



# Montana Lidar Plan

Troy Blandford | Erin Fashoway  
Montana State Library

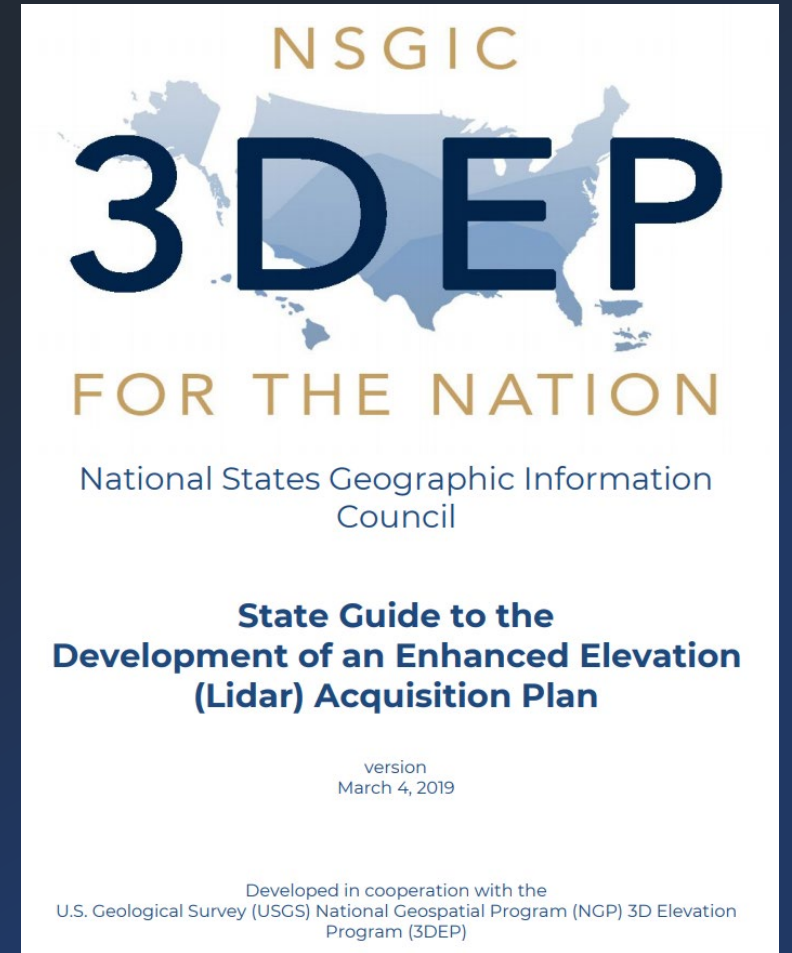
# ACKNOWLEDGEMENT

Thank you to NSGIC for being the catalyst for this plan.

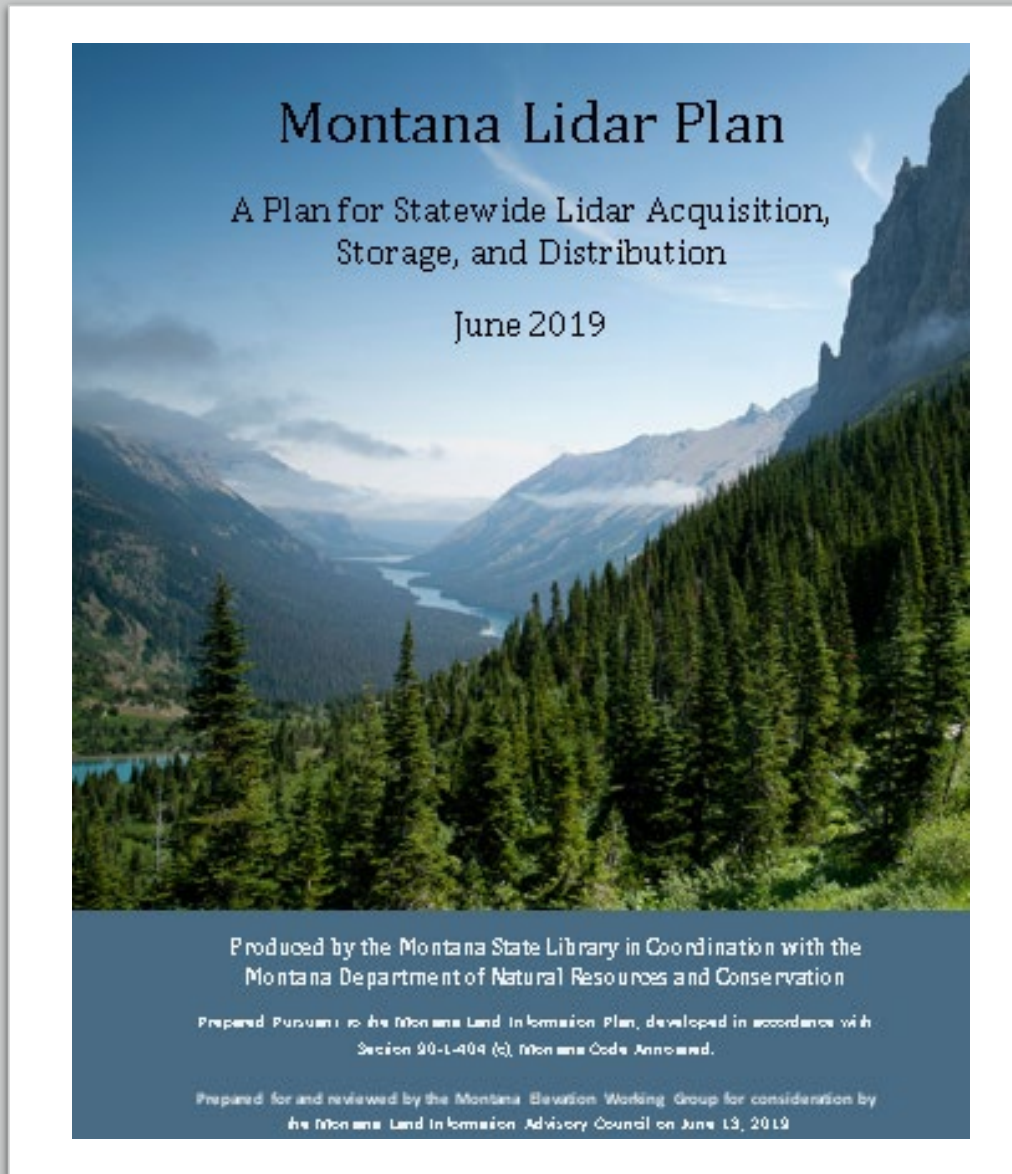
Thank you to everyone who has reviewed the Montana Lidar Plan.

Comments and suggestions to date were made by:

- Montana Bureau of Mines and Geology
- Montana DNRC
- Montana State Library
- Montana Natural Heritage Program
- USDA - NRCS
- USDA – Forest Service
- Atlantic
- Quantum Spatial, Inc
- The Sanborn Company, Inc.







# INTRODUCTION

- In April 2018, the Montana State Library became the state lead for elevation data
- First task, develop a plan for statewide lidar coverage
- The guiding principle of the Montana Lidar Plan is to be inclusive and maximize the number of uses and potential benefits.



# Measure Distance

Think sonar . . .

Think radar . . .

Think rangefinder . .

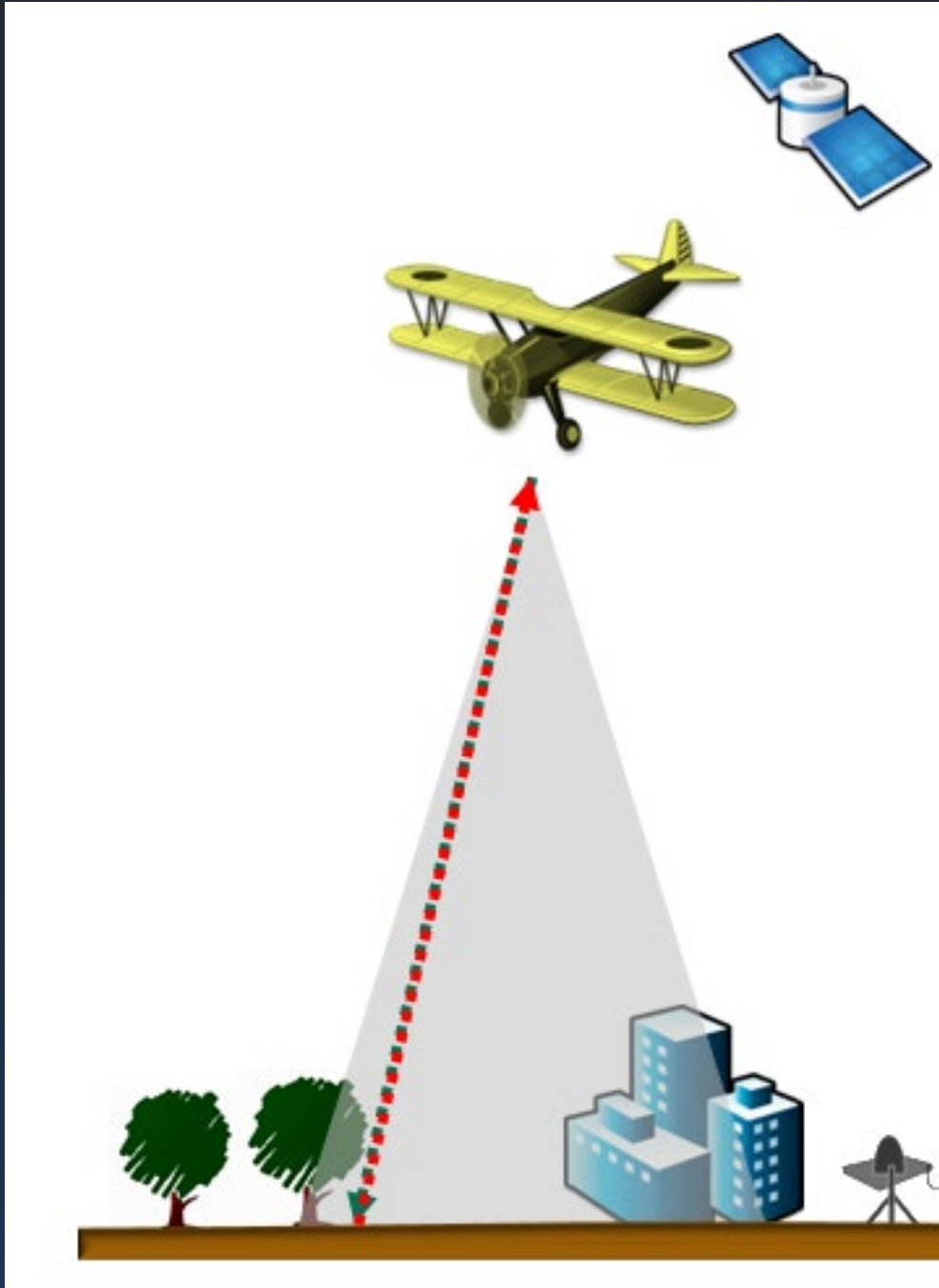
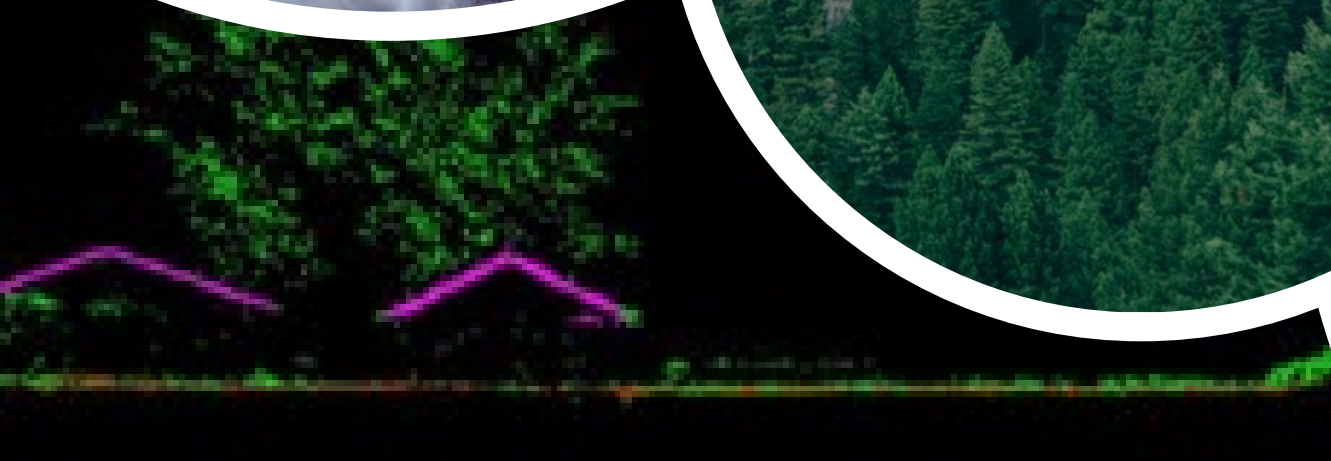
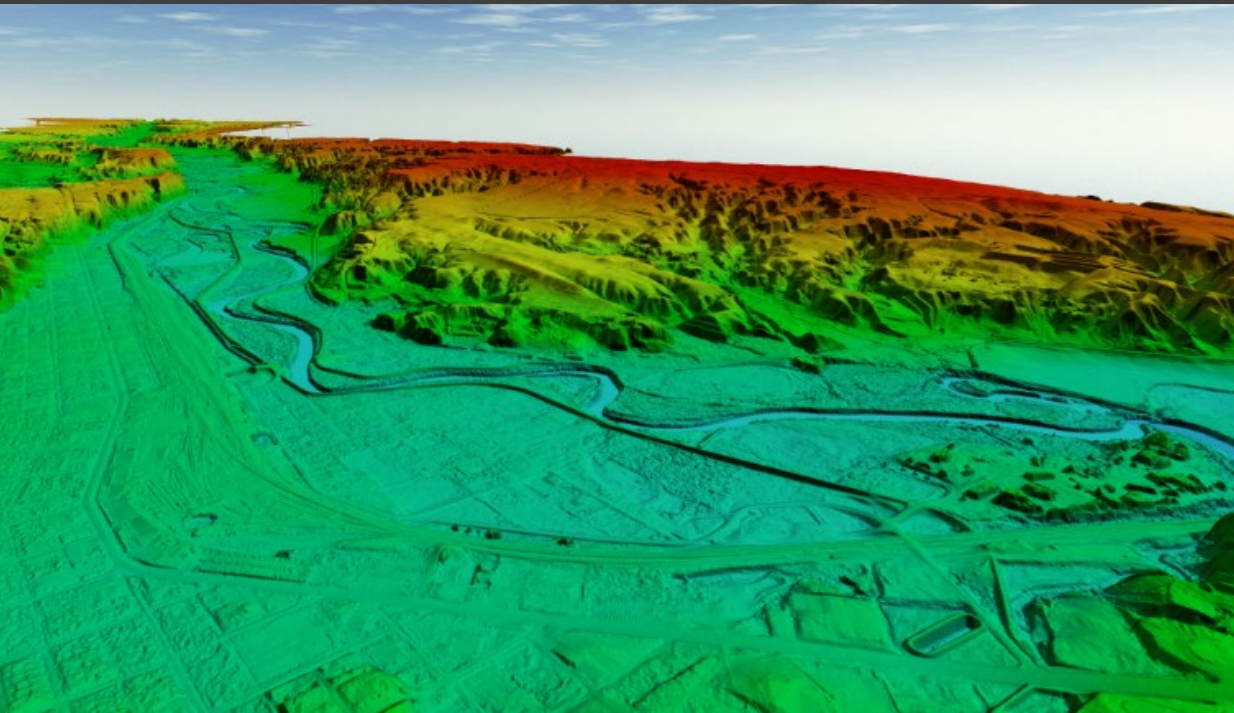
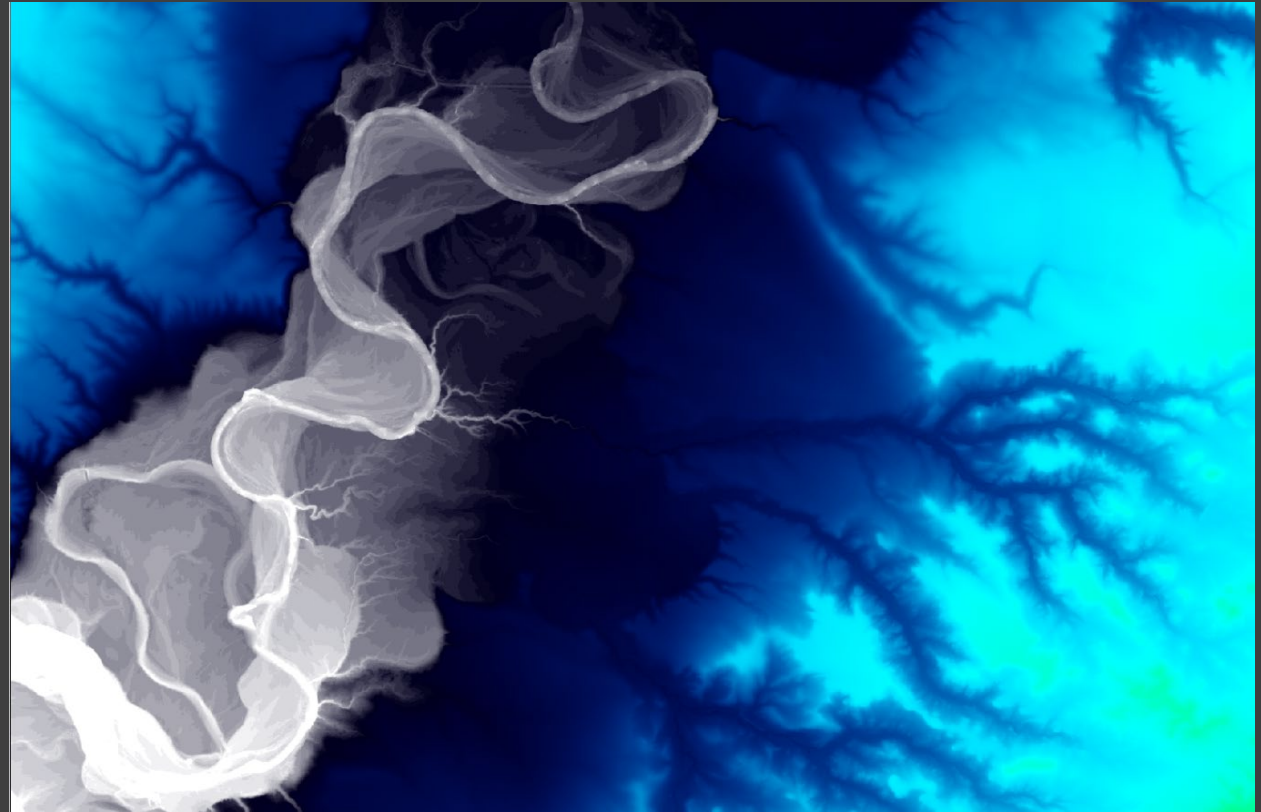
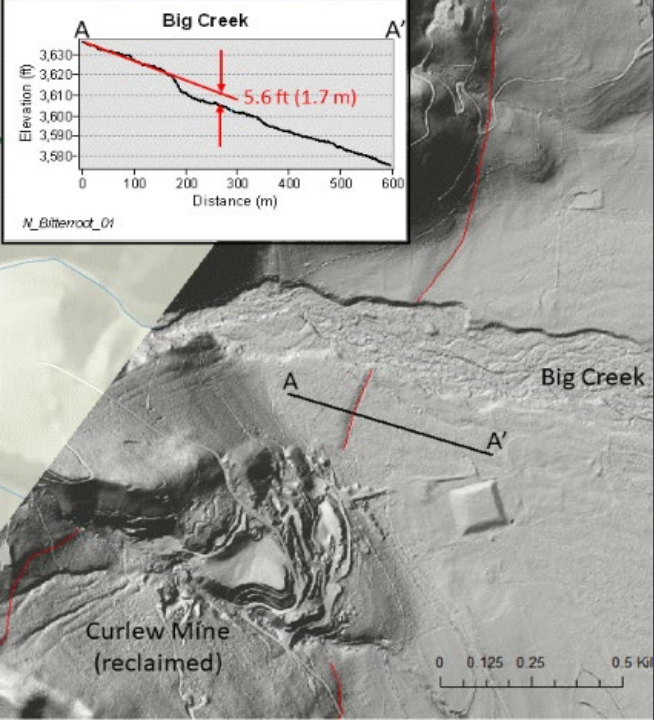


Image from ESRI ArcGIS Desktop Help











# PURPOSE

Provide recommendations for the collection, maintenance, and dissemination of lidar data in Montana. The goal of the plan is statewide lidar coverage by the end of 2023.

**States with a plan are in the best position to leverage funding opportunities and achieve statewide lidar coverage.**

# PROBLEM STATEMENT

Most lidar acquisitions in Montana have been a piecemeal approach. This is not cost-effective, is hard to manage, is expensive to fly, does not realize the full potential of lidar uses, and can lead to overlapping acquisitions.

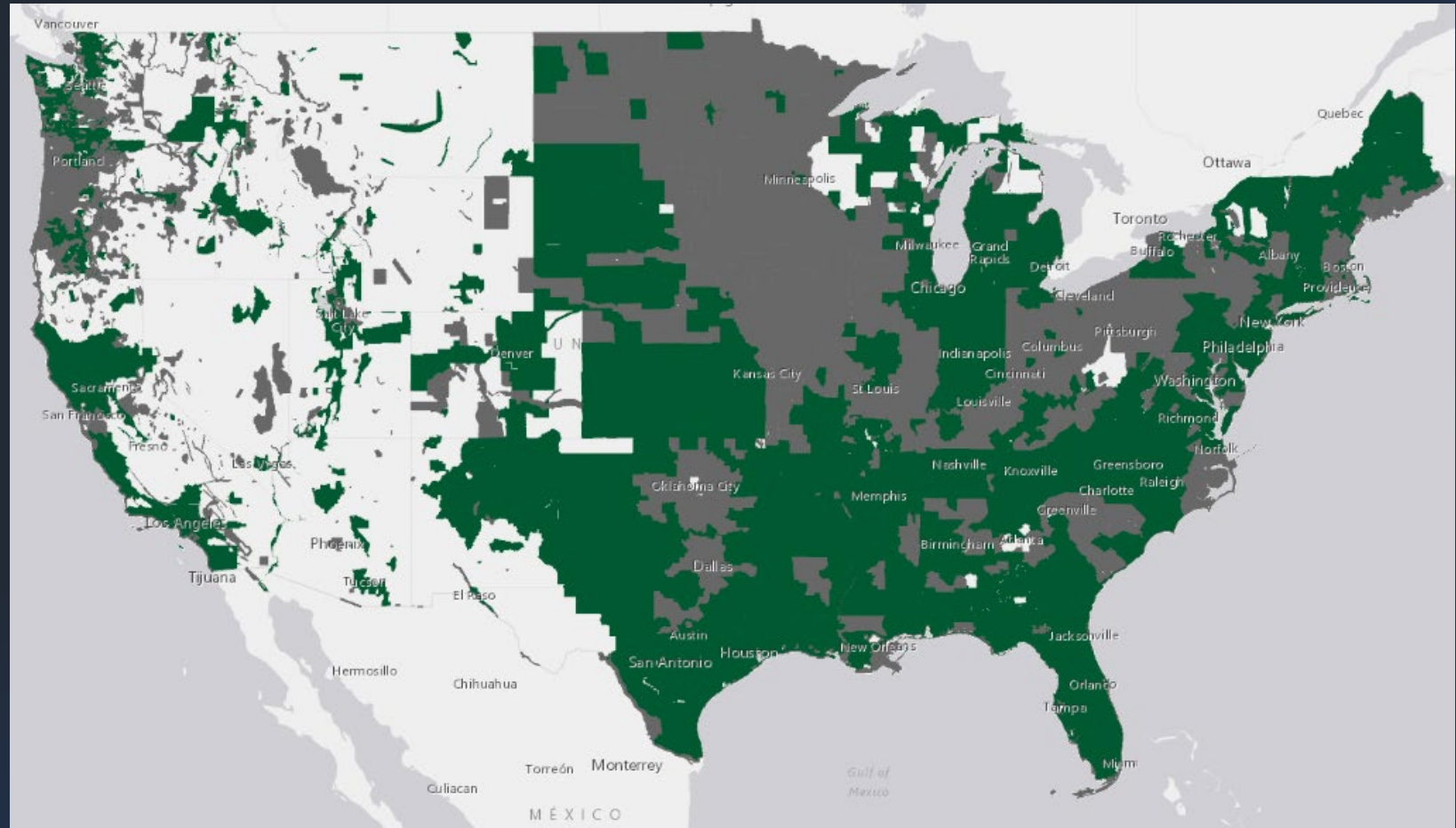
***Montana Lidar Plan, Page 9***





# PROBLEM STATEMENT

Lidar coverage is woefully incomplete in the West.



Gray = lidar of any quality Green = lidar meeting USGS Specs.

Description	Square Miles	Percent of MT Total Area
Existing lidar coverage, any quality and any collection date	47,000	32%
Existing lidar coverage meeting USGS baseline specifications (QL2 or better)	42,000	28%
Existing lidar coverage that has become dated (more than 10 years old, 2008)	500	< 1%
Overlapping acquisitions	2,000	< 1%
Lidar needed to reach the goal of the Montana Lidar Plan (complete coverage)	100,000	68%



# BENEFITS

Though expensive, the collection of elevation data in the form of lidar has a good benefit/cost ratio and ROI

Expected annual benefits	\$13.08 million
Payback	3.8 years
ROI	2.1 to 1

*Carswell, 2014 and Maune, 2017*

1. terrain modeling, ski slopes, new ski areas
2. snow avalanche hazard mapping (*potential use*)
3. flood risk mapping
4. better contour maps needed
5. transportation and sidewalk design (*potential use*)
6. building footprints
7. locating/preserving cultural resources (*potential use*)
8. hydrologic modeling

33. mapping of riverine areas
34. dam and levee safety
35. state forest health
36. fire risk/fuels
37. natural resources damage recovery and planning
38. geophysical properties to support river restoration activities
39. transportation and infrastructure design

# Lidar Uses and Opportunities for Montana

11. geologic mapping
12. seismic analysis/risk mapping
13. modeling for groundwater development
14. water resources investigations and modeling
15. mapping surface water (hydrography database)
16. structures database
17. control point database
18. education and training
19. earth sciences research
20. geophysical engineering
21. landslides
22. water quality modeling
23. engineering and design
24. remediation
25. mining and reclamation
26. landfill and waste management
27. archeology and cultural resources
28. superfund sites
29. stormwater modeling
30. wetland mapping
31. disaster response

43. fish and wildlife habitat mapping
44. land cover mapping
45. Tribal resiliency planning
46. storm water infrastructure
47. tribal transportation planning
48. surveying
49. energy siting (*assumed use*)
50. tree assessment/removal (*assumed use*)
51. vegetation structure mapping, e.g for sage grouse
52. watershed boundary delineation
53. conservation planning
54. water resources management and planning
55. infrastructure design, construction, and maintenance
56. survey and ground modeling
57. water supply: municipal, rural, industrial and irrigation
58. renewable energy – wind
59. height, shape, and height to crown of trees, forest inventory parameters
60. wildlife movement corridors

**NOT AN EXHAUSTIVE LIST**



# Who would use lidar data in Montana?

1. Bridger Bowl Ski
2. City of Great Falls
3. MHS SHPO
4. Lewis and Clark County
5. Missoula County
6. Montana Bureau of Mines and Geology
7. Montana State Library
8. Montana State University
9. Montana Tech
10. MT DEQ
11. MT DNRC
12. MT DOJ NRDP
13. MT DOT
14. MT FWP
15. MT NHP
16. Northern Engineering and Consulting
17. Northwestern Energy
18. NRCS
19. The Nature Conservancy
20. Pioneer Technical Services, Inc.
21. Ravalli County
22. Stahly Engineering & Associates, Inc
23. Tribal Nations
24. University of Montana
25. Yellowstone Ecological Research Center

Not an exhaustive list

# MONTANA STAKEHOLDER LIDAR USES



17

Flood Management



15

Water Resources/Hydrologic Modeling



13

Transportation/Infrastructure



11

Terrain Modeling/  
Ground Survey



9

Environmental/Geophysical



7

Hazard mapping



Other

Education, wildlife & habitat  
management, cultural  
resources, energy



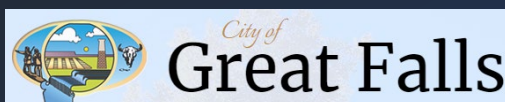
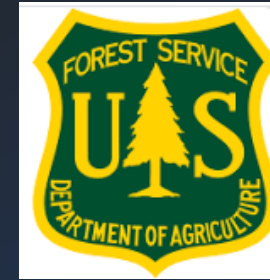


# STAKEHOLDERS, ROLES, AND COORDINATION

**The Montana Elevation Working Group is the coordination and communication foundation necessary to execute the Montana Lidar Plan.**

# Montana Elevation Working Group

- Federal, State, County, local, private participants



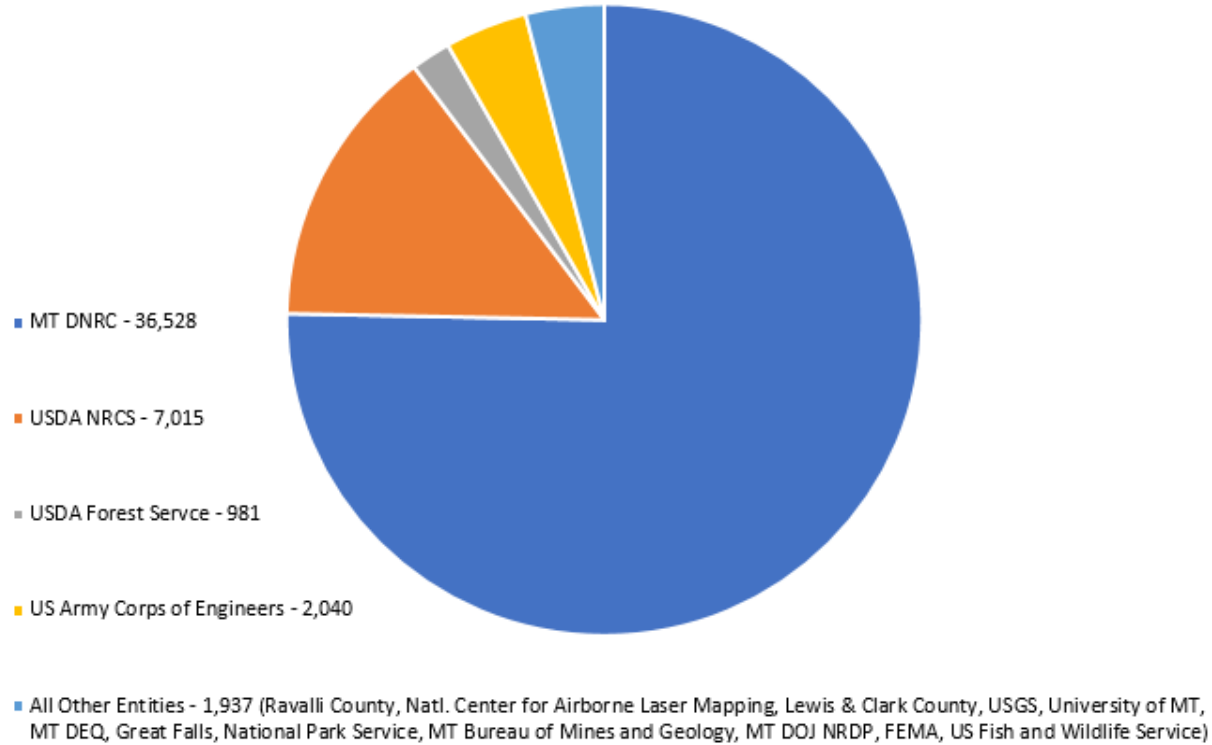


# PAST ACQUISITIONS AND THE MONTANA LIDAR INVENTORY

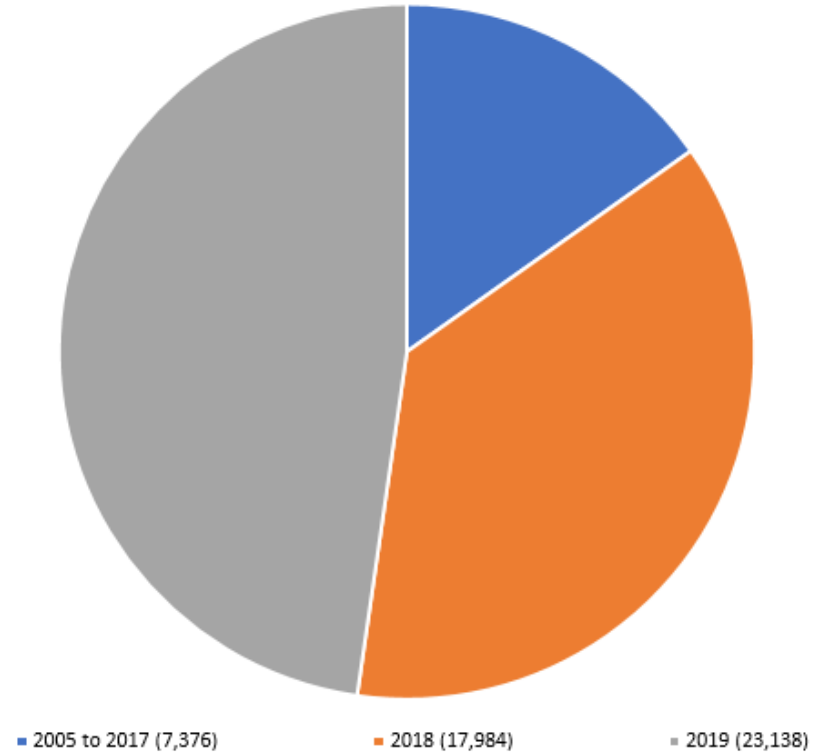
Most lidar acquisitions to date in Montana have been single-agency, rather than built on partnerships.

Federal funding has been critical.

Square Miles of Lidar Acquired by Organization



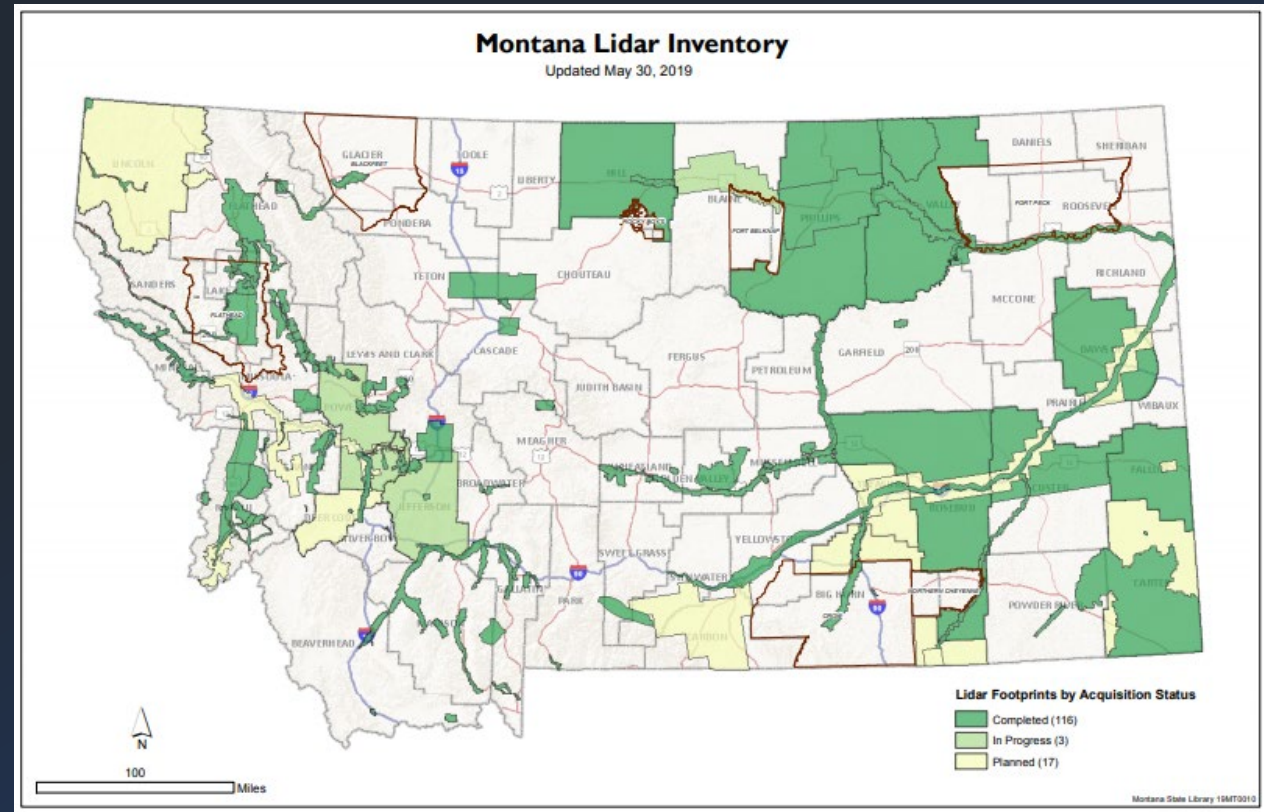
Square Miles of Lidar Acquired by Year





# Montana Lidar Inventory

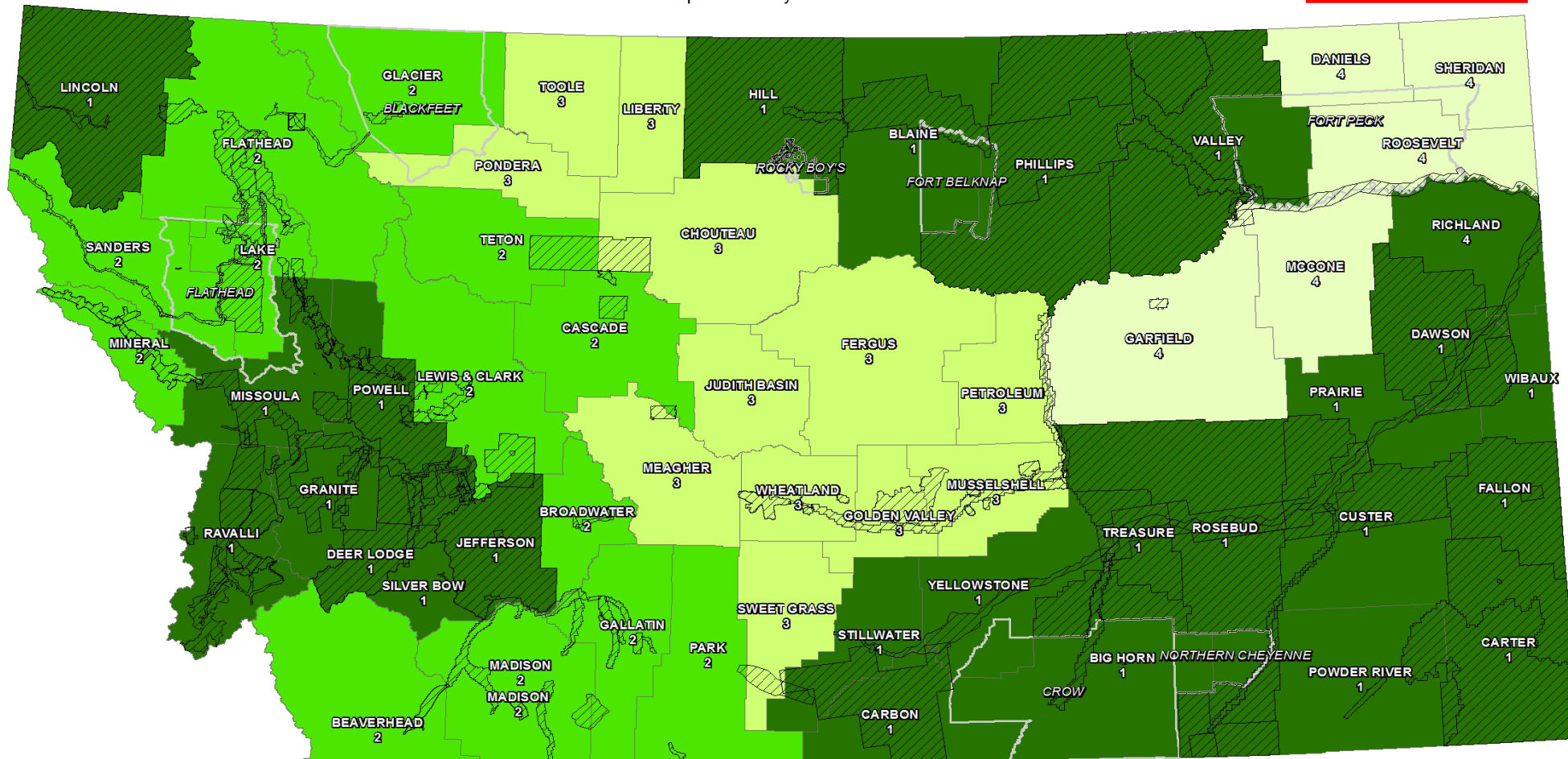
1. Completed/in-progress acquisitions
2. Planned lidar acquisitions
3. Priority areas of interest for future acquisitions



<http://msl.mt.gov/gis/lidarinventory>

# Proposed Montana Lidar Acquisition Plan: Phased, Multi-year Approach by County

Updated May 2019



**Prioritization**

- Priority 1 Regional Consistency - finish partially completed counties and gaps between counties for temporal consistency (2019-2020)
- Priority 2 Hazard Mapping - counties with geological hazards AND high hazard dams (2020-2021)
- Priority 3 State and Federal Priorities - counties with large portions of state and federal areas of interest (2021-2022)
- Priority 4 Final Completion Statewide - counties with few priorities identified to date (2022-2023)
- Completed/In-Progress Acquisitions



110

Miles

Map is intended for planning purposes. Future acquisitions and timing will likely vary from this plan.

# Recommendation

**Recommendation 1:** Enhance the Montana Lidar Inventory to readily report overlapping areas of interest, with the purpose of prioritizing areas by county based on partnership opportunities. Actively engage additional Montana experts from various professions and sectors to submit their priority areas of interest. Include federal priorities from SeaSketch in the Montana reporting.

*Montana Lidar Plan, page 19*





# PARTNERSHIPS AND COLLABORATION

- Differing fiscal and project timelines have made multi-agency partnerships difficult.
- Ideally, acquisition planning should be in motion approximately 18 months to two years ahead of the planned collection date.

***See Acquisition Planning  
Calendar, page 22***

**This is why Montana needs a plan!**

# Recommendations

**Recommendation 2:** Develop a 3DEP BAA application template that cites the Montana Lidar Plan. This template will expedite application development and demonstrate that Montana is coordinated and has a plan. Similarly, develop a Montana lidar contract template for projects that cannot be conducted through 3DEP (or are not awarded). This contract will ensure consistency across future acquisitions.

**Recommendation 3:** Task the MEWG with actively pursuing partnership opportunities when new collections are in the early planning phase or where there are overlapping priority areas of interest.

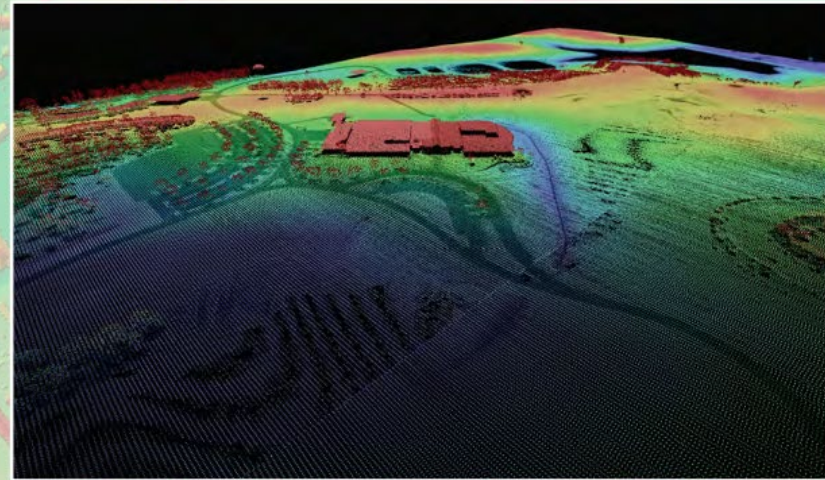
**Recommendation 4:** Task the MEWG with providing technical assistance and review of 3DEP BAA applications and lidar acquisition agreements in Montana.

# Technical Specification

National Geospatial Program

## Lidar Base Specification

Chapter 4 of  
Section B, U.S. Geological Survey Standards  
Book 11, Collection and Delineation of Spatial Data



Techniques and Methods 11–B4  
Version 1.0, August 2012  
Version 1.1, October 2014  
Version 1.2, November 2014  
Version 1.3, February 2018



# Technical Specification

## Recommended Quality Level 1

### Recommended:

Quality Level 1	DEM Cell Size	Aggregate Nominal Pulse Spacing	Aggregate Nominal Pulse Density	Absolute Vertical Accuracy <u>RMSE<sub>z</sub> (nonvegetated)</u>	Relative Vertical Accuracy (repeatability)  <u>RMSD<sub>z</sub></u>
Topo Lidar	1 m  (3 foot)  0.5 m (1.5 foot) DEM possible	0.35 m	8 pls/m <sup>2</sup>	0.1 m	0.06 m

Table 5. Montana's recommended lidar quality level.

## Required Quality Level 2

### Required:

Quality Level 2	DEM Cell Size	Aggregate Nominal Pulse Spacing	Aggregate Nominal Pulse Density	Absolute Vertical Accuracy <u>RMSE<sub>z</sub> (nonvegetated)</u>	Relative Vertical Accuracy (repeatability)  <u>RMSD<sub>z</sub></u>
Topo Lidar	1 m  (3 foot)	0.71 m	2 pls/m <sup>2</sup>	0.1 m	0.06 m

Table 6. Montana's required lidar quality level.

# Montana Deliverable Standards

- Bare-earth AND Highest-hit (surface) elevation model
- All rasters (bare-earth DEM, highest hit surface elevation model, hillshade, etc.) mosaicked to the entire project extent, or to 1:24,000 USGS quadrangle extents if the project area is large (e.g, countywide acquisitions)
- LAS Dataset for the entire extent
- All spatial data in the Montana State Plane Coordinate System NAD83 (2011), NAVD88, GEOID12B, meters
- Consistent file formats across acquisitions
- File formats that perform well at large size (e.g. \*.img)
- Consistent organization, file directory, and naming convention

***See Appendix C,  
page 37***



# MAINTENANCE AND DISSEMINATION

- MSL is a logical choice for developing and maintaining a repository for lidar data.
- Storage needs are tremendous (~300-500 TB for statewide lidar).
- Significant effort by MSL and NRCS is being applied to organizing and processing past acquisitions and developing a consistent format for public distribution.



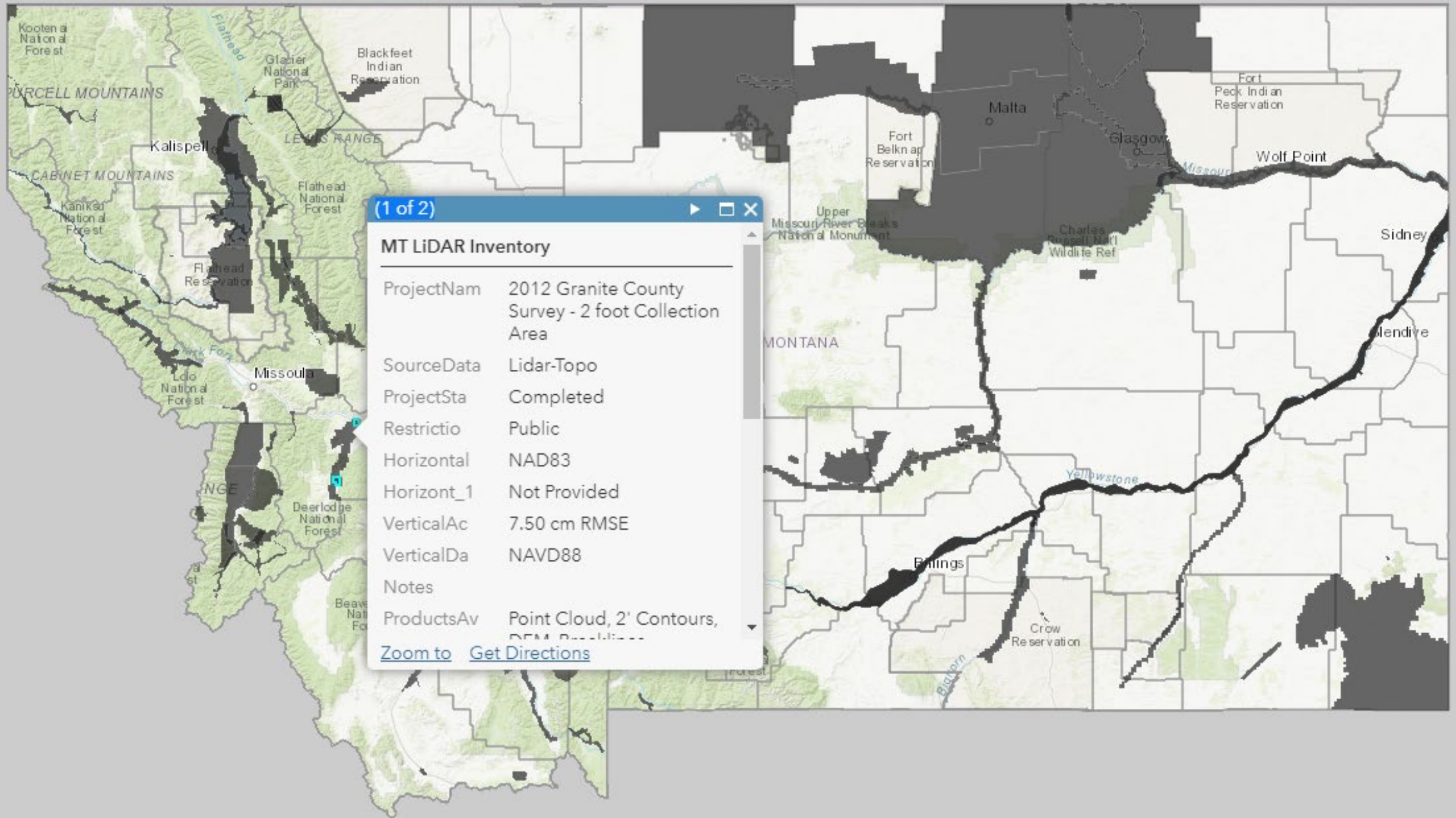
# Recommendations

**Recommendation 5:** The Montana State Library should seek IT budget increases to meet the tremendous data storage needs of a lidar repository. The storage cannot be assumed without additional resources.

*page 25*

**Recommendation 6:** Continue to develop a Montana lidar repository at the State Library. Expand the Montana Lidar Inventory to become a lidar viewer and download platform.

*page 26*



# C O S T

Description	Square Miles	Percent of MT Total Area	Cost based on \$350/mi <sup>2</sup>
Lidar needed to reach the goal of the Montana Lidar Plan (complete coverage, with all new lidar acquired at QL1).	100,000	68	\$35 million
Largest sized Montana county (Beaverhead)	5,573	3.8	\$2 million
Median sized Montana county (Dawson)	2,384	1.6	\$835,000
Smallest sized Montana county (Silver Bow)	718	0.5	\$250,000

Based on \$350 per SM for QL1



# Funding Approach

Identify partnership opportunities and leverage the USGS 3D Elevation Program for cost-share.

*Montana Lidar Plan, page 27 and Appendix D page 42*

Total Estimated Project Cost (from previous page):		\$937,500.00		
Funding Partner(s)			% Cost Share for 3DEP Base Data	
Name(s)	Type	Proposed Contribution for Lidar Data Acquisition, Processing, QA/QC		
Montana DNRC Floodplain Management Program (provided by FEMA)	Nonfederal	\$250000.00		
Montana Bureau of Mines and Geology	Nonfederal	\$1500.00		
NRCS (Montana office)	Federal	\$250000.00		
Montana State Library	Nonfederal	\$1500.00		
USDA Forest Service (Montana office)	Federal	\$50000.00		
Missoula County	Nonfederal	\$10000.00		
Trout Unlimited	Nonfederal	\$1500.00		
Montana Department of Environmental Quality	Nonfederal	\$15000.00		
	Choose One	\$		
	Choose One	\$		
Funding Partner Totals (from above)		\$579,500.00		62%
Funds Requested from 3DEP		\$358,000.00		38%

*Hypothetical funding scenario*



# RECOMMENDATIONS

**Recommendation 7:** Submit a countywide or larger 3DEP BAA application by October 2019. Continue to submit 3DEP applications in subsequent years. Appendix D provides guidance for 3DEP proposals.

**Recommendation 8:** Investigate the potential for the Montana State Library to accept funds from other entities and develop cooperative agreements/MOUs for lidar acquisitions. The intent of this recommendation is to function as a consortium, pooling resources to achieve a common goal.

**Recommendation 9:** Conduct outreach on the Montana Lidar Plan, particularly focused on identifying and forming partnerships.

**Recommendation 10:** Identify and engage constituents with an interest in championing legislation to make a seed capital investment in lidar.

# Known Risks to Plan Execution

- Resources for the MEWG are currently limited to the volunteered time of its membership for meetings, research, documentation, and the execution of project tasks.
- State of Montana funding from the legislature for elevation/lidar data is non-existent, nor requested. State and local dollars are needed to maximize the 3D Elevation Program cost-sharing. (see Oregon example page 27)
- The infrastructure necessary to support storage and data access requirements for statewide lidar is substantial and cannot be assumed without financial support. Initial seed money was provided by the USDA NRCS; however, these funds were intended for a pilot project focused primarily on NRCS lidar holdings. Other states and the USGS have used a data and management cost estimate ranging from 5% (USGS) to 15% (Oregon Lidar Consortium) of the total project cost.
- To date, the largest amount of funding available for lidar acquisition in Montana has come from FEMA through the Montana Department of Natural Resources and Conservation for flood-risk management. DNRC is currently managing their own lidar planning and contracts, and their participation in the 3D Elevation BAA Program for cost sharing is uncertain.



# NEXT STEPS

**Plan Execution Status Table:**

<b>Recommendation</b>	<b>Approximate Schedule</b>	<b>Status (May 2019)</b>
1 - Enhance Lidar Inventory app. Increase expert input of AOIs.	Summer 2019	Early developments
2 - 3DEP BAA application template	October 2019	<b>Completed May 2019</b>
3 - Pursue partnerships	Ongoing cycle	Started (ramp up needed)
4 - Technical assistance with lidar specifications/deliverables	Ongoing	Ready
5 - Seek IT budget increases	--	Not started
6 - Lidar repository	Draft release summer 2019	Early developments
7 - Submit countywide 3DEP BAA	October 2019	<b>Completed May 2019</b>
8 - Investigate consortium	October 2019	Not started
9 - Outreach	Ongoing	Started (ramp up needed)
10 - Champion	--	Not started

# A big win already!

USGS 3DEP contribution of \$1,250,000 to acquire lidar in Montana. (6,300 square miles; 2.5 Counties)



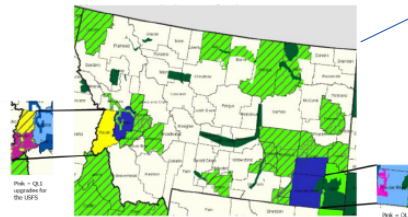
United States Department of the Interior

U.S. GEOLOGICAL SURVEY  
12201 Sunrise Valley Drive  
Reston, Virginia 20192

4 June 2019

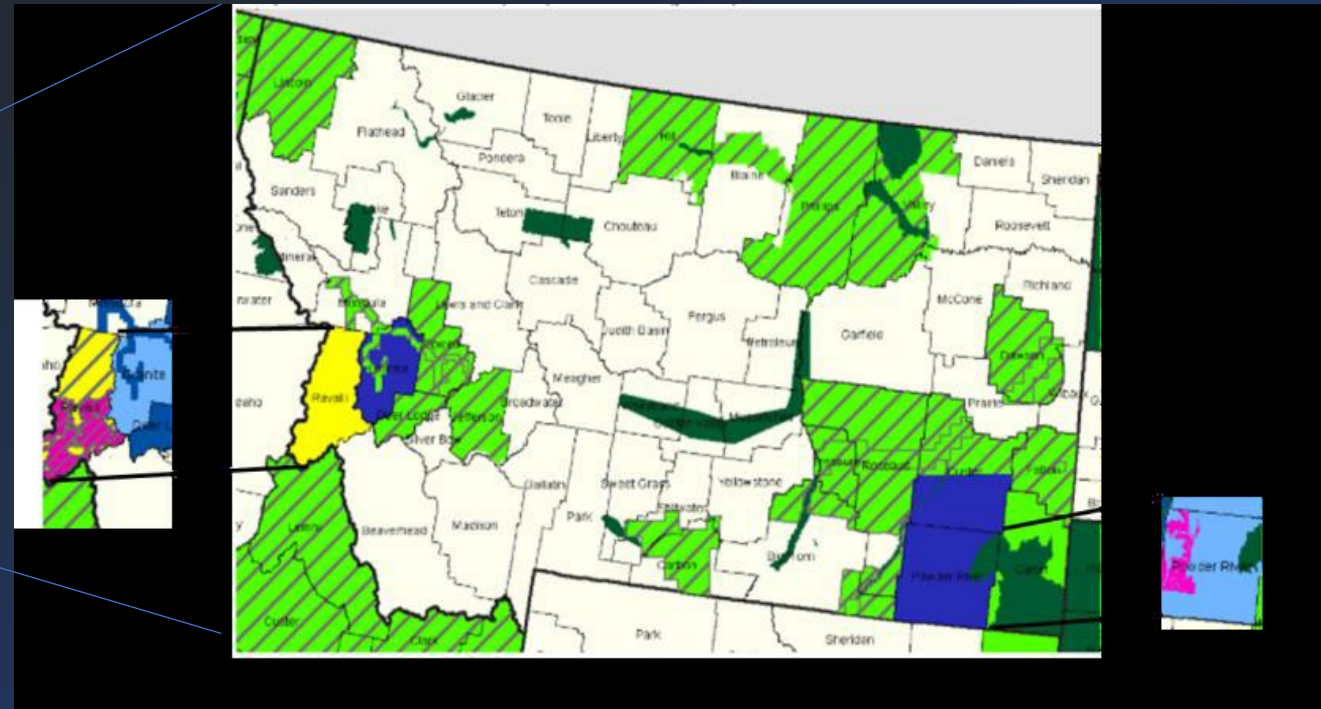
Dear Mr. Blandford,

Congratulations, your proposal for the acquisition and processing of lidar data titled *Montana Statewide Lidar Plan - Phase 1* submitted in response to U.S. Geological Survey Broad Agency Announcement for 3D Elevation Program (3DEP), 140G0118R0037/G18AS00078 has been recommended for partial funding, not to exceed a 3DEP contribution of \$1,250,000. In addition, the USGS is partnering with the USFS to acquire data for Ravalli County, we hope this data will be of benefit to a number of partners within the state. BAA awards are always based on the availability of funding. The USGS regrets that we have now reached our FY19 data acquisition limits, so were unable to satisfy your entire request; we do encourage your future participation in 3DEP as we collectively work on our mutual goals of state-wide lidar data for Montana. A shapefile of the reduced area is attached.



As your submission proposes to apply all awarded funds against the USGS Geospatial Product and Service Contract (GPSC), no Cooperative Agreement will be issued, rather, the USGS will issue a Task Order against the GPSC, as proposed. In order to proceed with issuance of the Task Order, the following steps will be taken:

1. A GPSC representative will begin the Task Order estimation process. During this process, final funding amounts from partner organizations and the USGS will be determined. The USGS recognizes the in-kind contribution of ~18,000 square miles of 3DEP data acquired through the Montana DNRC state contract. The period of performance for the GPSC Task Order will also be finalized.





THANK YOU

QUESTIONS/COMMENTS PLEASE.

