Aerial LiDAR

A brief primer on Aerial LiDAR prepared for the
Town of Chatham Zoning Board of Appeals

East-SouthEast, LLC

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LiDAR

- Light Detection And Ranging
- Laser Radar
- Laser Scanning

- The lasers are not visible so this is not some exciting laser light show.

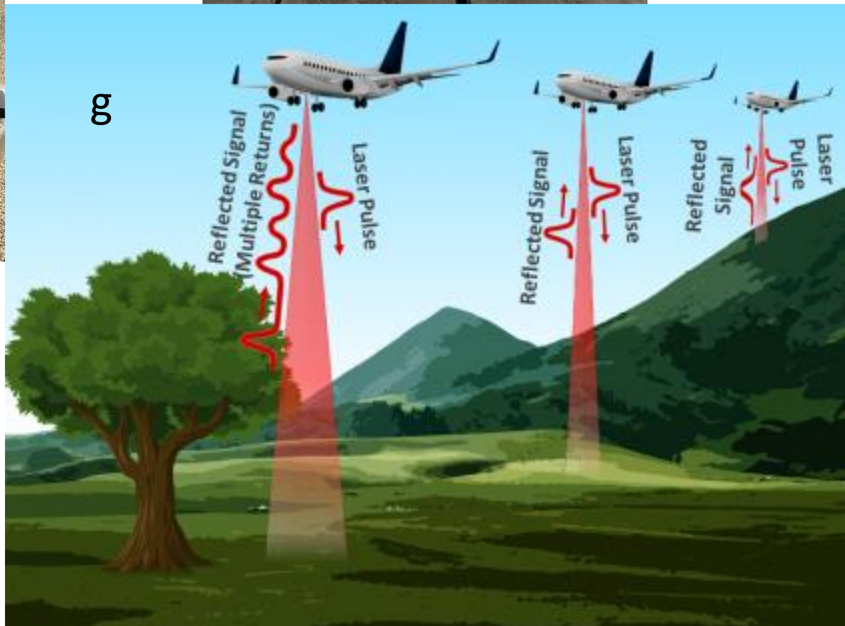
Phodar

- 3-d data obtained from photo-grammetry with a similar output as LiDAR.
- Usually from a drone but could be from a camera or cell phone camera.

Flavors of LiDAR and Phodar

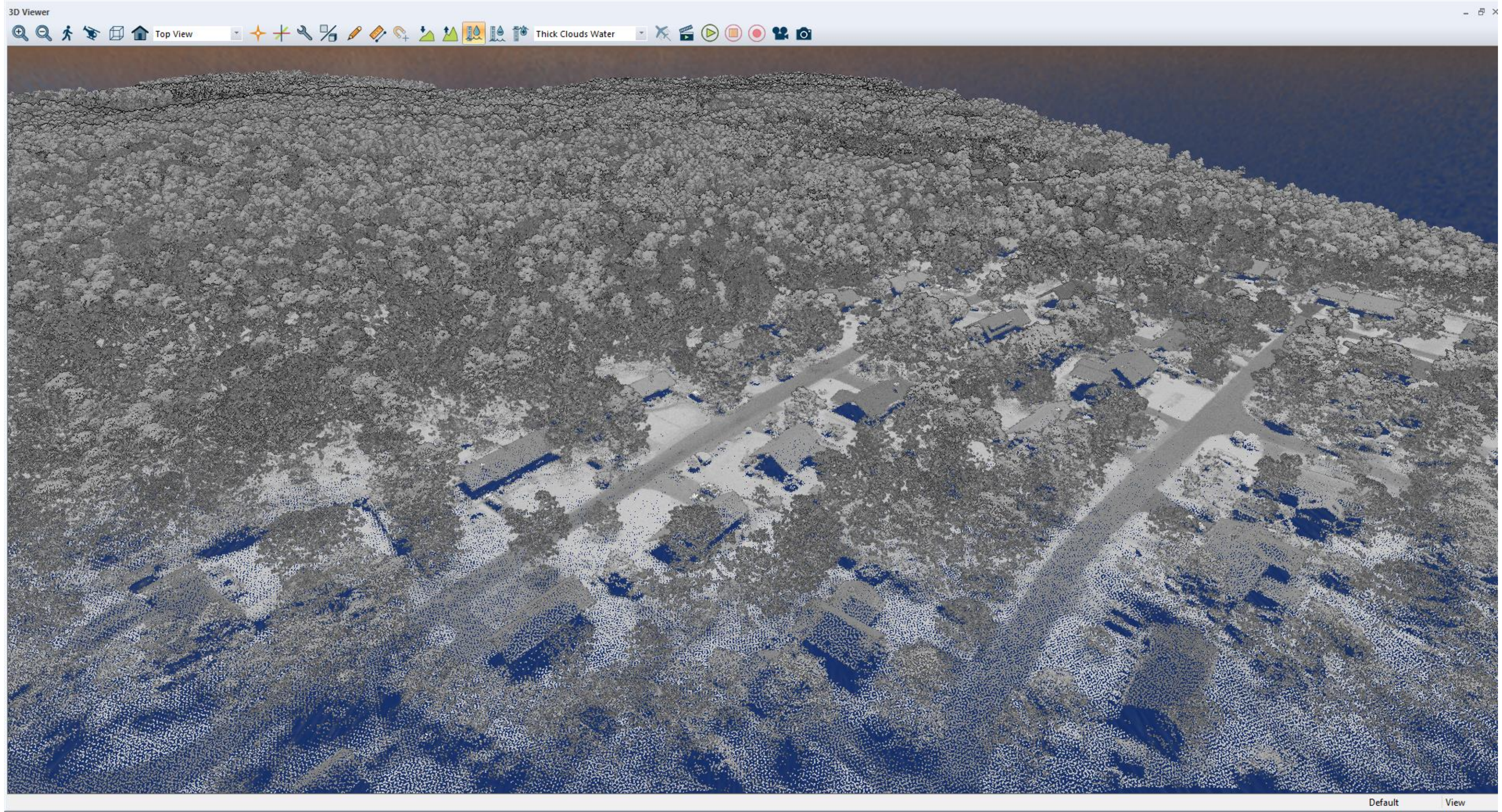
- Handheld LiDAR (a)
- Handheld Phodar (Camera) (b)
- Terrestrial Static (c)
- Terrestrial Mobile (d)
- Drone LiDAR (e)
- Drone Phodar (f)
- Aerial LiDAR (Aircraft) (g)

a



LiDAR

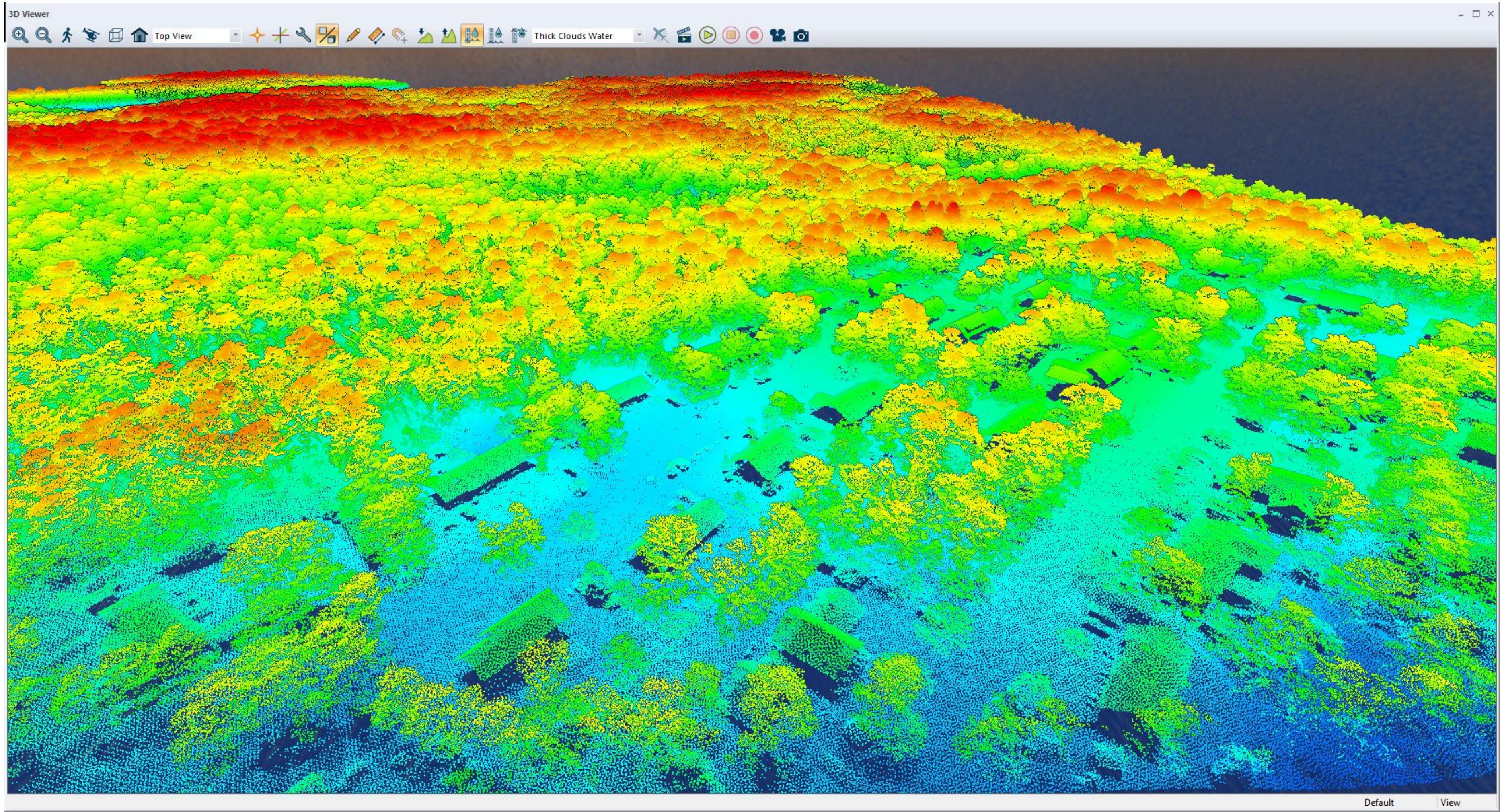
- First dataset is a mass called a Point Cloud – 3d bitmap.
- Most scanners return the reflectivity of the object scanned. This is a point attribute called Intensity as shown below. It's like a black and white imagery but a little different.



Hawksnest,
East Harwich

Visualization

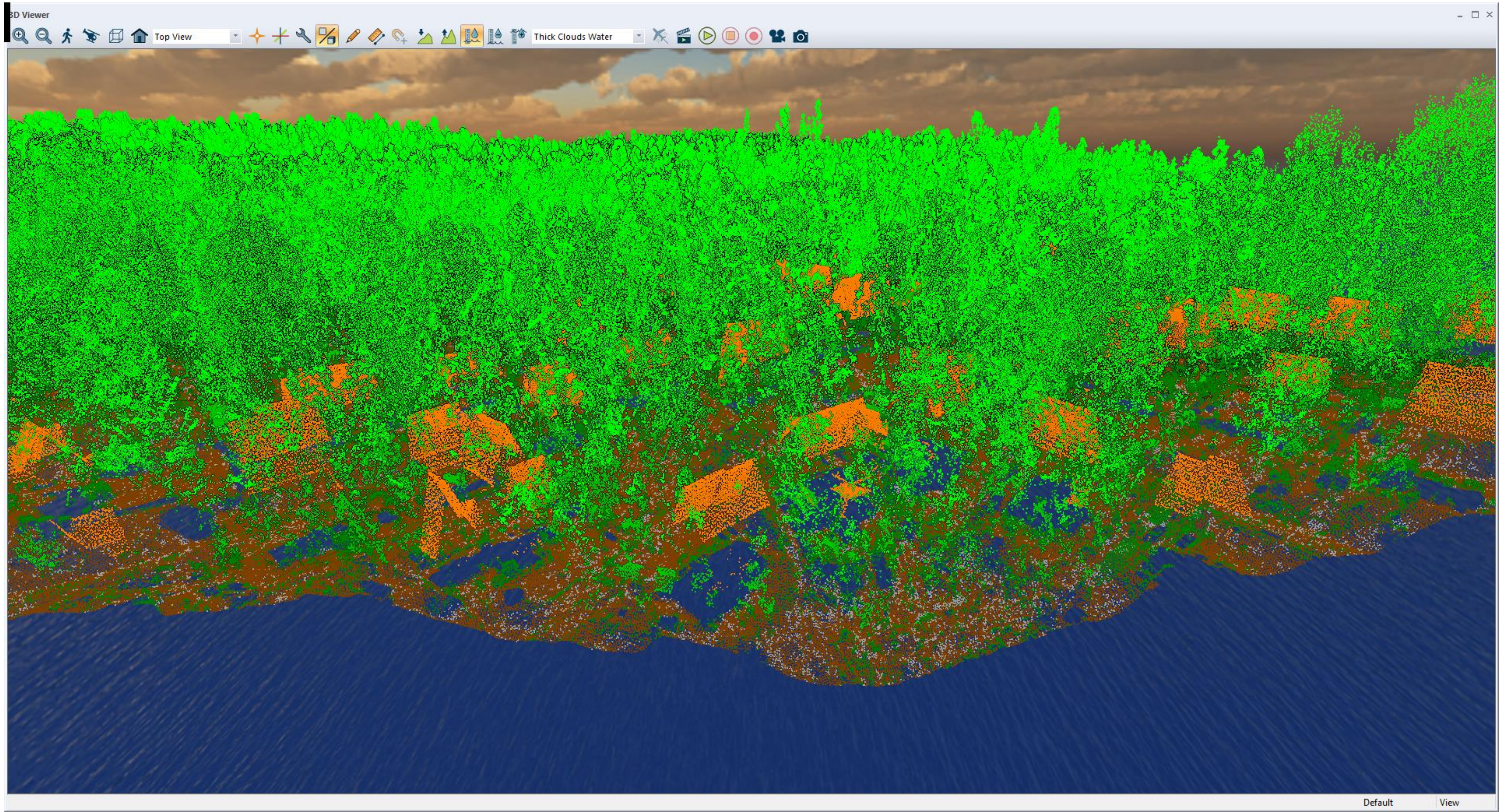
- This is based on elevation – blue is low, red is high and the colors in between represent the elevations in between.



Hawksnest, East Harwich

Classification

- One method to sort and view the data.
- Computer algorithms and human verification add another attribute to each point.
- Orange = Buildings, Green = Low, Medium, Tall Vegetation, Brown = Ground
- Because the data is all digital, one can exaggerate the vertical as shown below:



Hawksnest, East Harwich

LiDAR – Surface Modeling

- Multiple ancient structures that are not easily observable have been rediscovered with LiDAR surface modeling.

Lidar exposes the remnants of an overgrown ancient civilization in the Amazon

Devin Coldewey @techcrunch / 3:14 PM EDT • May 27, 2022 Comment

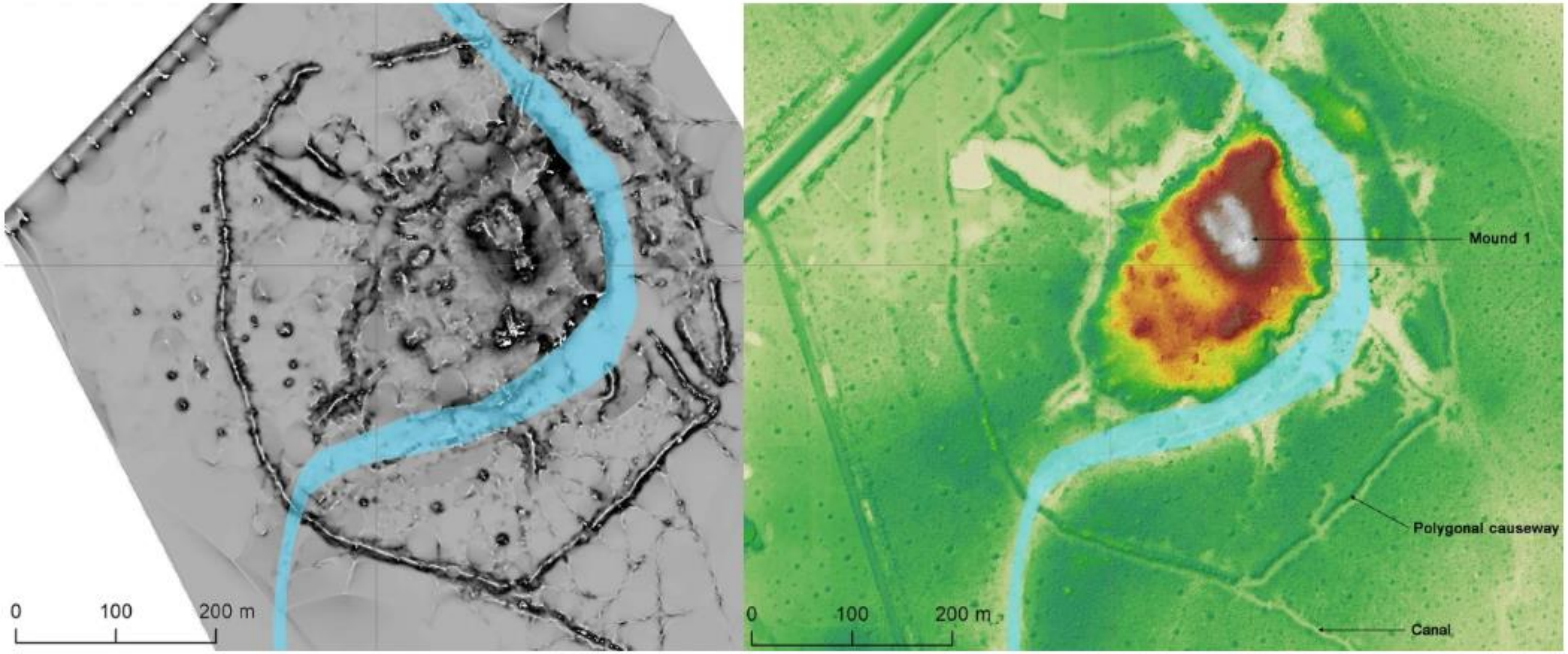
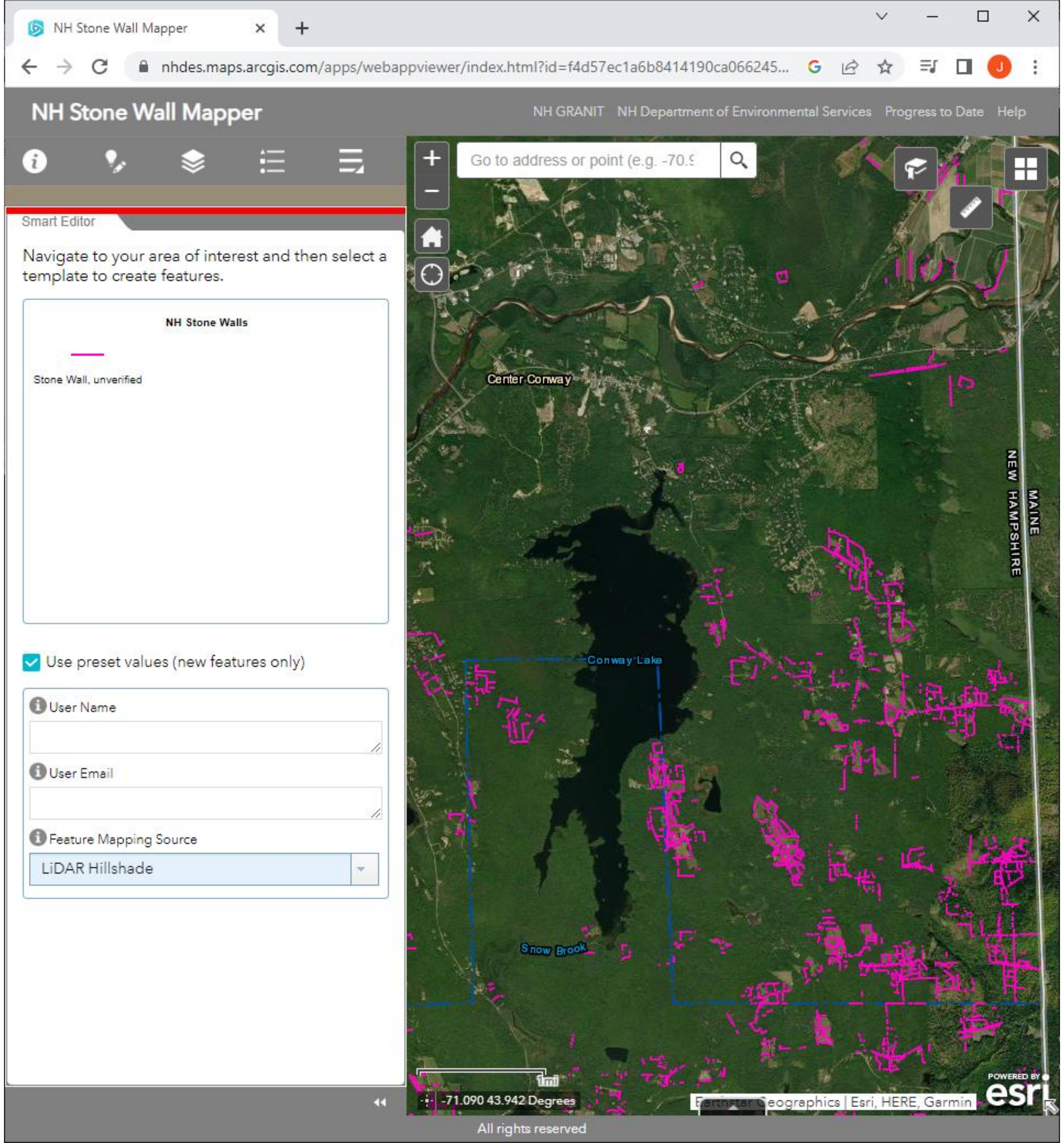


Image Credits: Prümers et al.

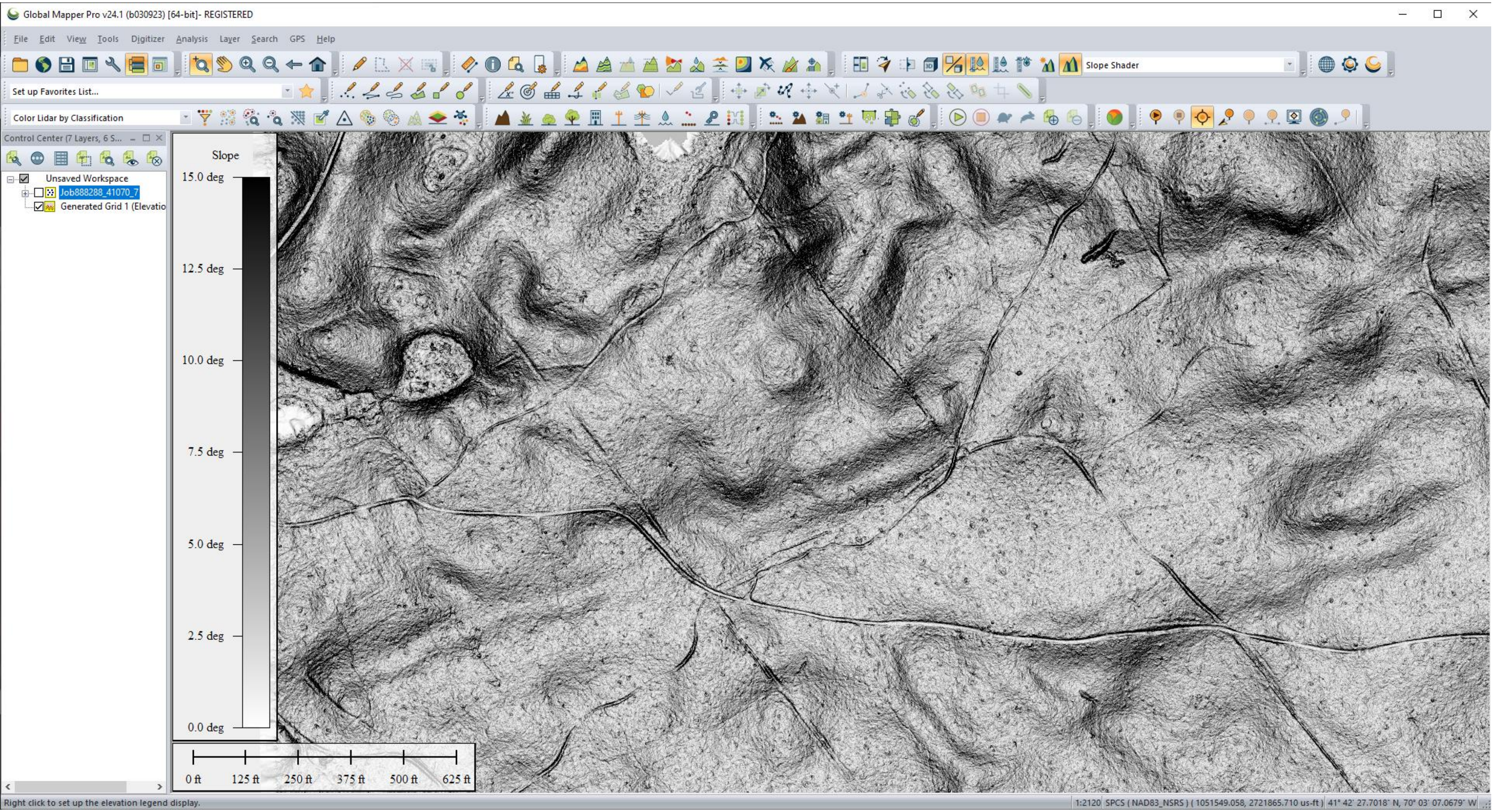
It's Friday and the world is falling apart, so let's just take a short mental health break with some interesting news out of the field of archaeology, where tech is enabling some fascinating new discoveries. A new lidar-powered analysis of land in the Amazon basin has provided evidence of a previously unknown urban center of "mind blowing" complexity.

UNH Stone Walls

- The University of New Hampshire has a program to define all of the stone walls in their state using aerial LiDAR.



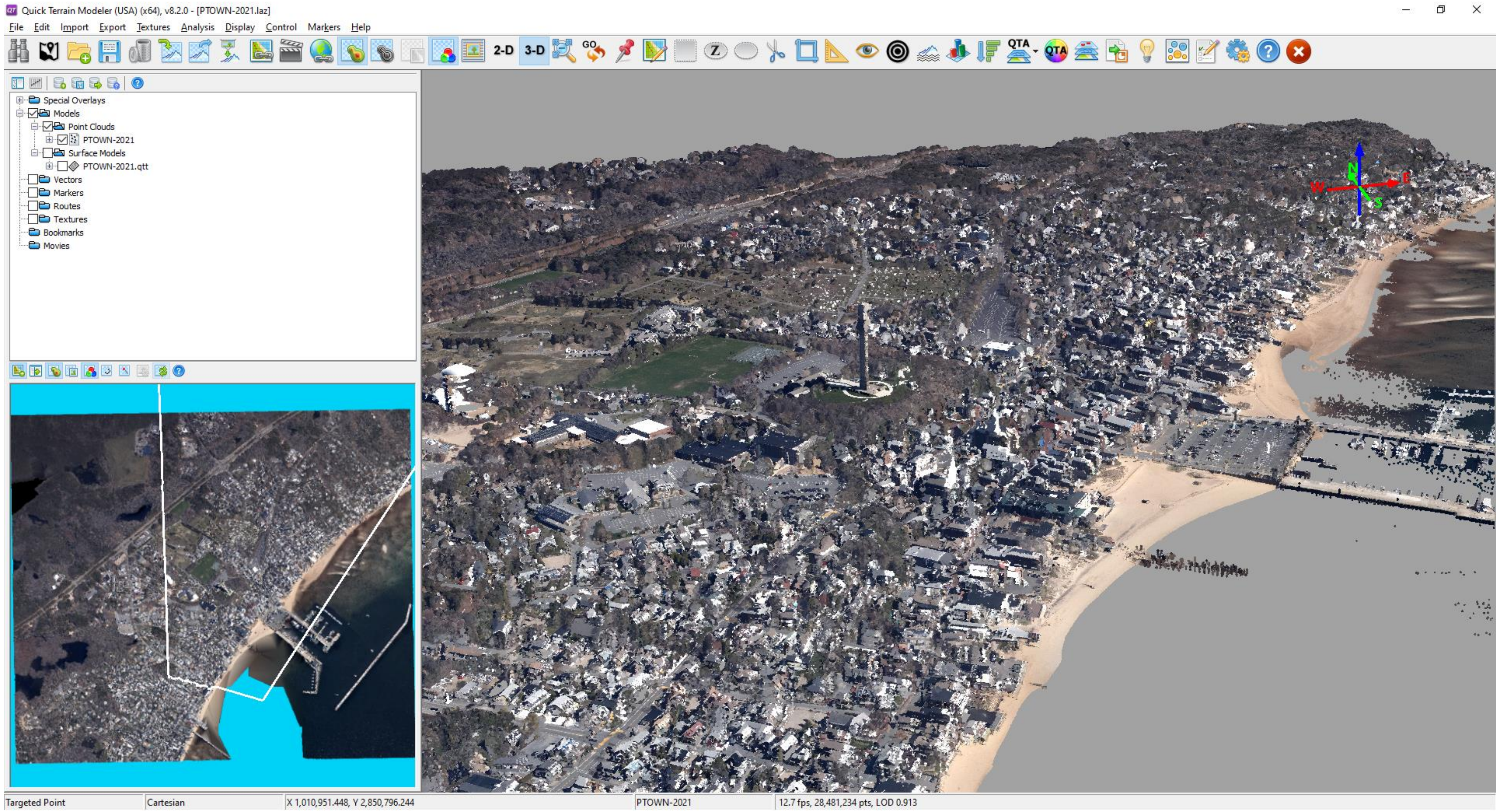
We don’t have ancient cities or ancient stone walls south of Route 6.



We do have roads (ancient and recent), paths, ridges, ditches, remnants of old farmed areas and other deviations in the surface model that can be seen. This is Hawksnest State Park in Harwich where many of the original boundaries can be seen in the form of ditches, ridges and roads.

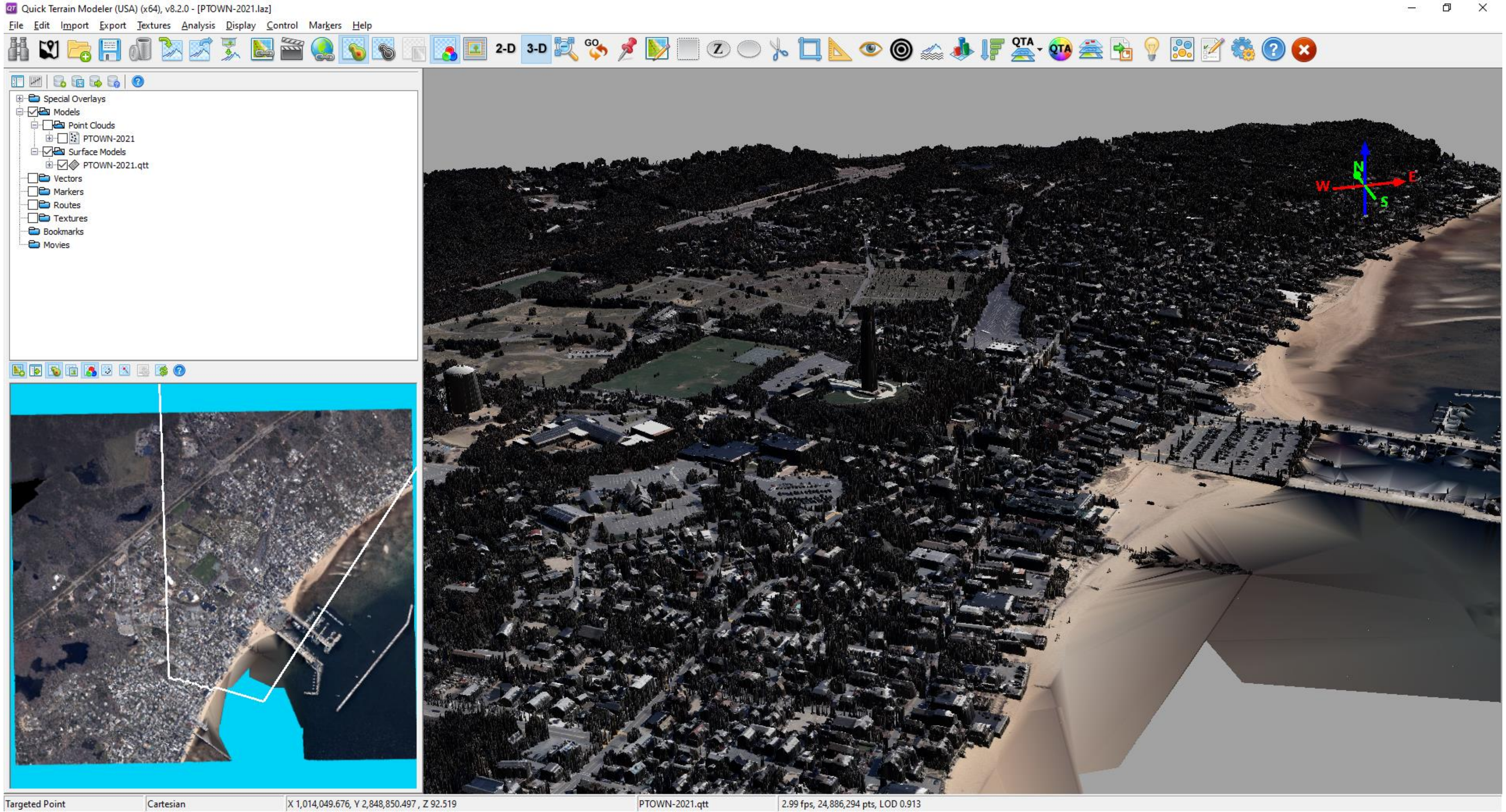
Colorized Point Cloud

2021 USGS LiDAR
2022 USGS Imagery
Colorized Point Cloud



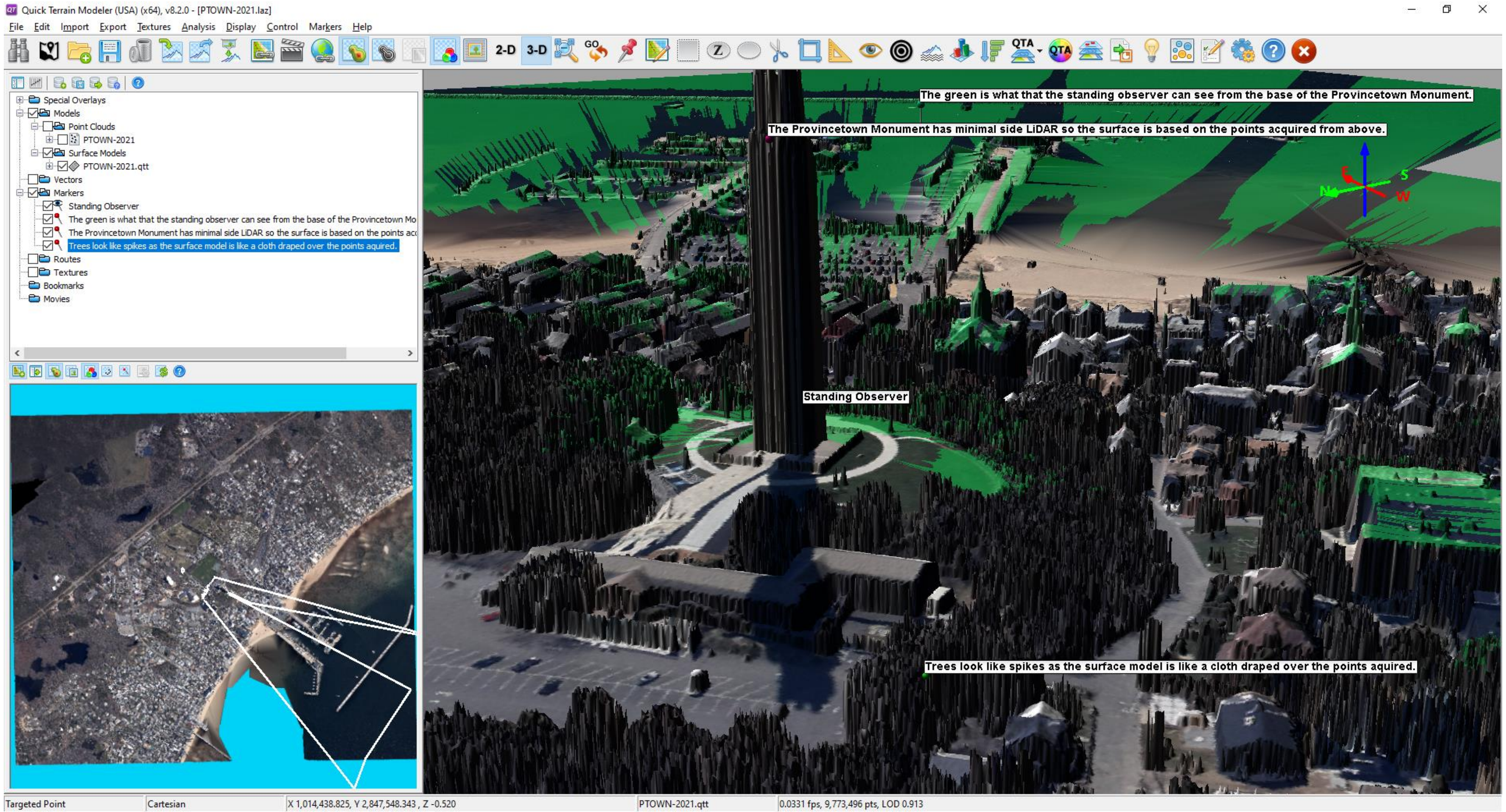
Colorized Surface Model

2021 USGS LiDAR
2022 USGS Imagery
Colorized Surface Model



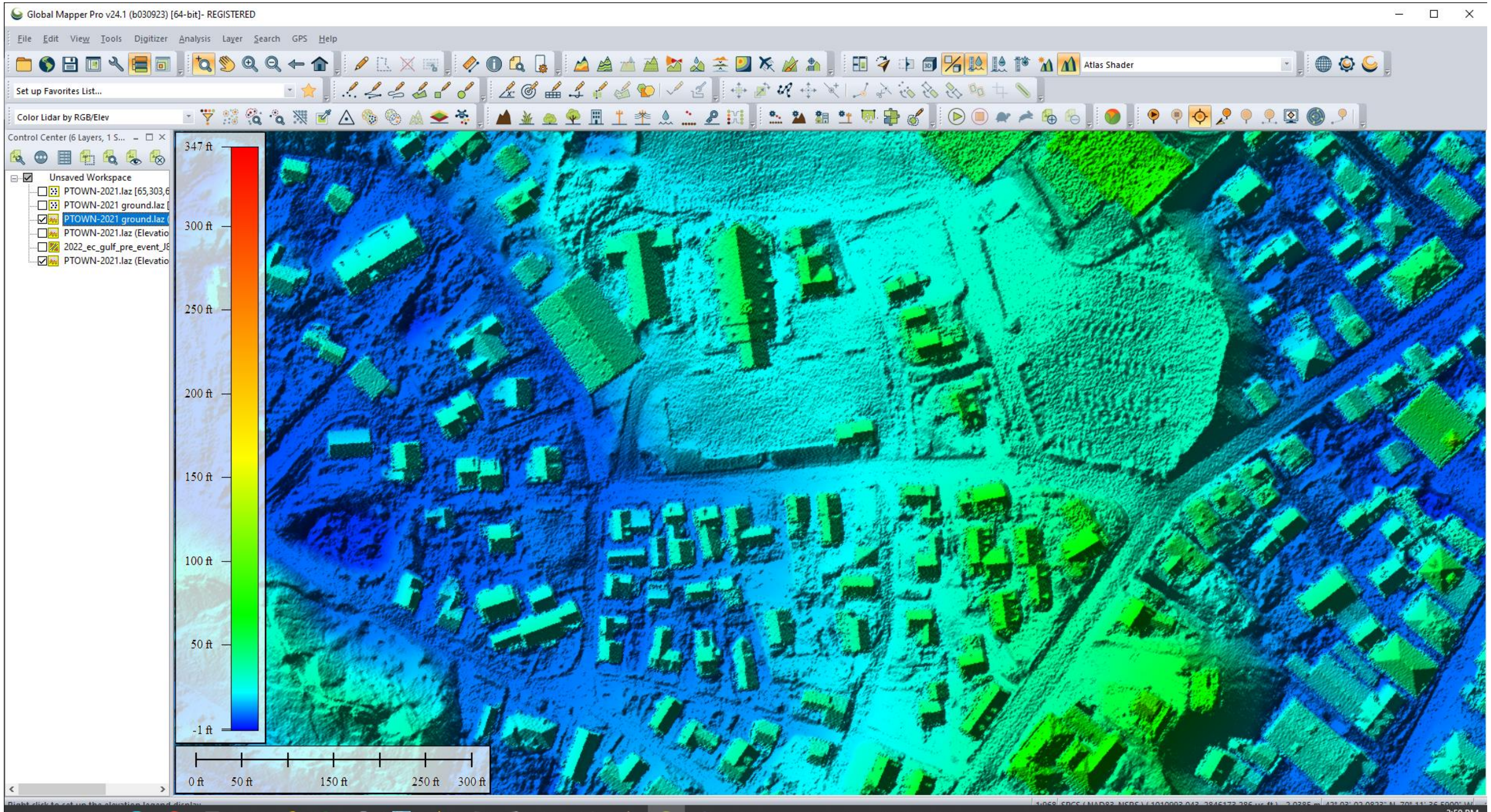
Line of Sight

2021 USGS LiDAR
2022 USGS Imagery
Colorized Surface Model



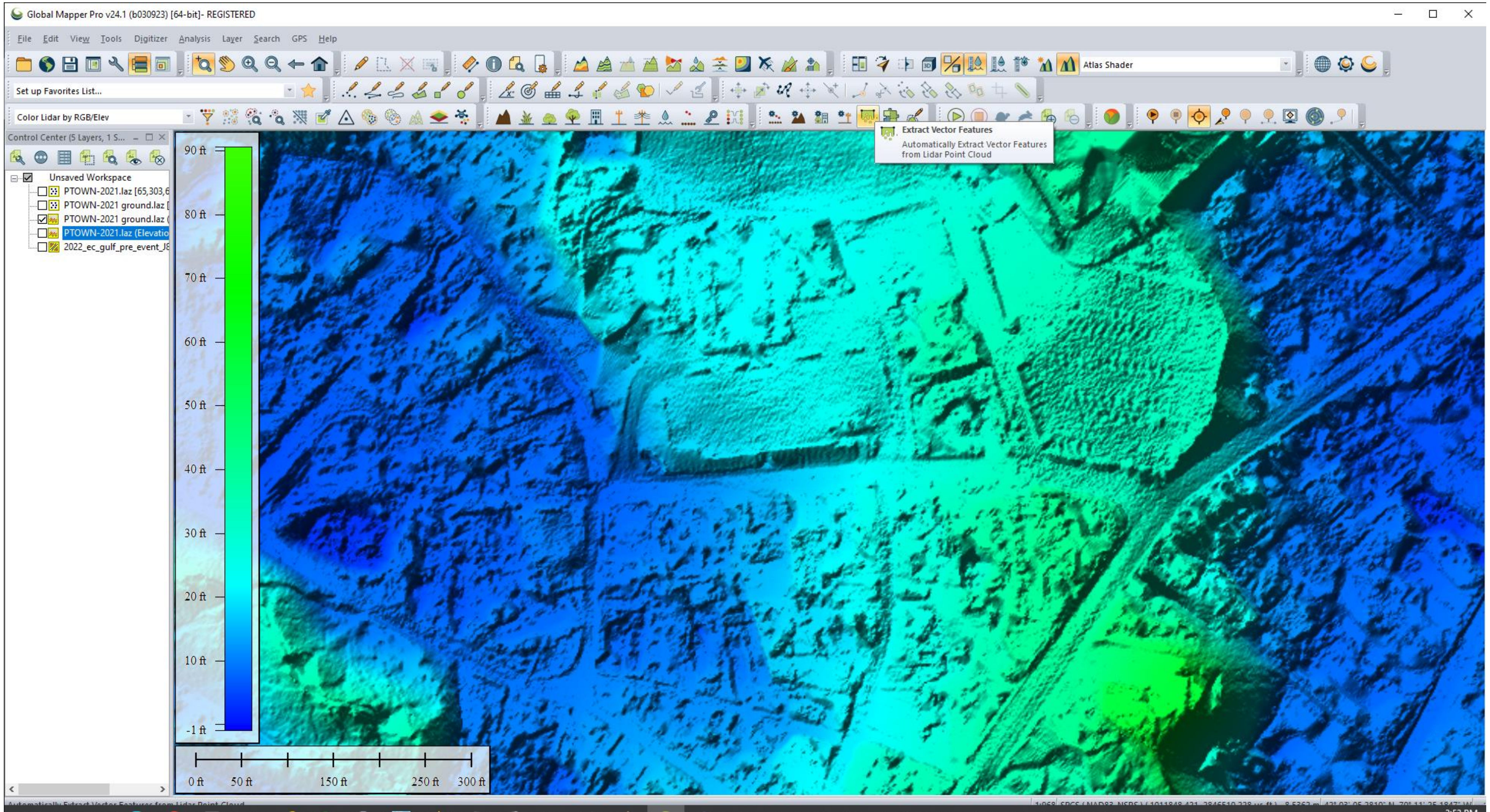
Volumes of Buildings

- Take a surface model that includes only the ground and the buildings.



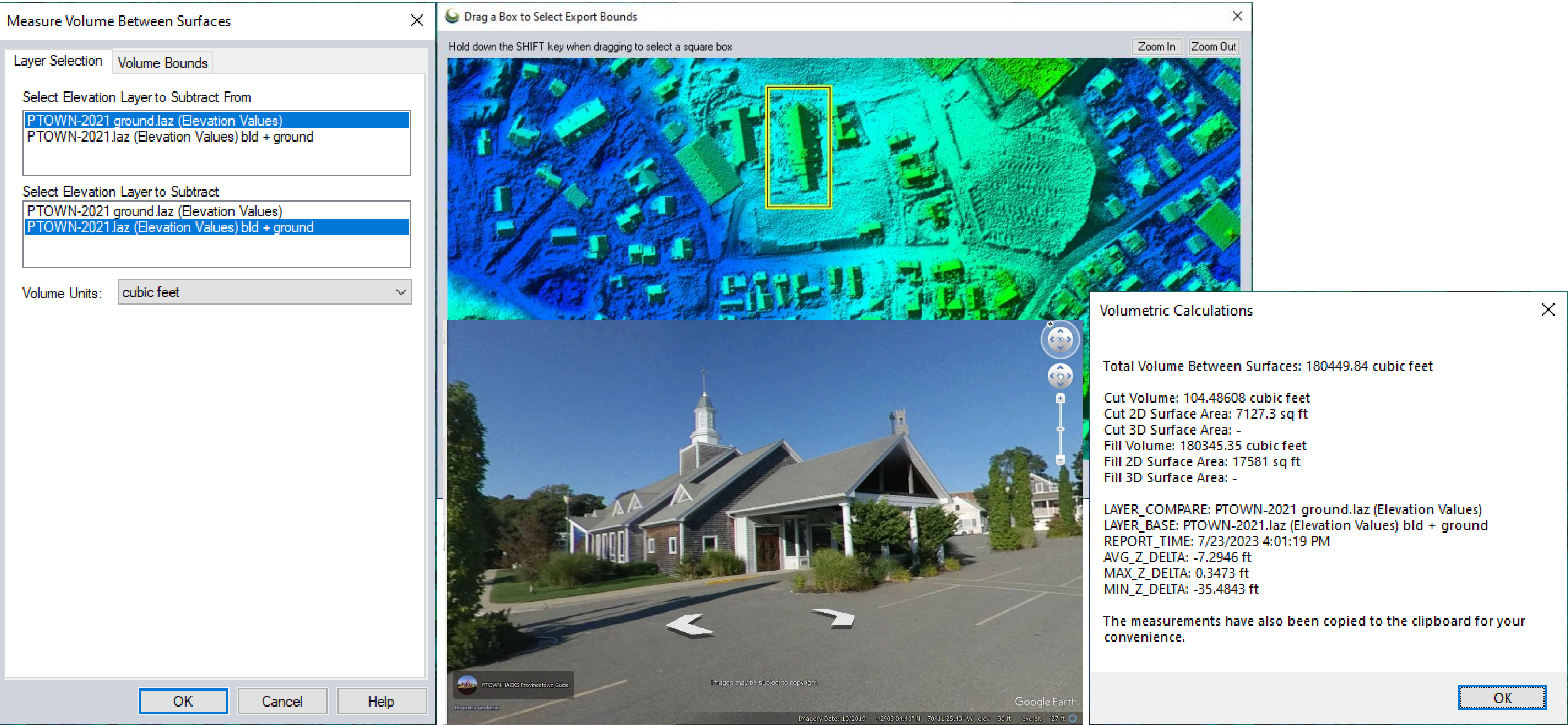
Volumes of Ground

- Take a surface model based only on the ground points. It fakes in under the buildings based on the elevations around the perimeter of the building.

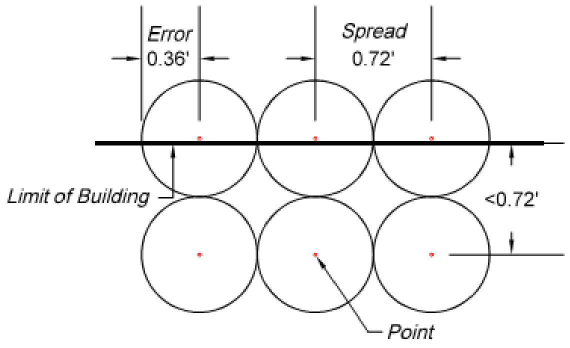


Volumes

- Compare the volumes of the two surfaces (A-B)



How close can we compute?



We take a homogenous group of points in that they are equidistant and the regular pattern is aligned with an edge of a building. We provide two extreme scenarios:

1. The points fall within a minimal distance of the edge of the building. For ease we will call this dimension 0.
2. One string of points fall just outside of the building, then the next row falls just under 0.72'. For ease we will call this 0.72'.

The horizontal error is disregarded since it would follow a normal distribution and compensate to null.

Building w/o overhangs		Area		Low				Percentage
20	40	800	S.F.	18.56	38.56	715	S.F.	89.4%
30	50	1500	S.F.	28.56	48.56	1387	S.F.	92.4%
40	80	3200	S.F.	38.56	78.56	3029	S.F.	94.7%
Building w/ 6" overhangs on lengths.								
20	41	800	S.F.	18.56	39.56	734	S.F.	91.8%
30	51	1500	S.F.	28.56	49.56	1415	S.F.	94.3%
40	81	3200	S.F.	38.56	79.56	3067	S.F.	95.9%
Building w/ 12" overhangs on lengths.								
20	42	800	S.F.	18.56	40.56	753	S.F.	94.1%
30	52	1500	S.F.	28.56	50.56	1444	S.F.	96.2%
40	82	3200	S.F.	38.56	80.56	3106	S.F.	97.1%

The best case scenario is the measurements are pretty close to perfect. The worst case scenario is somewhere above 90% depending on the size of the structure.
The horizontal and vertical errors are disregarded as they would follow a normal distribution and given the large enough sample set will average out to the desired point.
So we review the maximum recorded distance based on the spread. If the returned point is about 0.72’ from the edge of the building then the area will decrease and thus the computed volume will decrease.
All buildings have overhangs and the LiDAR acquires eaves, gutters, drip edges and other projections. The distribution of points will be closer that the extremes so as a rule of thumb these volumes will typically be better than 95% with a ± of 5%.

95% ± 5%

There is quite a bit more, but we have to save something for another day.

Provincetown Monument, Provincetown, MA
Ground Surface with Points for non ground objects.