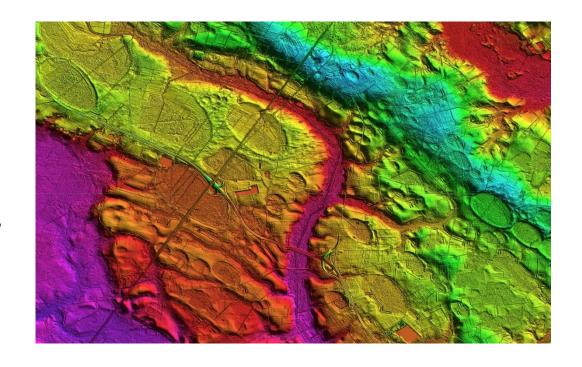
Welcome!

Thank you for inviting us to your meeting.

- We are excited to meet with you today to discuss lidar acquisition planning efforts in Minnesota.
- Members of the 3D Geomatics Committee Lidar Acquisition Workgroup will be introducing 3DGeo, sharing updates, and information about lidar collects for Minnesota.
- We welcome your input today and going forward.



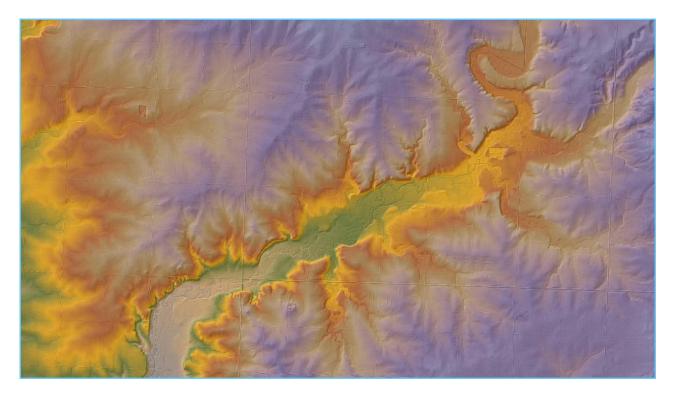
Meeting Housekeeping

- Please mute your microphone if you're not speaking
- Type in questions anytime into the chat window, and we'll address them during the Q&A section
 - Feel free to use your microphone during Q&A session
- Slides will be shared after the meeting



Goals for today

- Who is 3D Geomatics (3DGeo)?
- What is this partnership and plan all about?
- What is Lidar in 2020 and beyond?
- What do we get for the money we can contribute?
- When do we get our deliverables?
- What's the next steps after this meeting?





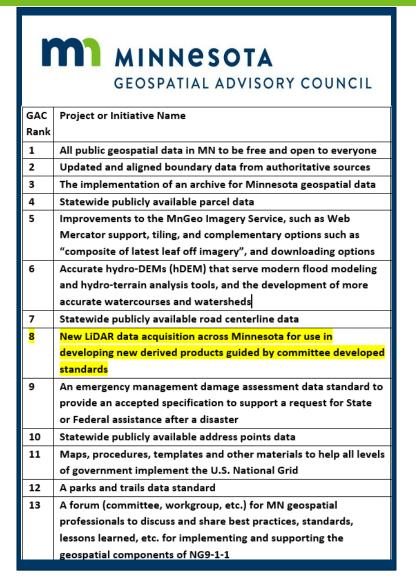
Geospatial Advisory Council (GAC) - 3D Geomatics Committee

Geospatial Advisory Council (GAC)

- Coordinating body for the Minnesota geospatial community.
- Cross-section of organizations that include counties, cities, universities, business, nonprofit organizations, federal and state agencies, tribal government, and other stakeholder groups.

3D Geomatics Committee (3DGeo)

- Committee under the GAC
- Works to identify and promote the need for planning, funding, acquisition, and management of three-dimensional geomatic data and derived products.
- Lidar acquisition led by a team with **dedicated time** working to bring new high-definition lidar to Minnesota.





3DGeo Workgroups

3DGeo Executive Steering Team

- Workgroups/Subgroups
 - Hydrogeomorphology
 - 1. Data Catalog
 - Foundational Hydrography Data Stewards
 - 3. DEM Hydro-modification
 - Vegetation
 - Education
 - Human Infrastructure
 - Data Acquisition

3DGeo - Data Acquisition Workgroup

Mission:

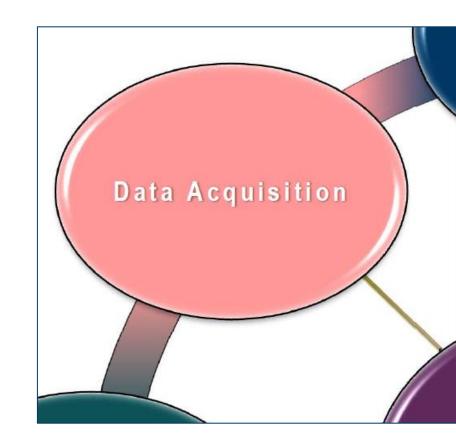
• The Data Acquisition Workgroup promotes procurement of foundational 3D data for Minnesota.

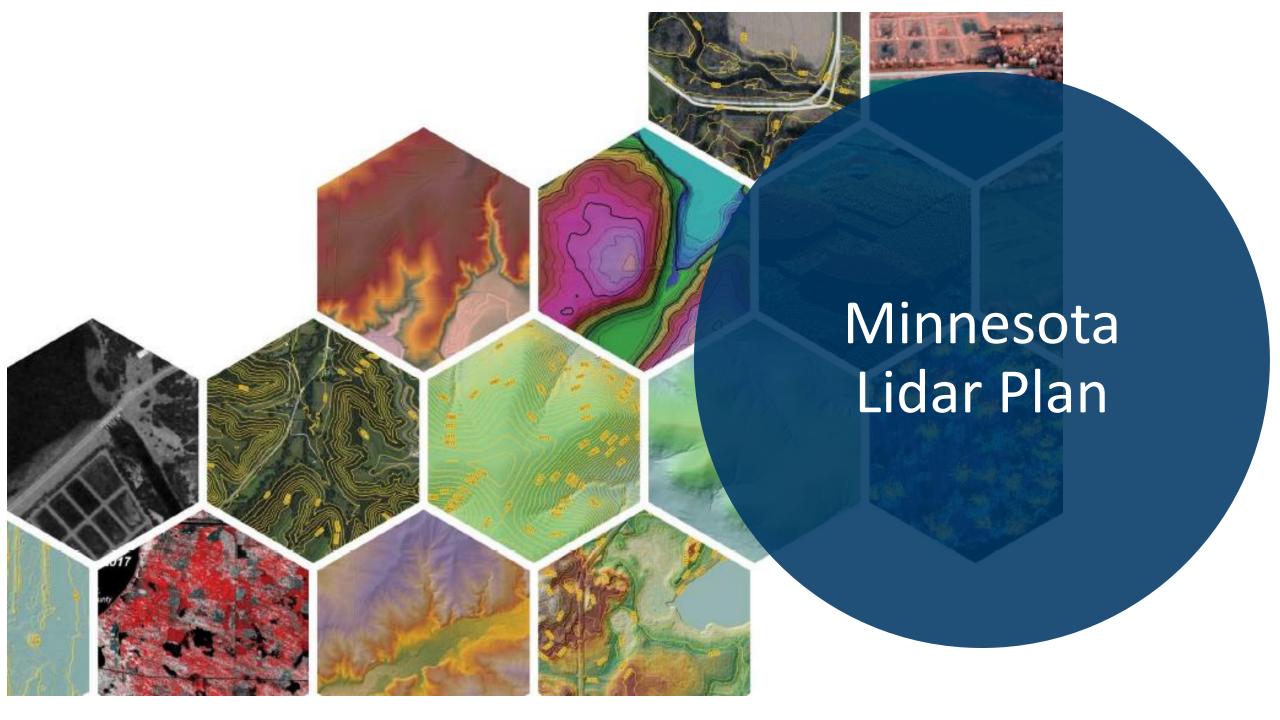
Co-Chairs

Sean Vaughn, Alison Slaats, and Gerry Sjerven

Lidar Acquisition Subgroup:

Alison Slaats (MnGeo), Jennifer Corcoran (DNR), Colin Lee (MnDOT),
 Sean Vaughn (MNIT DNR), Gerry Sjerven (MN Power), Dan Ross (MnGeo),
 Matt Baltes (NRCS), Joel Nelson (U of MN), Joe Sapletal (Dakota Co),
 Andra Mathews (MnDOT), and Brandon Krumwiede (NOAA), Jeff Weiss (DNR).





Minnesota Lidar Plan - Our Plan - Your Plan - One Plan

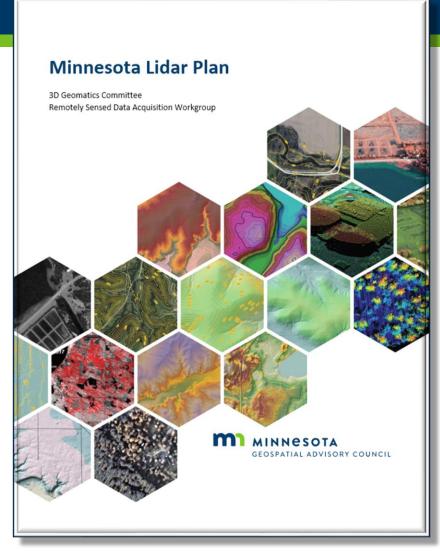


The Minnesota Lidar Plan

- One plan for Minnesota
- Committee led plan, not a state agency plan
- Collaboration of the geospatial community
- Coordination of lidar acquisition in Minnesota leverages federal match dollars

3DEP grant success is built on a guiding plan that pulls the community together to foster collaboration and coordinate funding to achieve the common goal of high density lidar acquisition across Minnesota

Minnesota State Lidar Plan and Story Map



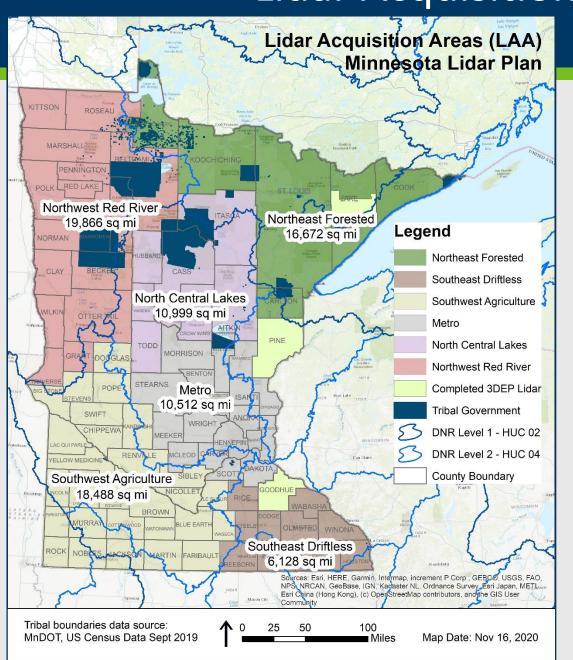


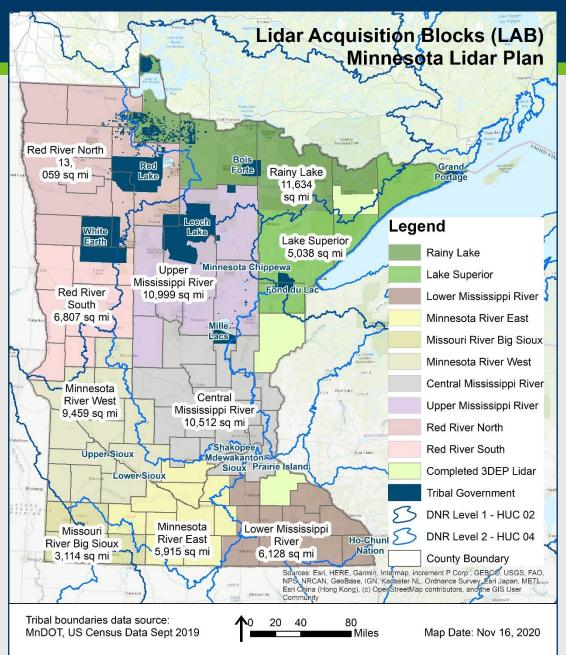
https://www.mngeo.state.mn.us/committee/3dgeo/ac quisition/Minnesota State Lidar Plan.pdf

Background

- Lidar acquisitions are coordinated by the GAC's 3DGeo Committee
- Minnesota's Lidar Plan divides up the state into lidar acquisition areas (LAA) based on political (county) and watershed boundaries
- Grant funds are available from USGS for lidar acquisition because there is a national need for a nationwide elevation layer
- 3DGeo is working to organize lidar acquisition so that Minnesota can take advantage of this USGS federal funding opportunity
- Economies of scale are achieved
 - The bigger the collection footprint, the lower the cost

Lidar Acquisition Areas and Blocks of Interest







USGS 3D Elevation Program (3DEP)

3D Elevation Program (3DEP)

- Systematically guiding the collection of 3D elevation data in the form lidar data for the United States, and the U.S. territories
- Goal: elevation dataset for the nation
 by 2023

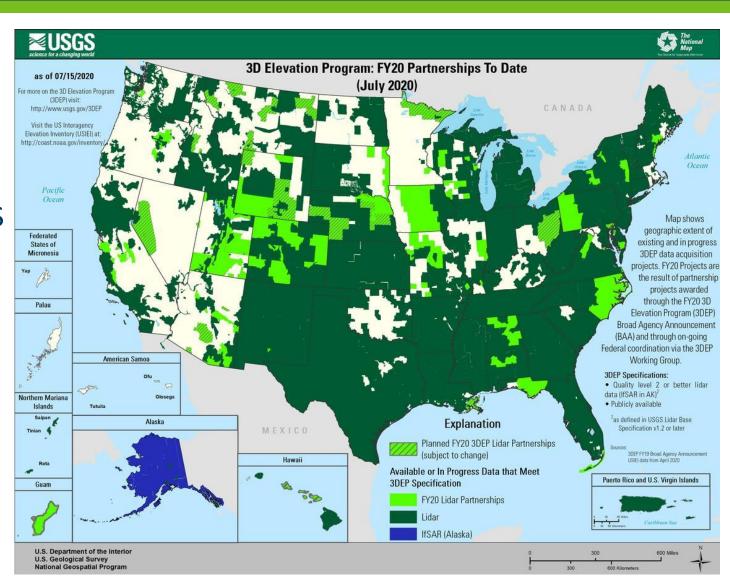


- Acquisition contracts are under two managerial mechanisms
 - GPSC
 - 。 COOP

USGS 3D Elevation Program (3DEP)

Broad Agency Announcement (BAA)

- Grant coordinating mechanism 3DEP
- Guides partnerships between the USGS and other Federal agencies with other public and private entities seeking high-quality 3D lidar elevation data acquisition.
- USGS is cost-sharing via grant funds for QL2 or greater
- Grants through "BAA" process deadlines are every fall (Oct/Nov)





What is lidar?

- Lidar stands for light detection and ranging
- It is a mapping technology that uses a
 pulsed laser to measure the time it takes for
 emitted light to travel from a sensor to the
 ground or other objects and back.
- The sensor can pulse a laser beam hundreds of thousands of times per second, millions of returns ("points") are captured, resulting in a "point cloud" of three-dimensional measurements.

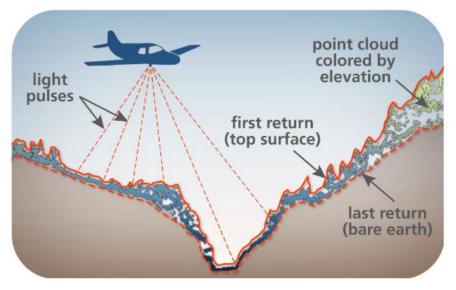
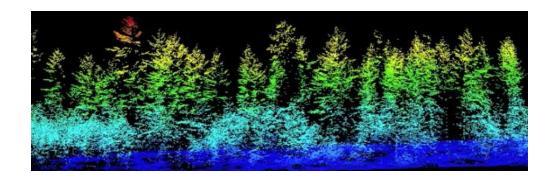


Image from the Washington Geological Survey



What is Lidar?

To Some Lidar Is:

A 3D Point Cloud

To Some:

- 2-ft Contours
- Digital Elevation Model (DEM)

Note: The two most downloaded authoritative lidar-derived products from MnTOPO are the 2-ft Contours and the DEM.

To Some:

- Hydro-modified DEM & Hydrography
- 1-ft contour Dataset
- Vegetation and Buildings
- Intensity Imagery
- Digital Surface Model (DSM)
- And Many other products

Regardless what lidar is to you and your business needs, "lidar" begins with collection of the data as part of a data procurement project within a 3D Geomatics lidar acquisition area.



Need for High-density Lidar

- Higher-resolution, higher-quality, and higher density lidar dramatically improves our ability to analyze the landscape in Minnesota, map assets, and assess resources
- Provides the foundation for development of authoritative derived products use to analyze and plan for current and future scenarios, and make better informed decisions
- Enables practitioners, managers, and researchers to be more proactive than reactive.



Lidar Point Cloud Colorized by Photo

What is High Density Lidar?

High-Density lidar is defined by

two measures:

- 1. Pulse Spacing
- 2. Pulse Density



LIDAR BASE SPECIFICATION (LBS)	LBS Table 1 Minimum Net Pulse Density and Spacing for a Single lidar Collection Mission	
Quality Level (QL)	Aggregate Nominal Pulse Spacing (ANPS) [m]	Aggregate Nominal Pulse Density (ANPD) [pulse/m²]
QL-0	≤ 0.35	≥ 8.0
QL-1	≤ 0.35	≥ 8.0
QL-2	4X ≤ 0.71	16X ≥ 2.0
QL-3	≤ 1.41	≥ 0.5

These two HD technical measures relate to flight mission and lidar platforms affecting:

- Point Density of the lidar
 Point Cloud
- 2. Derived Products

(shown in next slide)

Increased Density = Improved Detail

- QL1 = 8+ pulses per 1 square meter
- QL3 = 1 pulse per 2 square meters

That's 16+ QL1 pulses per the same 2m area of QL3

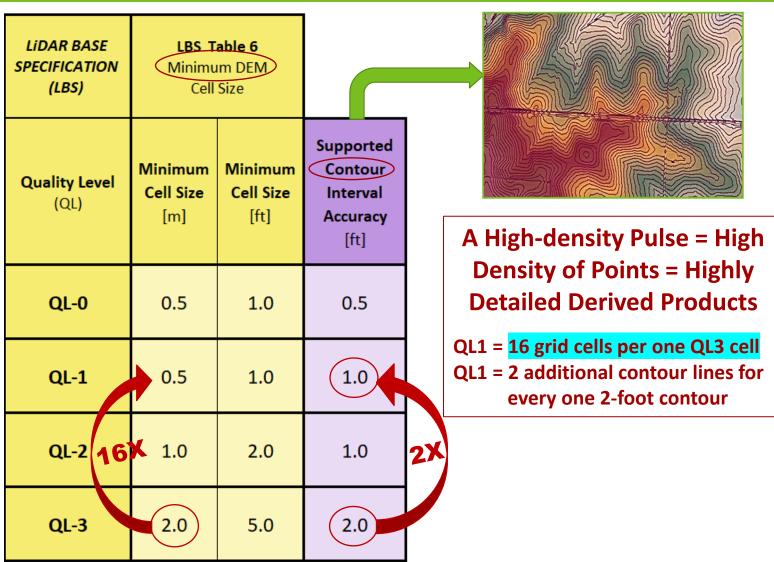
HD Lidar – Derived Products

Lidar Quality Levels Define Deliverable Specifications

- Minimum **DEM** Cell Size
- Minimum Contour Interval

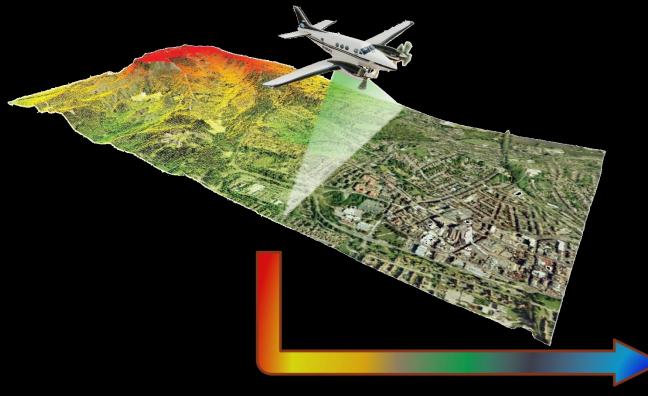


Current Minnesota Data Holdings



LiDAR Acquisition → Point Cloud

Lidar Acquisition

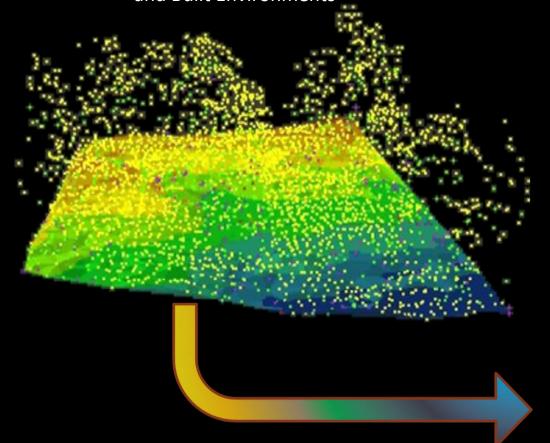


Painting Points

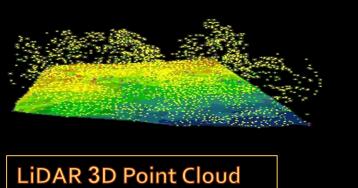
Lidar Point Cloud Classification

Lidar Point Cloud

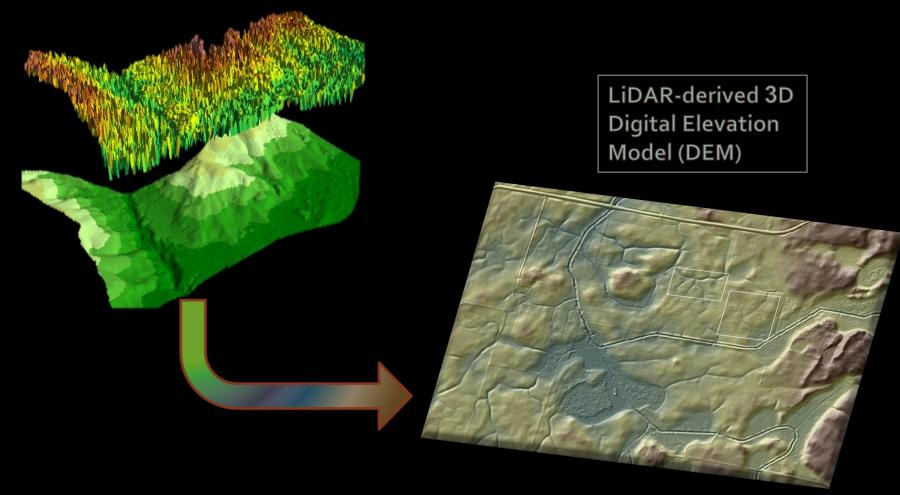
3D Rendition of Natural and Built Environments



LiDAR → Point Cloud → DEM

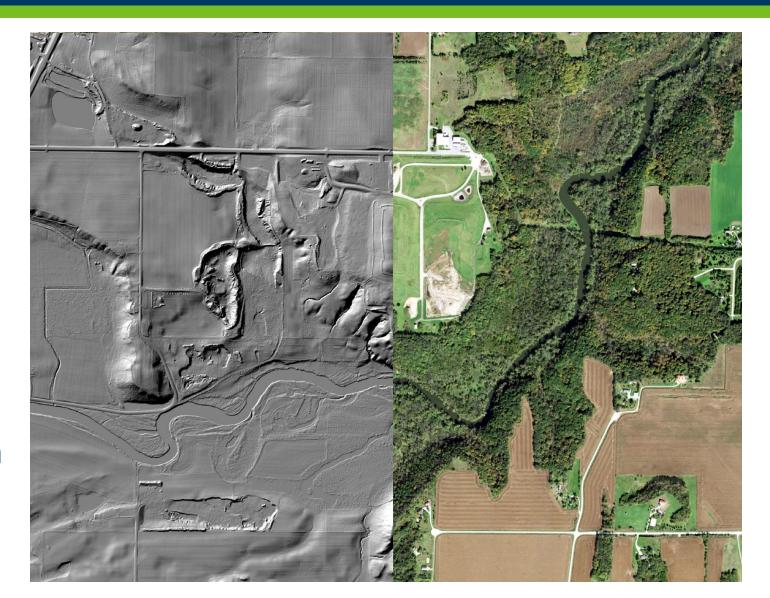


DIGITAL ELEVATION – The Catalyst for Minnesota's Initial Lidar



HD Lidar Examples: Soil and Water

- Model movement of water on the landscape
- Key building block of modeling processes
- Identification of best management practices (BMP)
- Wetland and vegetation management



HD Lidar – Derived Products - Hydrology Example

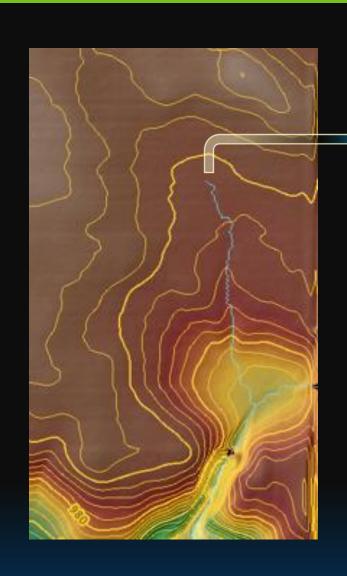
WATER CONVEYANCE LANDFORMS

Mapping the Unmapped



- Features of hydrologic Significance.
 - Nickpoint
 - Fluvial Processes
 - Soil Degradation
- Where does the watercourse begin?
 - Where concentrated flow begins. LiDAR captures these landform.

We Model this with DEMs



Features of hydrologic Significance.

- Nickpoint
- Water Conveyance Landform
- Hennepin County Curb & Gutter
- Where does the watercourse begin?
 - Where concentrated flow begins. LiDAR captures these landforms.

We Do this with Digital Elevation Models (DEM)

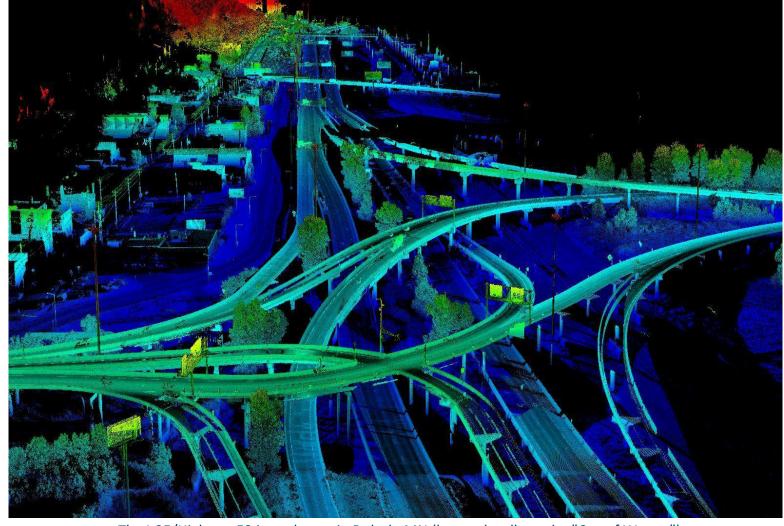
HD Lidar Examples: Infrastructure

Transportation

- 3d Design
- Traffic operations
- Signing and striping
- Highway safety
- Maintenance
- Asset management

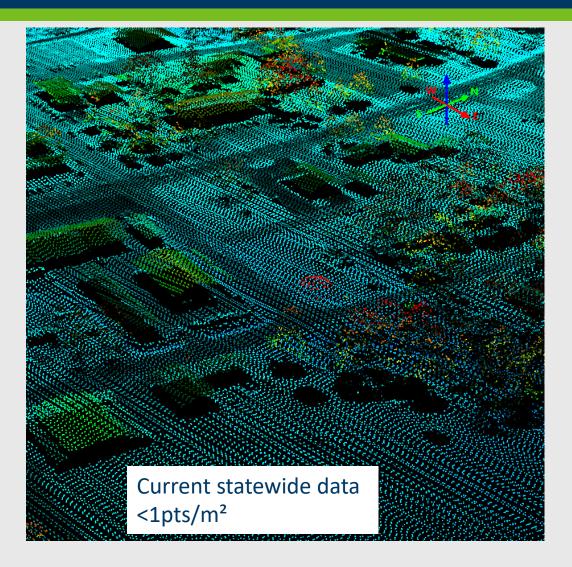
Energy

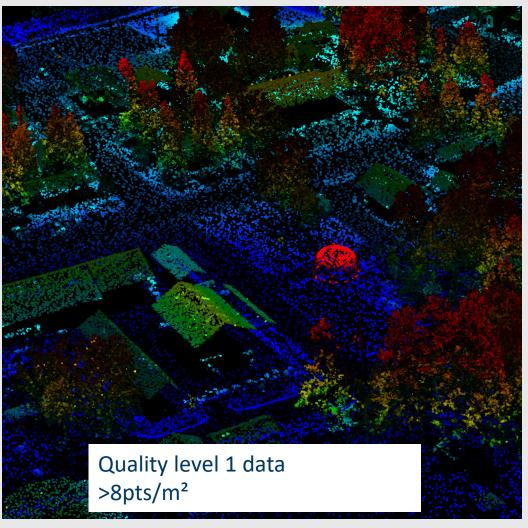
- Traditional
- Renewable/Alternative
- Cultural/Historical Resources



The I-35/Highway 53 interchange in Duluth, MN (known locally as the "Can of Worms")

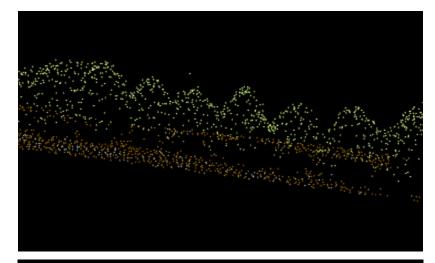
"...but you already have Lidar" Quality Matters





HD Lidar Examples: Vegetation Mapping

Low Density (QL3, 1ppm)





High Density (QL1, 8+ppm)





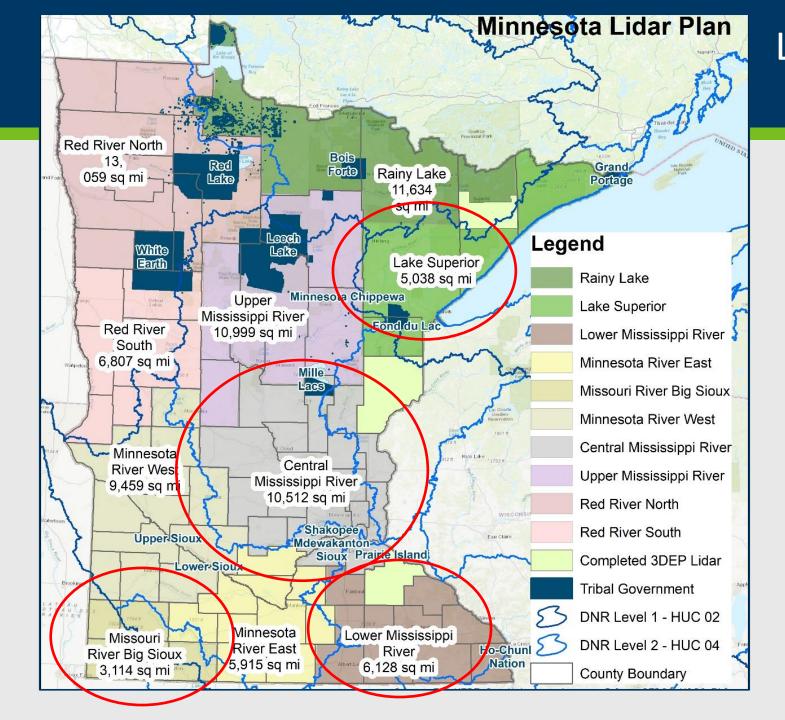
HD Lidar Examples: Floodplain Mapping

2021 - Progressive Approach

- We have an opportunity to be **proactive** and map this entire scene.
- New high density lidar not only maps this area of flood inundation but it maps all the infrastructure assets in the image.



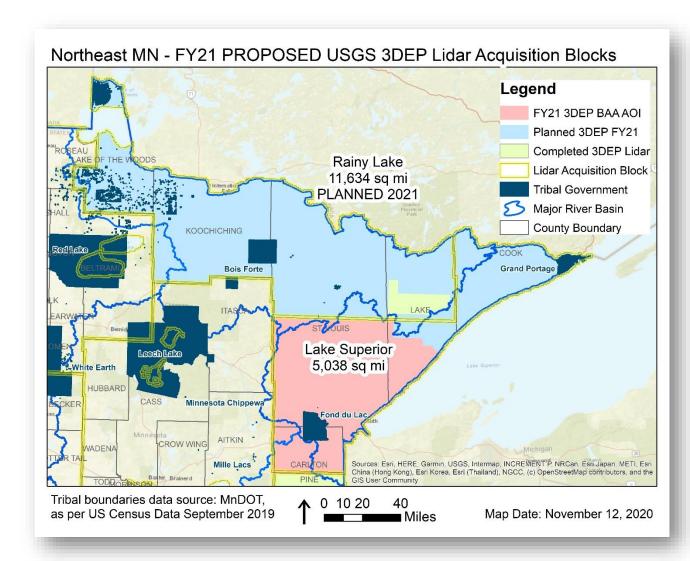




Lidar Acquisition Areas and Blocks of Interest

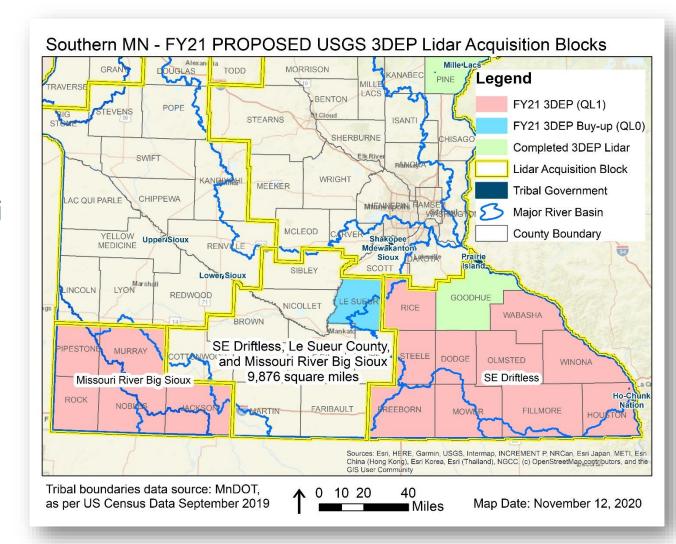
What is happening now?

- Rainy Lake is funded!!
 - QL1 Lidar to be flown Spring 2021
- Lake Superior application was just "Recommended for funding" by 3DEP as a Spring 2021 collection
- LAB Partners:
 - USGS, NRCS State and Federal Offices, MN DNR, MnDOT, MnGeo, Lake and St Louis Counties

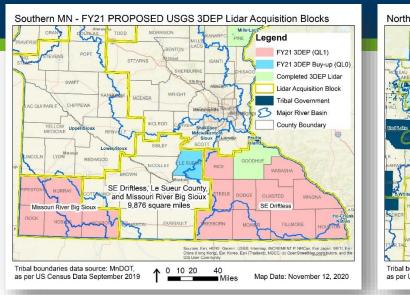


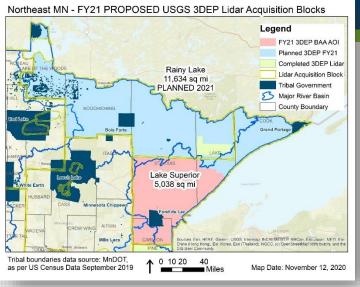
What is happening now?

- Goodhue County successfully collected
 QL0 in Spring 2020!
- Pine County also has 3DEP lidar, QL2
- The SE Driftless, Le Sueur, and Missouri River Big Sioux block applications were "Recommended for funding" by 3DEP as a Spring 2021 collection
- LAB Partners:
 - USGS, NRCS State and Federal Offices, MnDOT, MnGeo, and Nobles, Le Sueur, Winona, and other partners



What is happening now?

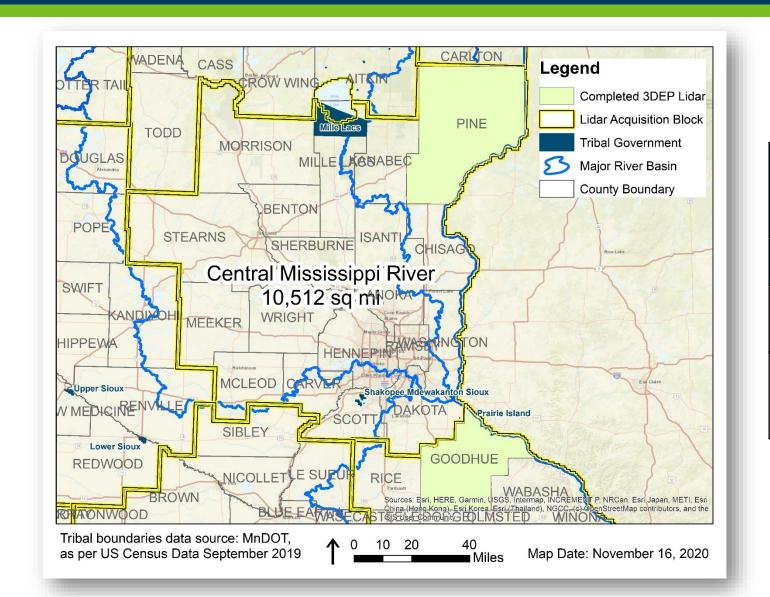




BAA Application	Minnesota Partners Funds	Amount requested from USGS
Lake Superior LAB	\$485,849.06 (28%)	\$1,271,455.72 (72%)
Southern Minnesota	\$1,228,932.08 (37%)	\$2,084,829.92 (63%)

• Coordination, Collaboration, the MN Plan is the success to this massive initiative.

Partners and Funds Needed: Central Mississippi River Lidar Acquisition Block



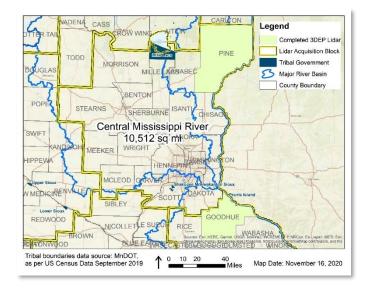
Estim USGS Contri	3DEP	Total P Contrik Nee	outions
%	\$	%	\$
40%	\$1,387,584	60%	\$2,081,376

10,512 square miles at \$330 per square mile = **\$3,468,960** TOTAL

Partners and Funds Needed: Central Mississippi River Lidar Acquisition Block

- TOTAL Est Funds Needed: \$3,468,960
- Estimated using \$330 per square mile for QL1
- 18 Counties* 10,512 square miles
- Estimated cost for QL0 is \$440.00 per sq mile

Contribut	ors	Goal Ro %			Goal Partnership Amount (\$)
USGS		40			1,387,584
Partners		60			2,081,376
	LAB Counties		~ 30**	\$57,816	1,040,688
	All Others		~ 30**		1,040,688
QL1 Total		100			3,468,960



^{*}Anoka, Benton, Carver, Chisago, Dakota, Hennepin, Isanti, Kanabec, McLoed, Meeker, Mille Lacs, Morrison, Ramsey, Scott, Sherburne, Stearns, Washington, Wright

^{**}This is an estimate, up to 30% of the TOTAL, and dependent on the Lidar Acquisition Block



Potential costs of lidar in Minnesota

Quality Level (QL)	Average Cost per mi2*
QL-0	\$440
QL-1	\$330
QL-2	\$200
QL-3	\$175

*Please note that these 3D Geomatics Committee cost estimates are:

- 1. From 2020
- 2. The 3DGeo Committee is advocating for QL1 and will assist partners to explore acquiring QL0 in their area of interest. An upgrade increases costs, but you get ultra high density lidar.

 The upgrade cost is the responsibility of the requesting partner(s)"
- 3. Created from an average of USGS 3DEP Independent Government Cost Estimate (IGCE) quotes, but do not represent a single formal USGS or vendor-derived quote. The estimates are better than just an educated guess created by the 3D Geomatics Committee (referenced as such in our outreach information).
- 4. Based on estimates from other areas of the southern part of the state, these areas do not represent the human infrastructure of the 3DGeo Metro/Upper Mississippi Lidar Acquisition Area (LAA). Please note that completely resolving all features of the mapping of the human infrastructure of the Metro LAA with high density lidar could increase costs above early estimates

3DEP Program - Lidar Data

3DEP Standard Deliverables

- Point Cloud (classified to minimum level meets most needs; data hosted online)
- Digital Elevation Model (DEM/Bare-Earth Surface Raster)
- Lidar Swath Polygon
- Hydro-breaklines
- Metadata
 - ✓ Collection Report . Survey Report of all ground survey data . Flight Mission Report . Processing Report Calibration & Classification . QA/QC Report accuracy assessment . Georeferenced polygon swaths . Georeferenced polygon extents

3DEP Program - Lidar Data and Derived Products

Possible Added Deliverables

- Not 3DEP funded deliverables, but can be part of the 3DEP contract as additional products and services with the 3DEP contract vendor
 - Higher density Point Cloud (3DGeo advocates for QL1, partners may upgrade areas to QL0)
 - Improved hydrographic products
 - ✓ Advanced hydro-modified DEM (Conditioned)
 - Bare Earth point cloud
 - Additional Point Classification
 - ✓ High vegetation and buildings
 - Intensity imagery, GeoTIFF

State Agency Lidar Derived Products

Foundational Derived Product

- Publicly available data served as authoritative products from state agency distribution portals
 - 1-ft Contour Dataset
 - Hillshaded DEM
 - Canopy Height Model
 - Other products to come?

Outreach and educational materials

The 3D Elevation Program—Summary for Minnesota

Introduction

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Elevation data are essential to a broad range of applications, including forest resources management, wildlife and habitat management, national security, recreation, and many others. For the State of Minnesota, elevation data are critical for agriculture and precision farming natural resources conservation, flood risk management, infrastructure and construction management, water supply and quality, coastal zone management, and other detection and ranging (lidar) data are the sources for creating elevation models and other elevation datasets. Federal, State, and local agencies work in partnership to (1) replace data, on a national basis, that are (on average) 30 years old and of lower quality and (2) provide coverage where publicly accessible data do not exist. A joint goal of State and Federal partners is to acquire consistent, statewide coverage support existing and emerging applications enabled by lidar data. The new 3D Elevation Program (3DEP) initiative (Snyder, 2012a,b), managed by the U.S. Geological Survey (USGS), responds to the growing need for high-quality topographic data and a wide range of other three-dimensional representations of the

Nation's natural and constructed features 3D Elevation Program Benefits for Minnesota

The top 10 Minnesota business uses for 3D elevation data, which are based on the estimated annual benefits of the 3DEF nitiative, are shown in table 1. National Enhanced Elevation Assessment (NEEA: Dewberry, 2011) survey respondents in the State of Minnesota estimated that

3DEP in Minnesota by	the Numbers
Expected annual benefits	\$13.64 million
Estimated total cost	\$28.15 million
Payback	2.1 years
Quality level 1 buy-up estimate	\$17.91 million

Total	13.62
Other	0.03
Renewable energy resources	0.07
Aviation navigation and safety	0.14
Geologic resource assessment and hazard mitigation	0.15

Figure 1. Map of Minnesota showing the areal extent and quality levels of planned and existing publicly available November 2012. No lidar data that meet 3DEP requirements for quality level 2 or better are publicly available for Minnesota. See table 2 for quality levels.

the national 3DEP initiative would result in at least \$13 million in new benefits annually to the State. The cost for such a gram in Minnesota is approximately \$28 million, resulting in a payback period of 2.1 years and a benefit-to-cost ratio of 3.9 to 1 over an 8-year period. Because monetary estimates were not provided for all reported benefits, the total benefits of the 3DFP to Minnesota are likely much higher. On the basis of the NEEA survey esults, all levels of government and many organizations in Minnesota could benefit rom access to statewide high-resolution elevation data.

The NEEA evaluated multiple datacollection programs to determine the optimal data quality and data replacement cycle relative to cost to meet the stated

needs. For Minnesota, approximately 76 percent of the total benefits are realized in agriculture and precision farming and as shown in table 1. The status of publicly available lidar data in Minnesota is shown in figure 1. By enhancing coordina-tion between the 3DEP and the various Minnesota, it may be possible to meet a higher percentage of the needs

3D Elevation Program

ged by the USGS to acquire highesolution elevation data. The initiative i of requirements (Dewberry, 2011) and s in the early stages of implementation SDEP will improve data accuracy and provide more current data than is avail-(NED). The goal of this high-priority ooperative program is to be operational overage of the United States by 2022 depending on funding and partnership The new program has the potential to generate \$13 billion/year in new benefit hrough improved government services eductions in crop and homeowner los resulting from floods, more efficient outing of vehicles, and a host of other overnment, corporate, and citizen activ ties (Dewberry, 2011).

enefits of a Funded National Program

- · Economy of scale-Acquisition of data covering larger areas reduces costs by 25 percent.
- · A systematic plan-Acquisition of data at a higher quality level reduces the cost of "buying up" to the highest levels needed by State and local
- · Higher quality data and national coverage—Ensure consistency for applications that span State meet more needs, which results in increased benefits to citizens
- Increase in Federal agency contributions-Reduces State and local partner contributions.
- · Acquisition assistance—Provided through readily available contracts and published acquisition specifications.

Mounds View, MN 55112

By William J. Carswell, Jr.

Minnesota Lidar Acquisition Plan Fact Sheet

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The 3D Geomatics Committee (3DGeo) of the Minnesota Geospatial Advisory Council (GAC) is working closely with the Minnesota Geospatial Information Office (MnGeo) under Minnesota IT Services (MNIT) to engage the geospatial community in developing, promoting, and funding a statewide high-density (HD) lidar acquisition plan for Minnesota. Higher-density and higher-quality lidar will dramatically improve our ability to analyze the landscape in Minnesota, inventory public and private infrastructure and assets, and plan for current and future scenarios, in support of better decision making for our natural, cultural, and built environments.

- . This will be a 5 year or longer effort with a grant request to the federal government each year.
- The plan covers acquisition of all lands within the state boundary 86.943 square miles
- . We are engaging partners in, state, federal, regional, and local government, tribal nations, academia, nonprofit, and private sectors to contribute to the plan and funding.
- . We will be seeking funding from the federal government through a US Geological Survey (USGS) grant program called a broad agency announcement (BAA) managed under the USGS 3D Elevation Program (3DEP).
 - Federal cost share averages about 38% of the cost but can cover as much as 75% depending on needs of federal agencies
- MNIT/MnGeo is the principal for this year's grant application and would likely be the aggregator and distributor for the data products generated over the course of this project and beyond.

Additional resources that can provide more information about upcoming plans for lidar in Minnesota:

- Minnesota State Lidar Plan
- Story Map about the Minnesota State Lidar Plan

Renefits

quality level 1 data, the payback would be 2.6 years. The top 10 Minnesota business uses for 3D elevation data, which are based on the estimated annual benefits of the 3DEP initiative, are shown in the table-1 below.

As customers of government agencies, citizens expect spatial data mapping of building placement, flood modeling, and water features are in harmony with the imagery on their phone. When agency data is out of date and at lesser resolution the bond of trust between the citizen and the agency providing services is broken.

MINNESOTA

The Minnesota 3D Geomatics Committee and the State

Geospatial Information Office, MnGeo, have developed

a 5-year draft plan to help guide the acquisition of new

Deliverables proposed include a lidar point cloud, digital

elevation model, canopy height model, and more

MINNESOTA

Minnesota State Lidar Plan - Announcement

Draft M

February 202 3D Geomatics Cor Remotely Sensed

ommittee and the State

eospatial Information Office, InGeo, have developed a draft dar Plan for the State of linnesota that will help guide t cquisition of new statewide lida

ollection timelines, standards, nd user needs, products, and torage/dissemination methods

Call to Action

- tate Lidar Plan.
- Identify and share requiremen
- and business use cases Provide your desired areas of
- Let us know if you can help provide matching funds
- Check out the draft State Lidar

Need for Lid Lidar data pr making for a to save costs infrastructur forestry. Lida a multitude o

Funding Opp

The USGS 3D

data and crea

depending on stakeholder needs and funding. www.mngeo.state.mn.us/committee/3dgeo/

State Lidar Plan

statewide lidar data.

Get Involved!

· Let us know if you can help

Share requirements and business use cases · Provide areas of interest and product needs

Nationwide. our current lidar data does not meet the new specifications.

Every fall, the USGS has a call for proposals to apply for grant funding to match local partnerships. To receive federal funding, we must provide a non-federal funding match. We are currently

reaching out high quality li be part of th

The quality and partner point cloud. others depen

and in the dra

Plan and StoryMap on the web

More inform

Get involved: Contact https://www.mngeo.state.

GEOSPATIAL ADV

MINNESO

MINNESOTA **♣** The Draft Minnesota State Lidar Plan

Minnesota, and the Minnesota State Lidar Plan.

http://bit.ly/MnLidarPlanStoryMap

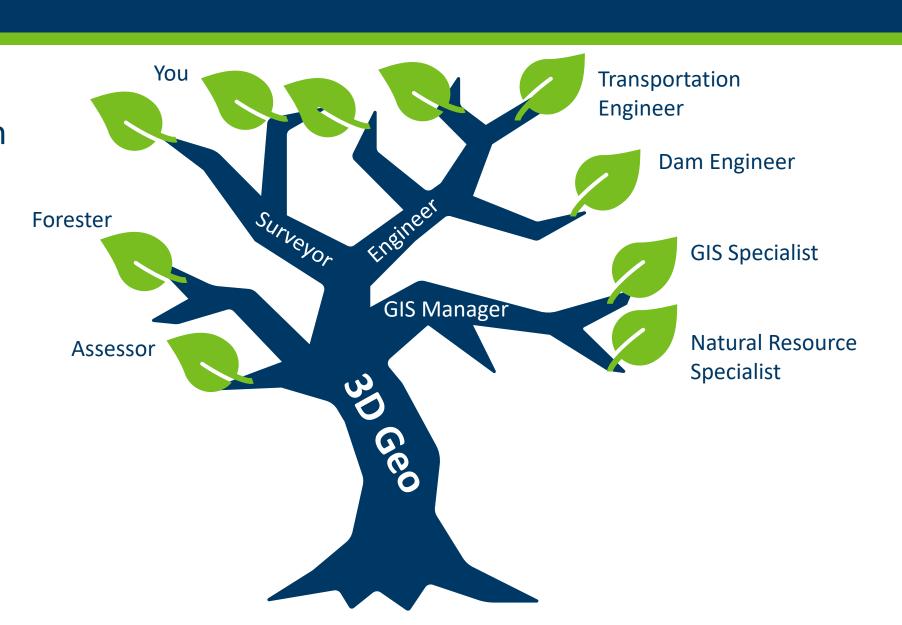


Next steps

You don't have to have money or be a decision maker to be a stakeholder . . .

You can be a voice of support . . .

A collaborator



Next steps

We need partners to help fund lidar acquisition!

- Stay in touch
 - Get on the Minnesota GIS News GovDelivery list
 - https://www.mngeo.state.mn.us/newsletter.html
 - Email 3DGeo
 - lidar@state.mn.us
- Openly discuss the need for new lidar with managers and decision makers.



Reminder to look at the MN Plan

Minnesota Lidar Plan

https://www.mngeo.state.mn.us/committee/3dgeo/acquisition/Minnesota_State_Lidar_Plan.pdf

Story Map about the Minnesota Lidar Plan

http://bit.ly/MnLidarPlanStoryMap

