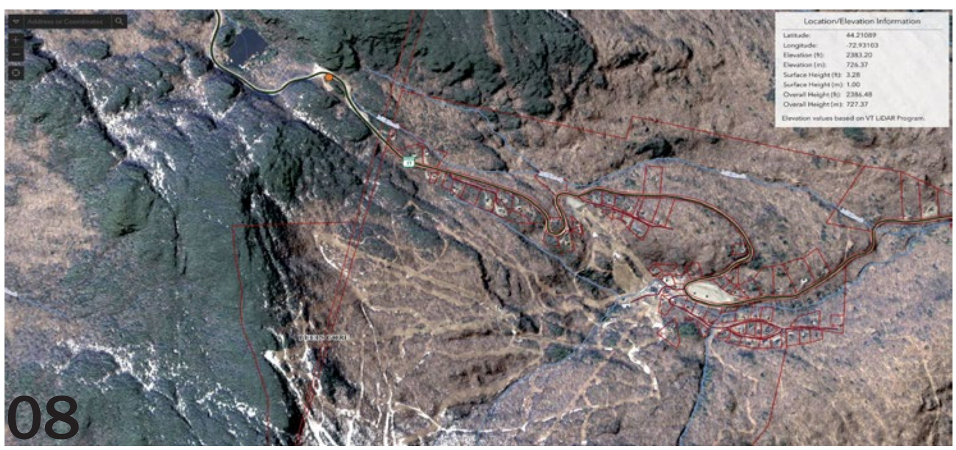
Image 08: Field working staff in the Agency of Natural Resources needed a quick and reliable way to estimate elevation for site work statewide. Their GIS group was able to develop a simple webtool to do just that by utilizing existing lidar-derived elevation data. Source: Erik Engstrom/ANR

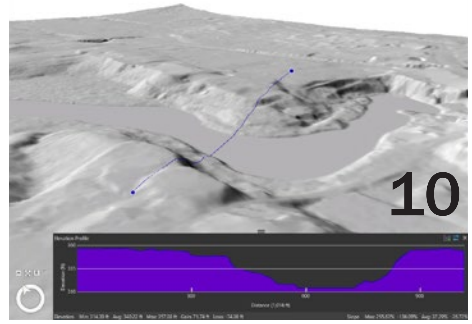
Image 09: Foresters and conservationists have been able to improve the mapped accuracy of forest patches and habitat zones using high-resolution elevation data.

Image 10: Quick assessment of elevation profiles statewide have been enabled by high-resolution lidar-derived elevation data.



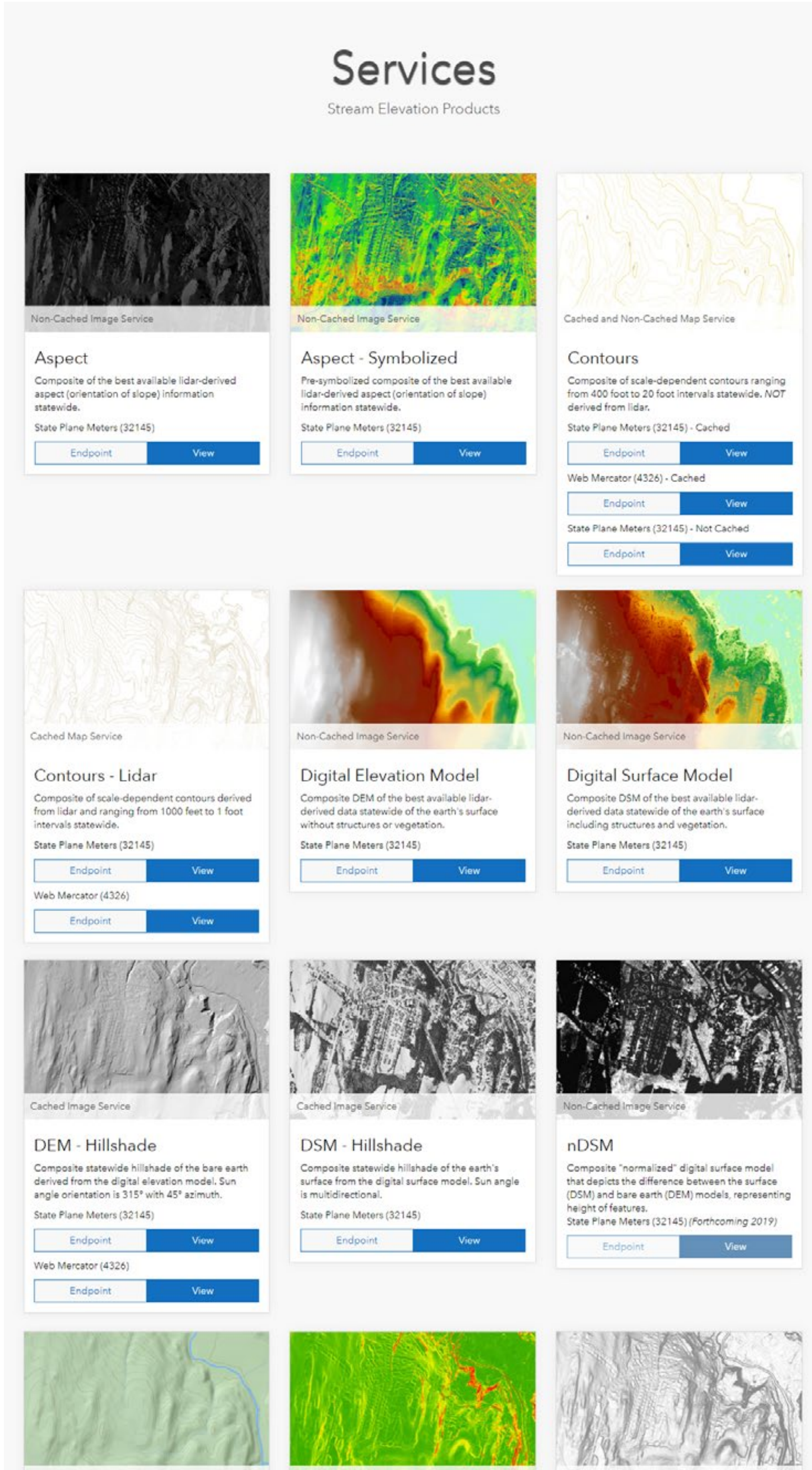




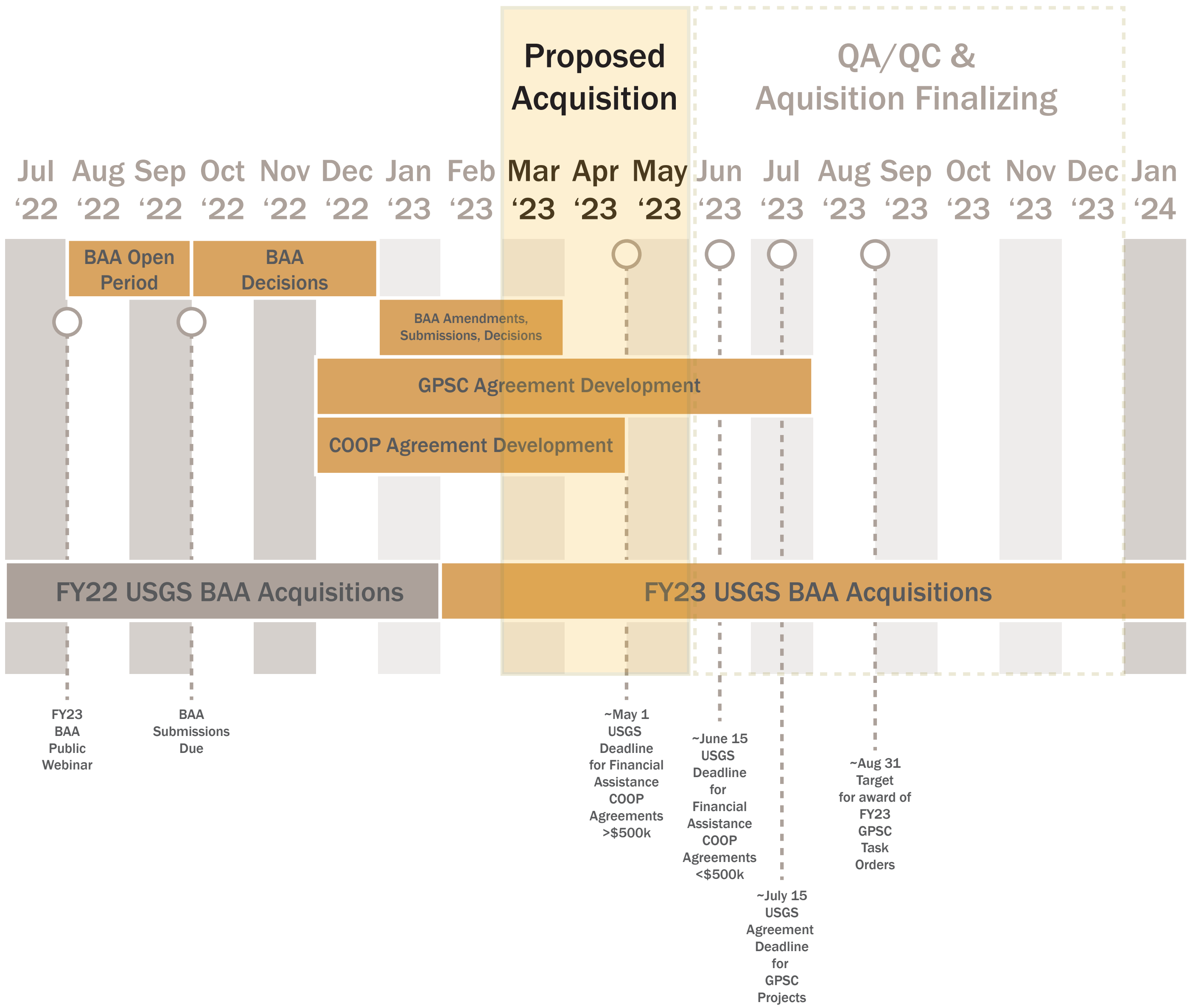


Easy, Comprehensive Data Access

Making lidar-derived high-resolution elevation data products easily available has been a key part of VCGI's role as a data steward and publisher. One can easily access many elevation products via the dedicated elevation page at the Vermont Open Geodata Portal, a section of which is shown at right. geodata.vermont.gov/pages/elevation



Proposed Schedule



Vermont Lidar Partnership Supporters

VERMONT

November 10, 2022

Leadership across agencies and departments in the State of Vermont strongly support the attached application to the United States Geological Survey's Federal FY 2023 Broad Agency Announcement (USGS BAA FFY23) in support of the 3D Elevation Program (3DEP).

Statewide Quality Level 1 (QL1) lidar coverage will support activities across all sectors of Vermont's Strategic Plan and core functions throughout Agencies and Departments in state government. For example, it will help us: 1) grow Vermont's economy by supporting housing development; 2) protect the vulnerable by improving the accuracy of mapped areas prone to flood inundation; 3) make Vermont more affordable by limiting the need for field data collection; and 4) modernize and improve efficiency of government with a single source of open and useful data available to local, regional, state and federal government.

Vermont has successfully participated in 3DEP in the past, acquiring quality level 2 (QL2) data which is now on average 8 years old and older than 10 years in parts of the state. The current availability of QL2 lidar has been a tremendous asset for many uses. Yet portions of the dataset are outdated and advancements in sensor technology coupled with the higher resolution offered by QL1 have created an opportunity to meet a greater number of uses now dependent on lidar-derived elevation data and with an exceptional return on investment. According to a recent requirements and benefits study from Dewberry, the majority of users required QL1 data or better and over 75% required data updated within the past 8 years. The goals of this project align with those findings and are consistent with stakeholder feedback in Vermont.

Figure 1 - Lidar use cases across the four sectors of Vermont's strategic plan

Lidar-derived elevation data provides the foundation for many of the state's critical data assets, and we are thrilled to see USGS leadership's commitment to the 3DEP program objectives of collecting high quality lidar data for the nation. Completing this statewide acquisition in one season would make Vermont the first state to have 100% coverage at a QL1 and will provide a tremendous asset to support and empower decision makers across all levels of government and beyond for broad public benefit.

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Secretary, Agency of Transportation

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Julie S. Moore P.E.
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Jenney Samuelson
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Secretary, Agency of Digital Services

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Asterisk(*) denotes Steering Committee Member

Related Information

Rank	Business Use	Annual Benefits in Thousands
1	Geologic Resource Assessment and Hazard Mitigation	$417
2	Natural Resources Conservation	$378
3	Agriculture and Precision Farming	$326
4	Flood Risk Management	$236
5	Infrastructure and Construction Management	$84
6	Forest Resources Management	$83
7	Water Supply and Quality	$69
8	Aviation Navigation and Safety	$29
9	River and Stream Resource Management	$4
10	Renewable Energy Resources	$3
	Other	$6
	Total	$1,635

Table 2: Conservative benefits estimates for the top ten Vermont business uses of the proposed 3DEP data identified in the National Enhanced Elevation Assessment (Dewberry, 2012)

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Report written by John E. Adams, Tim Terway, and Steve Fugate of The Vermont Center for Geographic Information (VCGI) in January 2023. All graphics by Tim Terway of VCGI unless noted in caption.

References

Dewberry, 2022. 3D National Requirements and Benefits Study, Final Report - September 15, 2022. NOAA NGS Contract: EA133C-14-CQ-00087 (Shoreline Mapping). Task Order Number: T-0020. Fairfax, VA., Dewberry, 171 p. Accessed October 3, 2022 at https://www.dewberry.com/docs/default-source/documents/3d-nation-elevation-requirements-and-benefits-study/3d_nation_study_final_report.pdf

Dewberry, 2012, Final report of the National Enhanced Elevation Assessment (revised March 29, 2012): Fairfax, Va., Dewberry, 84 p. plus appendixes, accessed July 6, 2022 at http://www.dewberry.com/services/geospatial/national-enhanced-elevation-assessment.

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., accessed July 7, 2022, at http://dx.doi.org/10.3133/cir1399.

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