LiDAR Quality Assessment Report

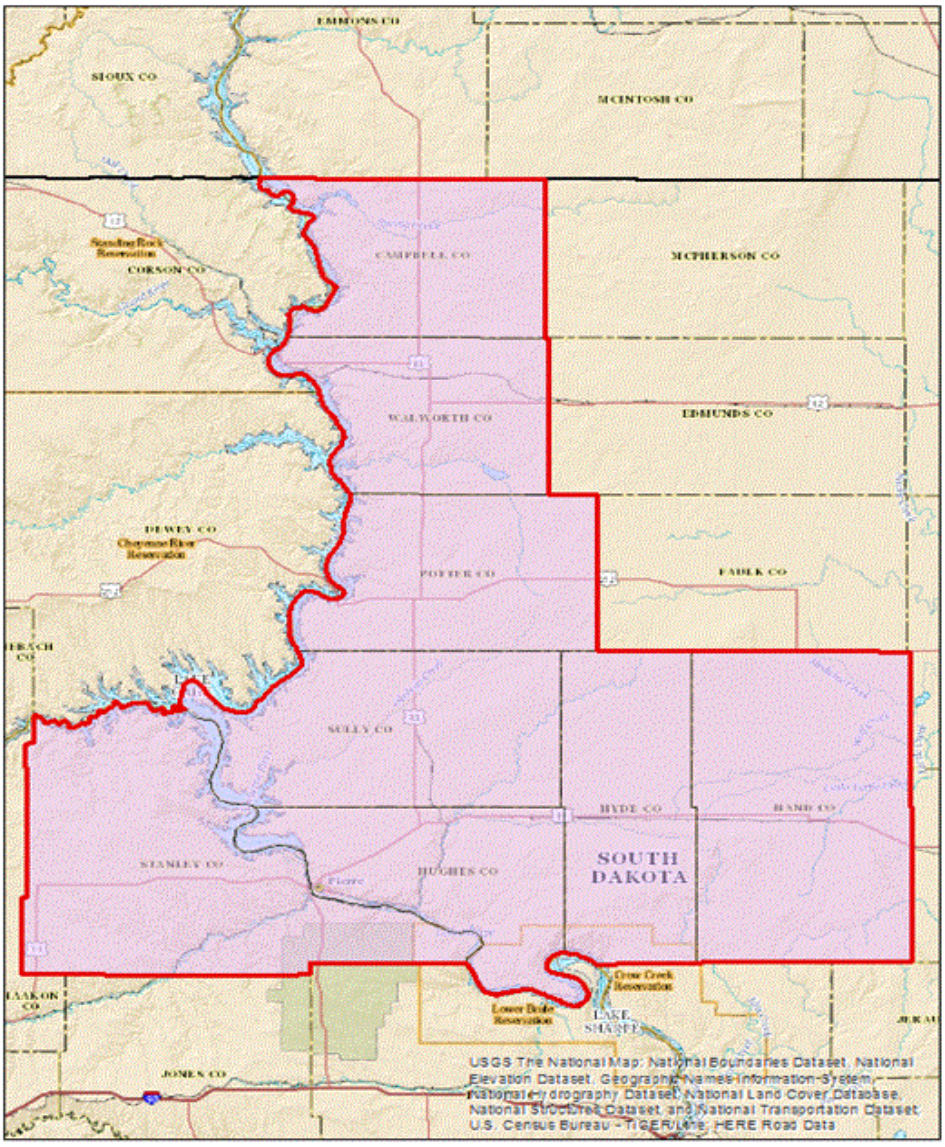
The USGS National Geospatial Technical Operations Center, Data Operations Branch is responsible for conducting reviews of all Light Detection and Ranging (LiDAR) point-cloud data and derived products delivered by a data supplier before it is approved for inclusion in the National Elevation Dataset. The USGS recognizes the complexity of LiDAR collection and processing performed by the data suppliers and has developed this Quality Assessment (QA) procedure to accommodate USGS collection and processing specifications with flexibility. The goal of this process is to assure LiDAR data are of sufficient quality for database population and scientific analysis. Concerns regarding the assessment of these data should be directed to the Chief, Data Operations Branch, 1400 Independence Road, Rolla, Missouri 65401.

SD_Missouri River Lidar Dewberry_2016_D16 - Block 8

NGTOC

2018-06-18

Sarah Klaas



Project Information

Project: SD_Missouri River Lidar Dewberry_2016_D16 - Block 8

Contractor: Dewberry

Project Type:
GPSC

Applicable Specification:
NGP LiDAR Base Specification V 1.2

Project Points of Contact:

Name:	Type:	Email:
Dan Vincent	CPT	dvinc@usgs.gov

REPORT QUALIFICATION SUMMARY:

Task Order Overall:
Does Not Meet Requirements

Metadata:
1 of 1 Reviews Accepted
0 Reviews Not Accepted

Vertical Accuracy:
0 of 1 Reviews Accepted
1 Reviews Not Accepted

Swath/Raw LAS:
0 of 1 Reviews Accepted
0 Reviews Not Accepted

Tiled/Classified LAS:
0 of 1 Reviews Accepted
1 Reviews Not Accepted

Breakline:
1 of 1 Reviews Accepted
0 Reviews Not Accepted

DEM(s):
0 of 1 Reviews Accepted
1 Reviews Not Accepted

NED Review:
1 of 1 DEM tile reviews recommended for NED 1/3rd
0 of 1 DEM tile reviews recommended for NED 1/9th

Project Subdivision: Lots

List Subdivision:
•
of: 7

Dates Collected Range:
Collection Start: 6/11/2016
Collection End: 6/28/2016

Project Aliases:

Licensing:
Public Domain

Project Description:
This task is for a high resolution data set of Geiger-Mode lidar covering approximately 8104 square miles affecting Campbell, Walworth, Potter, Sully, Stanley, Hughes, Hyde and Hand counties in South Dakota.

Review Information

Reviewer:	Sarah Klaas	*Date Delivered:*	6/1/2018
3rd Party QA Performed:	☐	*Date Assigned:*	6/4/2018

Action To Contractor Date:	*Issue Description:*	*Return Date:*
6/15/2018	see report	9/12/2018
9/14/2018	Please deliver a project boundary shapefile. See DEM error section.	

Review Complete:
6/18/2018

Dates Project Worked:

Start:	6/15/2018	9/14/2018
End:	6/18/2018	9/14/2018

Project Materials Received

All project deliverables must be supplied according to collection and processing specifications. The USGS will postpone the QA process when any of the required deliverables are missing. When deliverables are missing, the Contracting Officer Technical Representative (COTR) will be contacted by the Elevation Section supervisor and informed of the problem. Processing will resume after the COTR has coordinated the deposition of remaining deliverables.

METADATA

Deliverables	*Delivered*	*XML Metadata*	*Required*	*Format*	*Quantity*	*Additional Details*
Collection Report:	☑		☑	*PDF*	*1*	
Survey Report:	☑		☑	*PDF*	*1*	
Processing Report:	☑		☑	*PDF*	*1*	
QA/QC Report:	☑		☑	*PDF*	*1*	
Project Level XML Metadata:	☐		☐	*XML*		
Project Extent:	☑	☑	☑	*.shp*	*1*	
Tile Scheme:	☑	☑	☑	*.shp*	*1*	

Control (Calibration) Points:	☑	☑	☑	.shp	1	
Check (Validation) Points:	☑	☑	☑	.shp	1	
Additional Comments:						

LIDAR DATA

Deliverables	Delivered	XML Metadata	Required	Format	Quantity	Additional Details
Swath Data:	☐	☐	☐	Select...		
Classified/ Tiled Data:	☑	☑	☑	.las	1,044	Block 3
Additional Comments:						

DERIVED DELIVERABLES

Deliverables	Delivered	XML Metadata	Required	Format	Quantity	Additional Details
DEM Tiles:	☑	☑	☑	IMG	1,044	Block 3
Breaklines:	☑	☑	☑	FGD	1	ESRI GDB
Additional Comments:						

OTHER

Additional Deliverables	Delivered	XML Metadata	Required	Format	Quantity	Additional Details
Intensity Imagery	☑	☑	☑	.tif	5,488	
Additional Comments:						

Geographic Information

Area Extent:	8104	*Sq. Miles*
Tile Size:	2,000 x 2,000	*Meters*
DEM/DTM Grid	0.5	*Meters*

Spacing:

Coordinate Reference System:

UTM Zone 14

Projection: Mercator

Horizontal Datum: NAD83

(•) Meters ( ) U.S. Feet ( ) Int'l Feet

Vertical Datum: NAVD88

(•) Meters ( ) U.S. Feet ( ) Int'l Feet

THIS PROJECTION COORDINATE REFERENCE SYSTEM IS CONSISTENT ACROSS THE FOLLOWING DELIVERABLES

- [x] *Project Extent*
- [x] *Project Extent XML Metadata*
- [x] *Project Tile Scheme*
- [x] *Project Tile Scheme XML Metadata*
- [x] *Control Points*
- [x] *Control Points XML Metadata*
- [x] *Checkpoints*
- [x] *Checkpoint XML Metadata*
- [x] *Tiled/Classified XML Metadata*
- [x] *Tiled/Classified LiDAR*
- [x] *DEM(s)*
- [x] *DEM XML Metadata*
- [x] *Breakline(s)*
- [x] *Breakline XML Metadata*

Additional Comments:

Collection Information

Quality Level: 1

Configured Nominal Pulse Spacing:

0.35 Meters

Additional Comments:

Metadata Review Accepted

Vendor provided metadata files have been parsed using 'mp' metadata parser. Any errors generated by the parser are documented below for reference and/or corrective action.
Parser can be found @ http://geo-nsdi.er.usgs.gov/validation/

The Project Extent XML Metadata parsed without errors.

Check if 'Best Use' metadata for NED: ☐

The Project Tile Scheme XML Metadata parsed without errors.

Check if 'Best Use' metadata for NED: ☐

The Control Point XML Metadata parsed without errors.

Check if 'Best Use' metadata for NED: ☐

The Check Point XML Metadata parsed without errors.

Check if 'Best Use' metadata for NED: ☐

The Classified XML Metadata parsed without errors.

Check if 'Best Use' metadata for NED: ☐

The DEM XML Metadata parsed without errors.

Check if 'Best Use' metadata for NED: ☑

The Breakline XML Metadata parsed without errors.

Check if 'Best Use' metadata for NED: ☐

Additional Comments:	*Note: Metadata lists Gail Dunn as the CPT point of contact but gives Dan Vincent's contact information

Based on this review, the USGS accepts the xml metadata provided.

End of Metadata Review

Vertical Accuracy Review Not Accepted

ASPRS recommends that checkpoint surveys be used to verify the vertical accuracy of LiDAR data sets. Checkpoints are to be collected by an independent survey firm licensed in the particular state(s) where the project is located. While subjective, checkpoints should be well distributed throughout the dataset. National Standards for Spatial Data Accuracy (NSSDA) guidance states that checkpoints may be distributed more densely in the vicinity of important features and more sparsely in areas that are of little or no interest. Checkpoints should be distributed so that points are spaced at intervals of at least ten percent of the diagonal distance across the dataset and at least twenty percent of the points are located in each quadrant of the dataset.

NSSDA and ASPRS require that a minimum of twenty checkpoints (thirty is preferred) are collected for each major land cover category represented in the LiDAR data. Checkpoints should be selected on flat terrain, or on uniformly sloping terrain in all directions from each checkpoint. They should not be selected near severe breaks in slope, such as bridge abutments, edges of roads, or near river bluffs. Checkpoints are an important component of the USGS QA process. There is the presumption that the checkpoint surveys are error free and the discrepancies are attributable to the LiDAR dataset supplied.

For this dataset, USGS checked the spatial distribution of checkpoints with an emphasis on the bare-earth (open terrain) points; the number of points per class; the methodology used to collect these points; and the relationship between the data supplier and checkpoint collector. When independent control data are available, USGS has incorporated this into the analysis.

Required Vertical Accuracy

◉ *Yes* ○ *No*

REQUIRED NON-VEGETATED VERTICAL ACCURACY FOR SWATH AND DEM FILES

Required Unit:	Centimeters
Required # of checkpoints:	166
Required RMSEz:	10
*Required Vertical Accuracy (RMSEz * 95th CI)*	19.6

REQUIRED VEGETATED VERTICAL ACCURACY FOR DEM FILES

Required Unit:	Centimeters
Required # of checkpoints:	119
Required Vertical Accuracy (@ 95th percentile)	29.4
Additional Required Vertical Accuracy Information:	

Reported Vertical Accuracy

◉ *Yes* ○ *No*

REPORTED NON-VEGETATED VERTICAL ACCURACY FOR SWATH LIDAR FILES

Reported Unit:	Centimeters
Reported # of checkpoints:	171
Reported RMSEz:	0.156
*Reported Vertical Accuracy (RMSEz * 95th CI)*	

REPORTED NON-VEGETATED VERTICAL ACCURACY FOR DEM FILES

Reported Unit:	Centimeters
Reported # of checkpoints:	171
Reported RMSEz:	0.156
*Reported Vertical Accuracy (RMSEz * 95th CI)*	

REPORTED VEGETATED VERTICAL ACCURACY FOR DEM FILES

Reported Unit:	Centimeters
Reported # of checkpoints:	130
Reported Vertical Accuracy (95th percentile)	0.447
Additional Reported Vertical Accuracy Information:	

Reviewed Vertical Accuracy

◉ *Yes* ○ *No*

CHECKPOINT REVIEW

Checkpoints are well distributed?	☑
Enough checkpoints for task order?	☑
Checkpoints meet USGS LiDAR base-spec in quantity and quality?	☑

REVIEWED NON-VEGETATED VERTICAL ACCURACY FOR SWATH LIDAR FILES

Reviewed Unit:	Centimeters
Reviewed # of checkpoints:	163
Reviewed RMSEz:	9.00
*Reviewed Vertical Accuracy (RMSEz * 95th CI)*	17.64

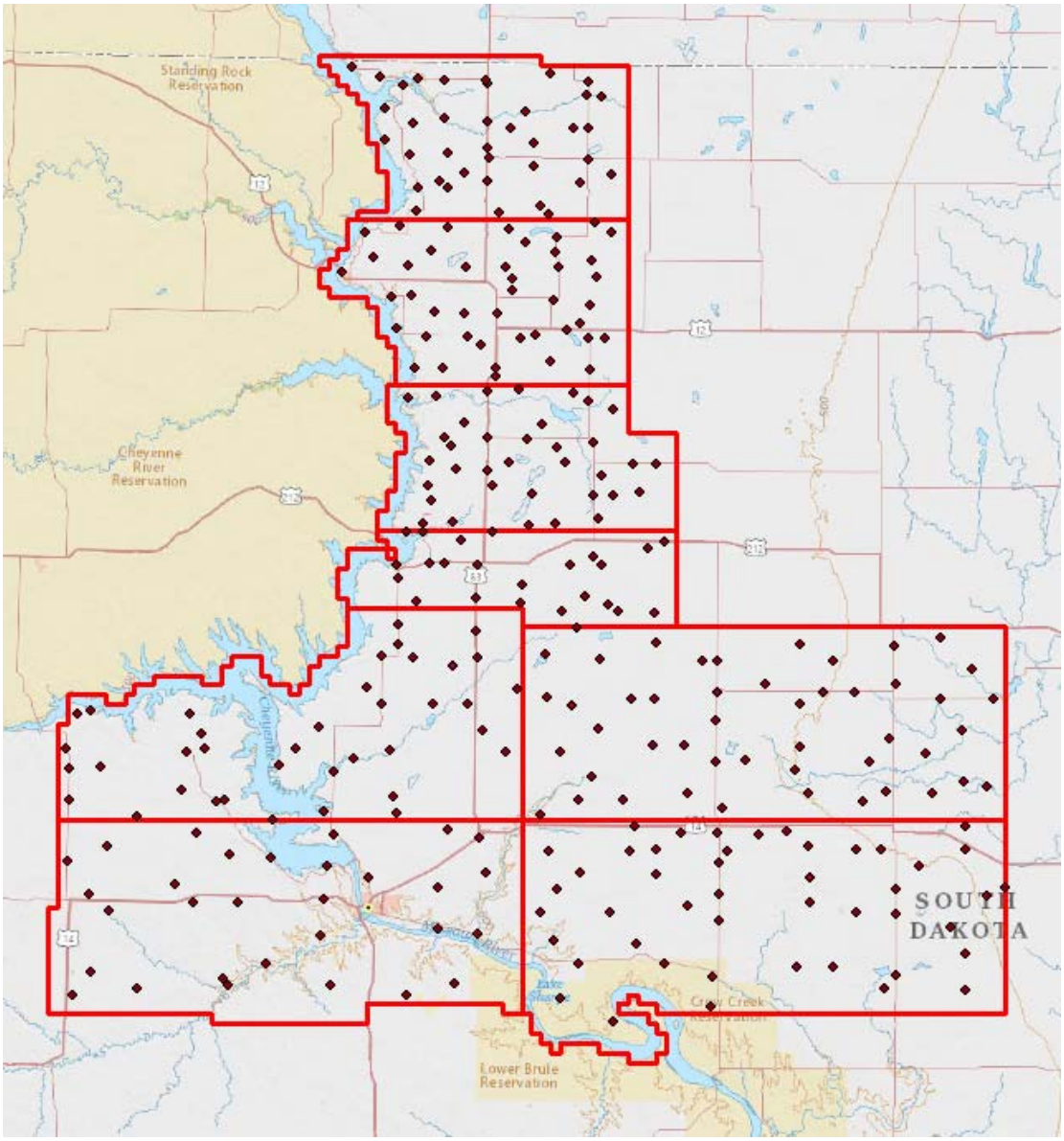
REVIEWED NON-VEGETATED VERTICAL ACCURACY FOR DEM FILES

Reviewed Unit:	Centimeters
Reviewed # of checkpoints:	170
Reviewed RMSEz:	8.06
*Reviewed Vertical Accuracy (RMSEz * 95th CI)*	15.8

REVIEWED VEGETATED VERTICAL ACCURACY

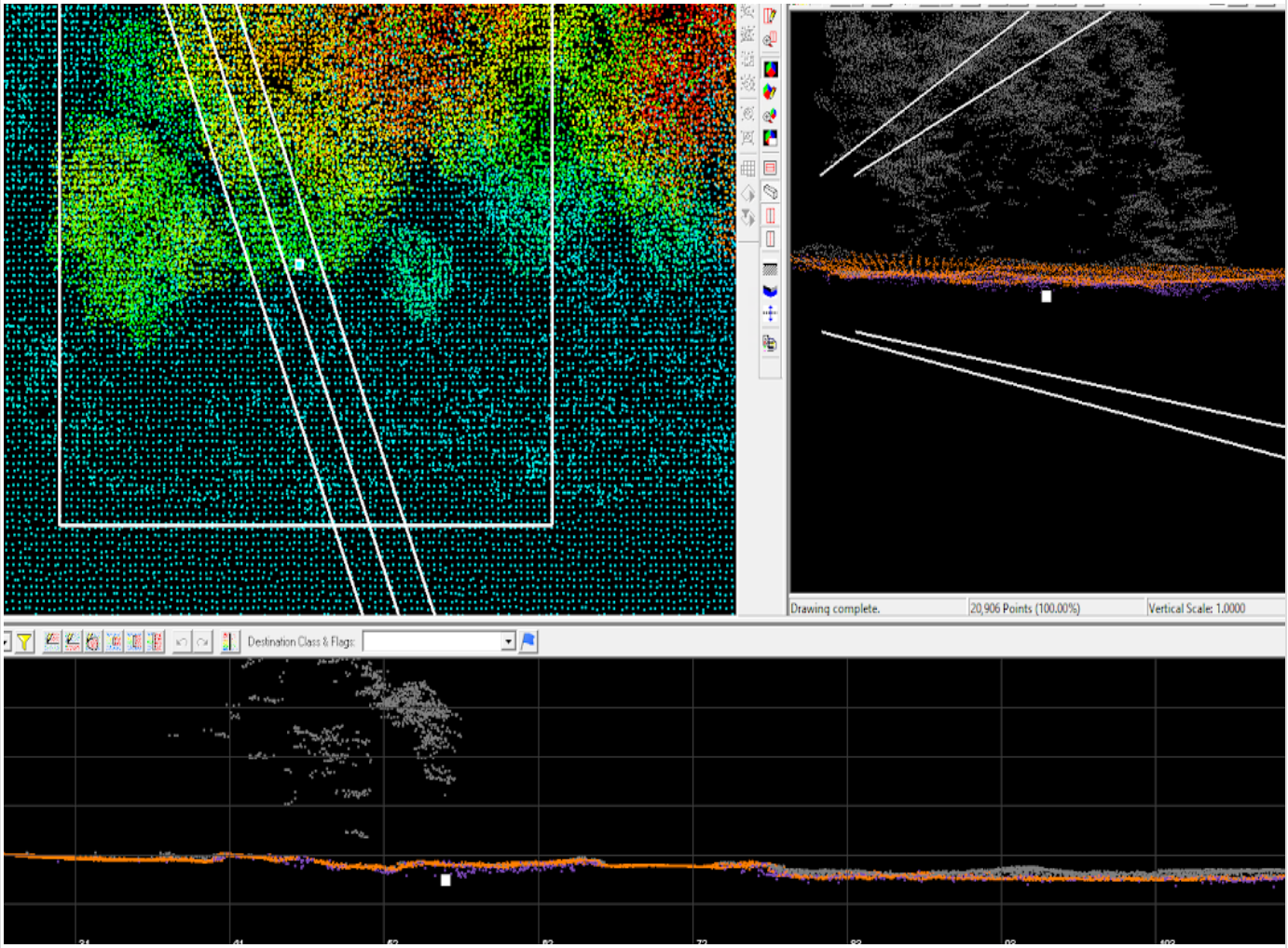
Required Unit:	Centimeters
Required # of checkpoints:	130
Reviewed Vertical Accuracy (95th percentile)	42.31

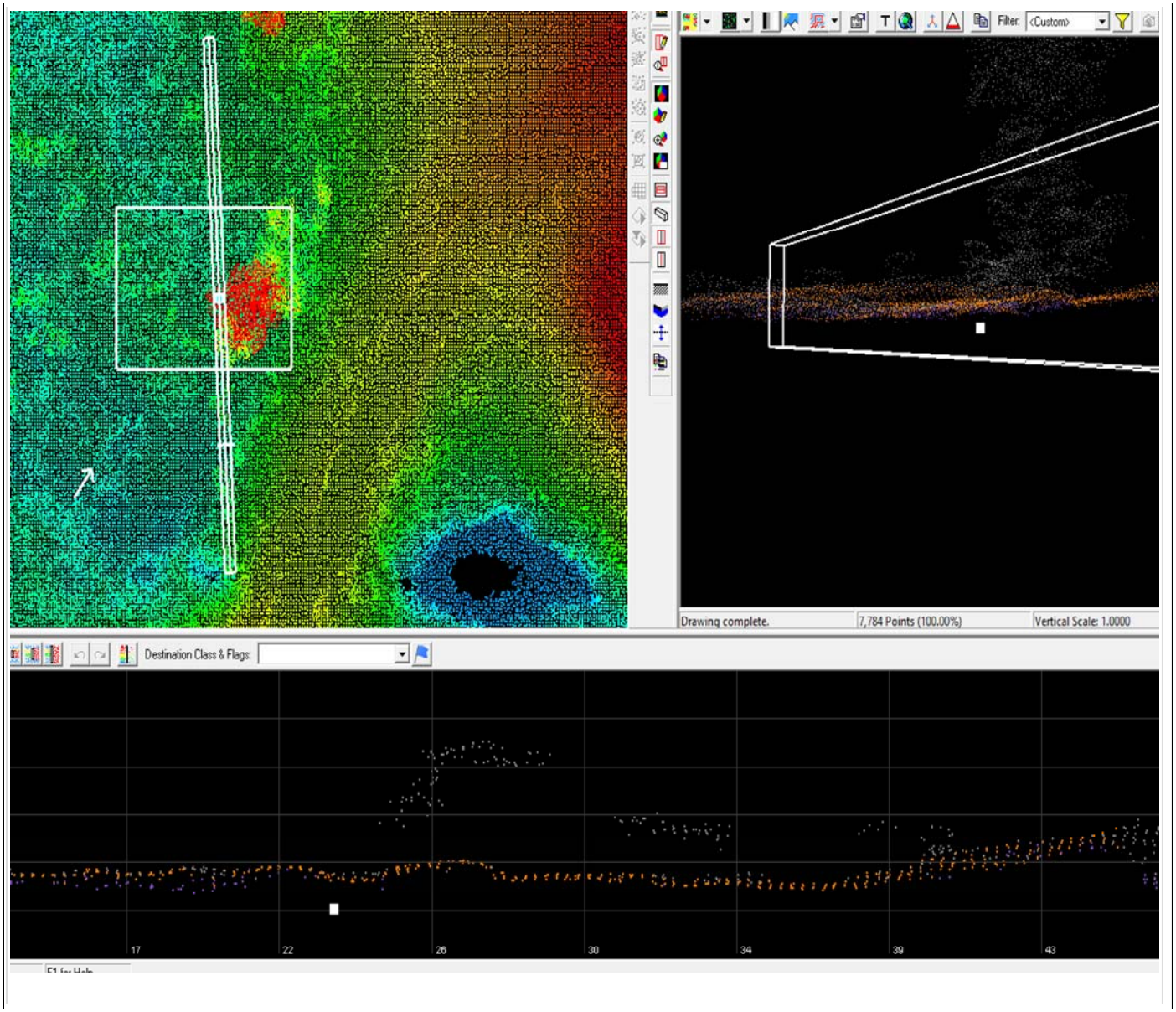
Checkpoint Distribution Image

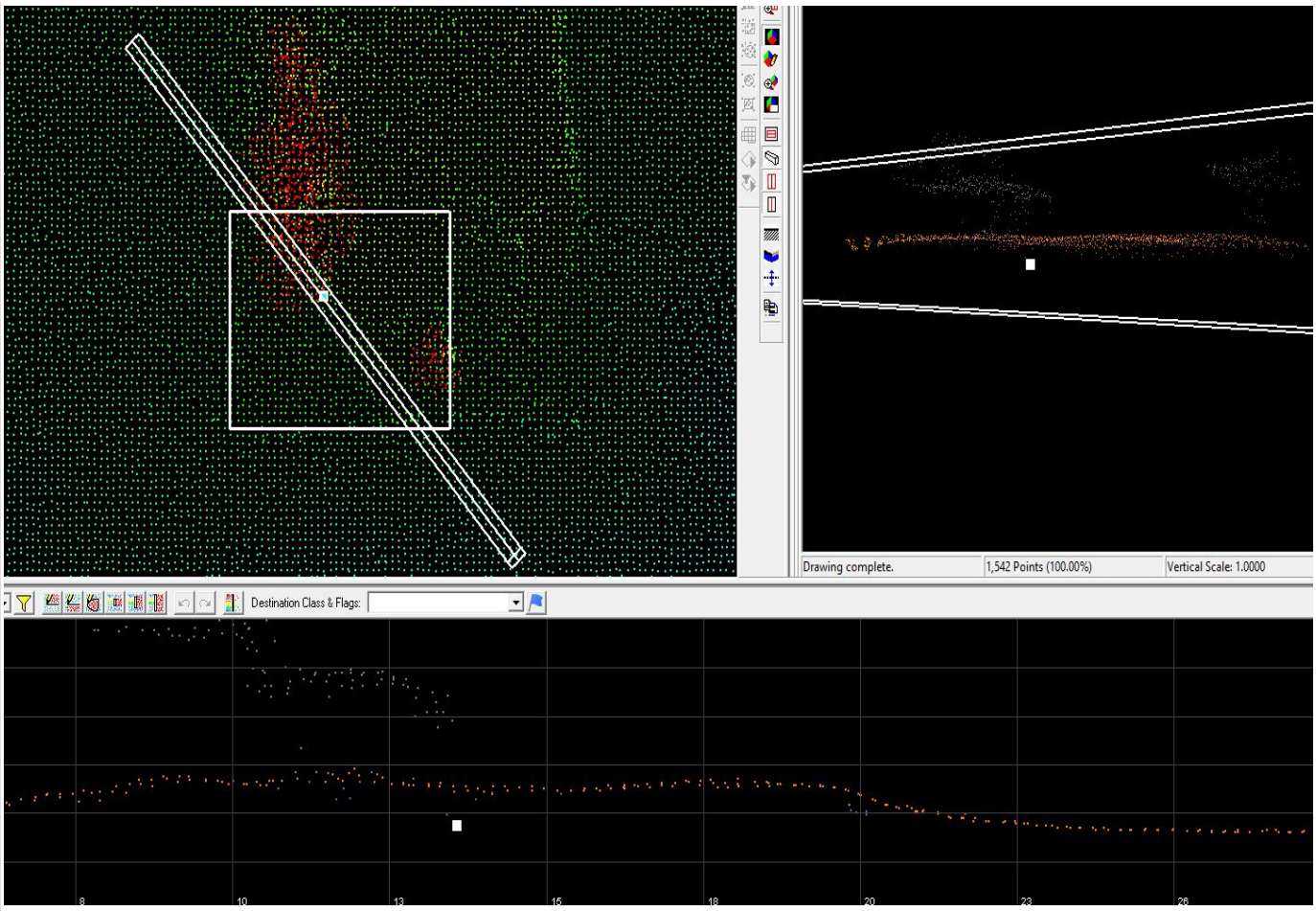


Vertical Accuracy Results:

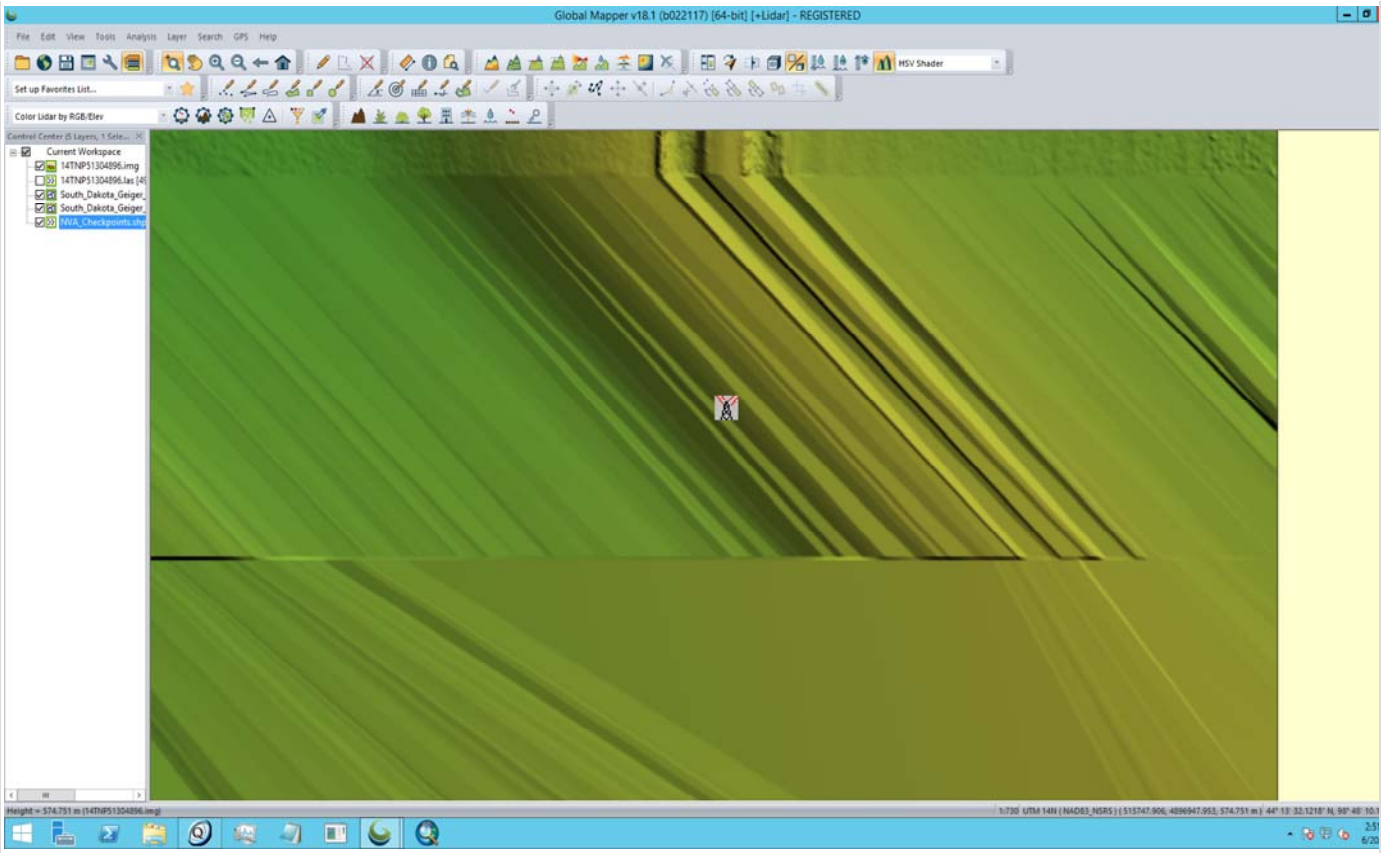
VVA testing failed to meet USGS specifications. Three of the worst points are pictured below, showing the checkpoint below the ground surface.




Filter: <Custom>
Drawing complete.
7,784 Points (100.00%)
Vertical Scale: 1.0000
Destination Class & Flags:
17
22
26
30
34
39
43



NVA point 171 was removed from DEM vertical testing. It was found that this point was in an area of data void which was causing a dz value of -1.



meters.

Additional Reviewed Vertical Accuracy Information:	Swath NVA was tested on the classified point cloud Points not tested for classified NVA are due to las files having the incorrect global encoder that could not be loaded into the same layer as the majority of the files in ArcMap

Based on this review, the USGS does not accept the vertical accuracy.

End of Vertical Accuracy Review

Raw-Swath LiDAR Review

LAS swath files or raw unclassified LiDAR data are reviewed to assess the quality control used by the data supplier during collection. Furthermore, LAS swath data are checked for positional accuracy. The data supplier should have calculated the Non-Vegetated Vertical Accuracy using ground control checkpoints measured in clear open terrain (*see Vertical Accuracy Review Section*).

Review Required: ◉ *Yes* ○ *No* *Not Delivered*

Tiled/Classified LiDAR Review Not Accepted

Classified LAS tile files are used to build digital terrain models using the points classified as ground. Therefore, it is important that the classified LAS are of sufficient quality to ensure that the derivative product accurately represents the landscape that was measured. Classified LAS Tiles are comprised as follows, "all project swaths, returns, and collected points, fully calibrated, adjusted to ground, and classified and cut, by tiles, excluding calibration swaths, cross-ties, and other swaths not used, or intended to be used, in product generation".

Review Required: ◉ *Yes* ○ *No*

CLASSIFIED LIDAR TILE CHARACTERISTICS

☑ *Separate folder for classified/tiled LiDAR files*

LAS Version: 1.4

Point Record Format: 6

*If specified, *.wpd files for full waveform data have been provided:* Not Required

☑ *Classified LAS tile files conform to project tiling scheme*

☑ *Quantity of classified LAS tile files conforms to project tiling scheme*

☑ *Classified LAS tile files do not overlap*

☑ *Classified LAS tile files are uniform in size*

☑ *Correct and properly formatted georeference information is included in all LAS file headers, including the use of OGC 2001 Well Known Text (WKT).*

☐ *Adjusted GPS time used with the global encoder id set to 1*

Global Encoder is set to 17

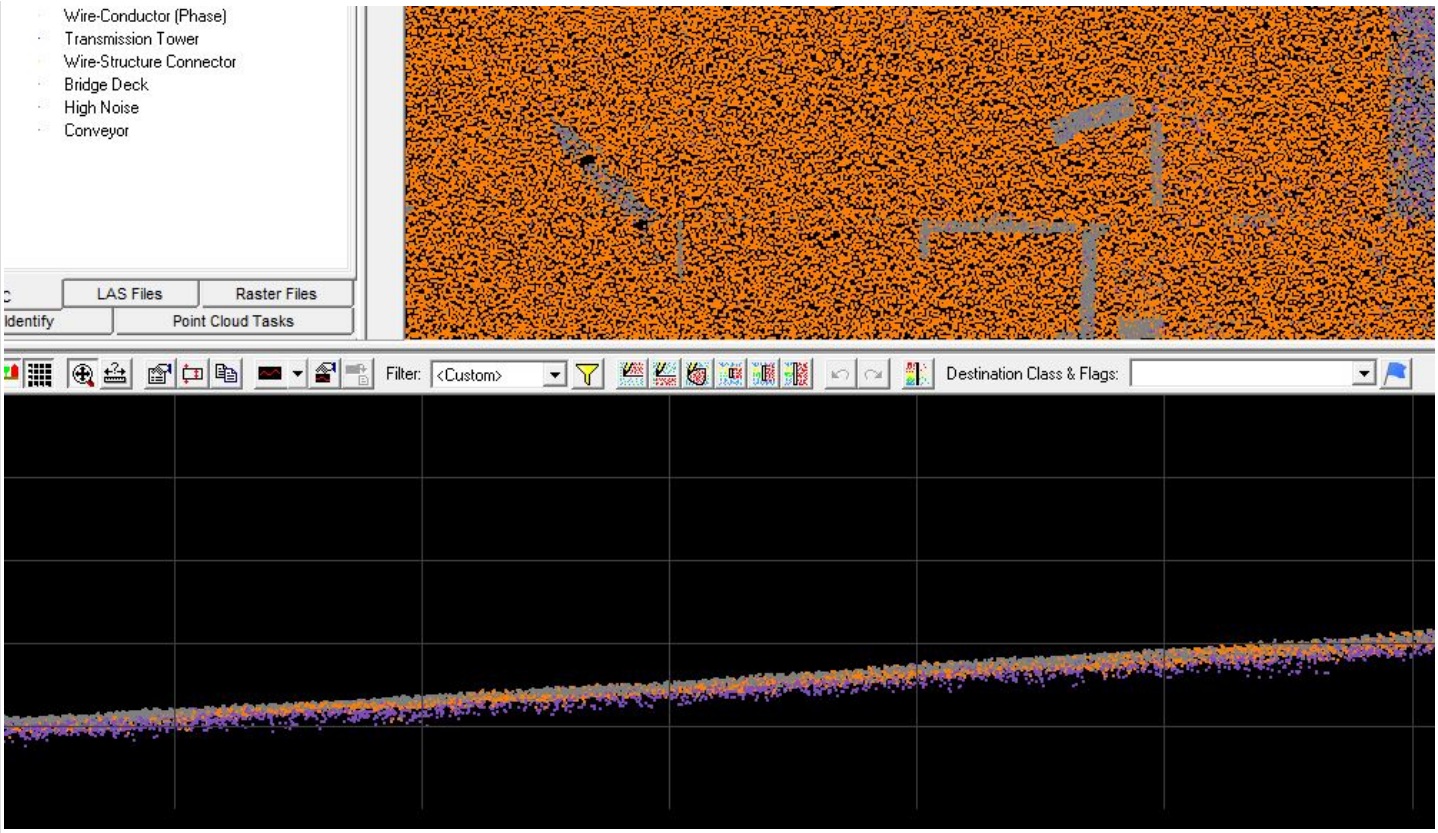
☑ *Classified LAS tile files have no points classified as '12' (Overlap) and correctly use overlap bit.*

☑ *Point classifications are limited to the standard values listed below:*

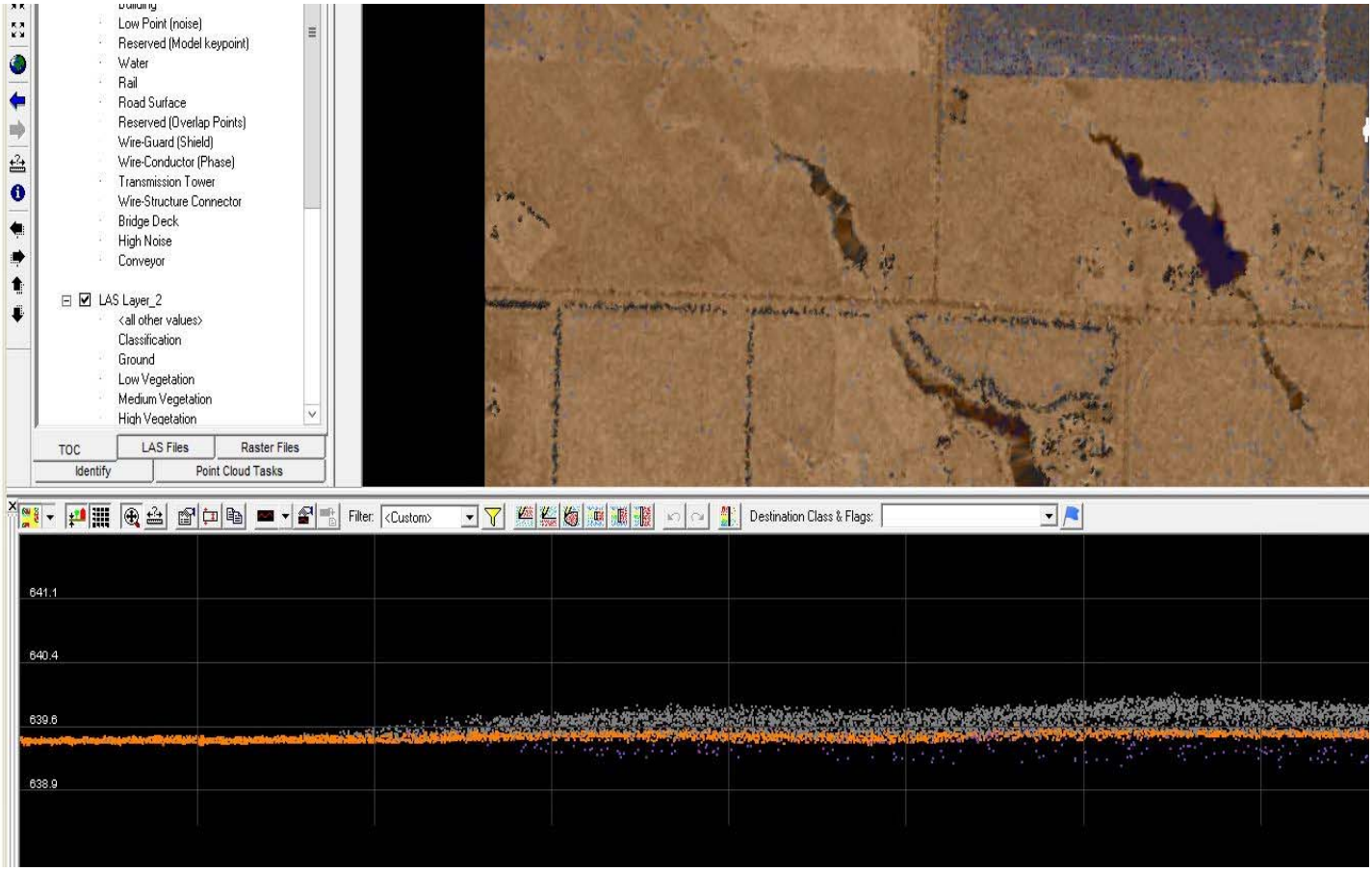
Code	Description	Used
1	Processed, but unclassified	☑
2	Bare-earth/Ground	☑
7	Noise (low, manually identified, if needed)	☑
8	Model key points	☐
9	Water	☑
10	Ignored ground (breakline proximity)	☑
11	Withheld (if the "Withheld Bit" is not implemented in the processing software	☐
17	Bridges	☑
18	Noise (high, manually identified, if needed)	☑

Additional comments:

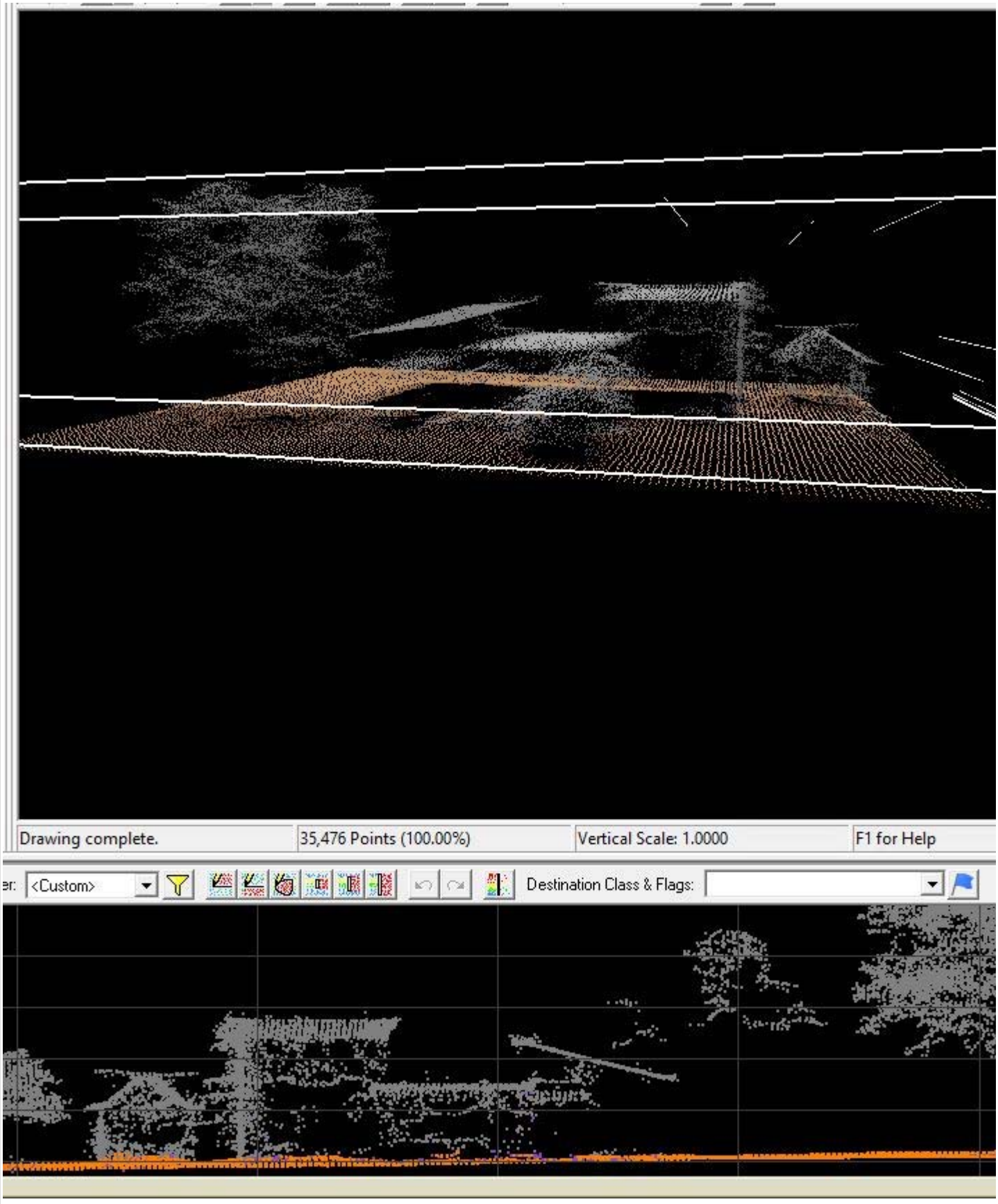
Noise and ground points in an agricultural field with probable vegetation. (6/18/18)
Vegetation Issue remains. (9/14/2018)

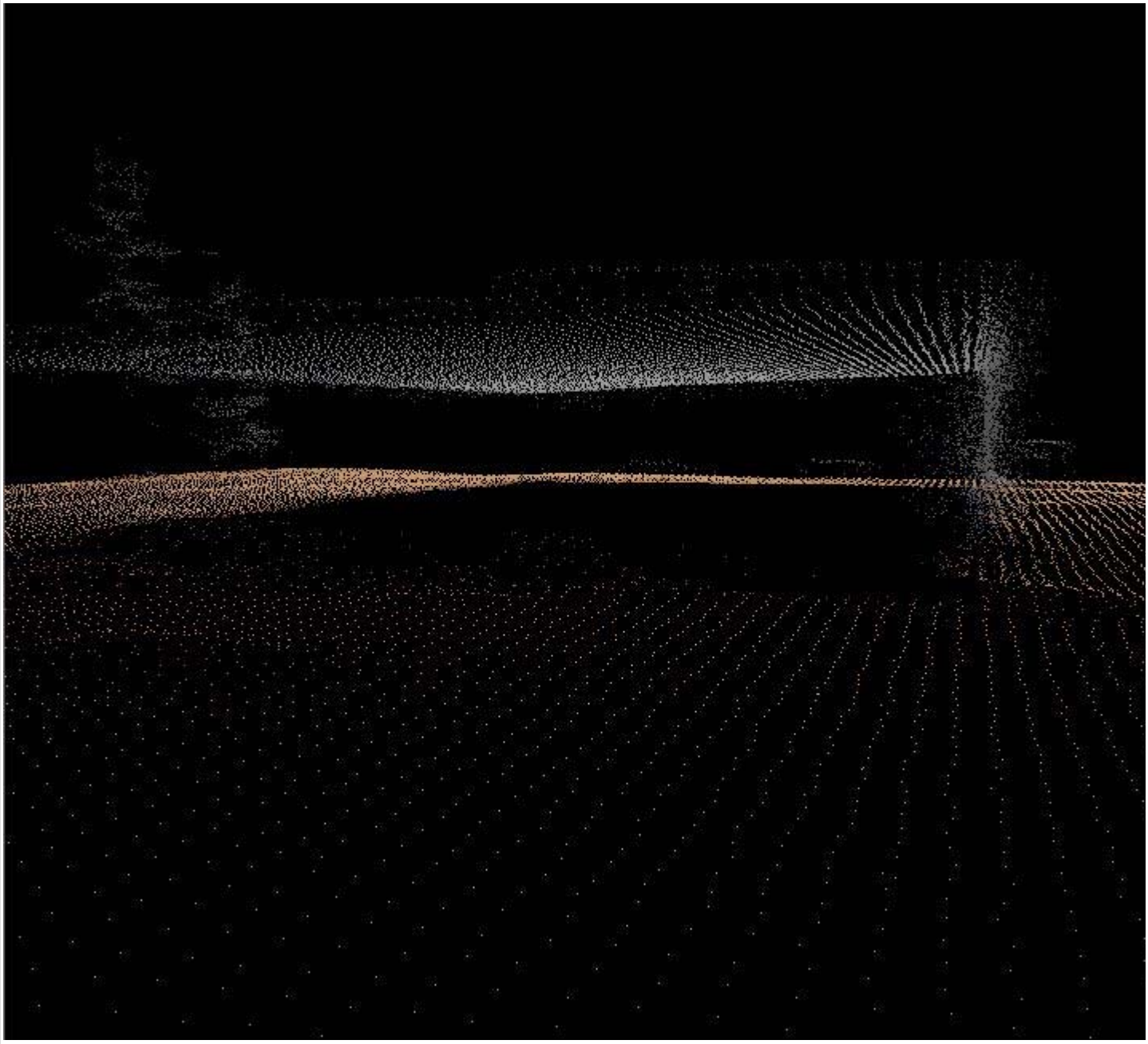


Example of a similar area in another block where the classification of the ground points looks correct.



Examples of vertical wall structure scatter from the geiger mode sensor





Based on this review, the USGS <u>does not accept</u> classified/tiled LiDAR data.

End of Tiled/Classified LiDAR Review

Breakline Review Accepted

Breaklines are vector feature classes that are used to hydro-flatten the bare earth Digital Elevation Models.

Review Required: ◉ *Yes* ○ *No*

BREAKLINE FILE CHARACTERISTICS:

☑ Separate folder for breakline files.

☑ Breaklines contain elevation values.

Elevation values stored in <u>Geometery (ZEnabled)</u> .

Units: <u>Meters</u>

☑ Waterbody Breaklines.

Polyline ☐ Polygon ☑
☑ Single elevation value per waterbody feature.
☑ Required.
Waterbody Elevations were created via Unknown waterbody level techniques.

☑ Double Line Stream Breaklines (Streams Approximately > 100 ft).

Polyline ☐ Polygon ☑
Downstream DLS Flow is Monotonic .
☑ Required.

☐ Single Line Breaklines.
☑ No missing or misplaced breaklines.

Based on this review, the USGS accepts the breakline files.

End of Breakline Review

DEM Review Not Accepted

The derived bare-earth file(s) receive a review of the vertical accuracies provided by the data supplier, vertical accuracies calculated by the USGS using supplied and independent checkpoints (*see the prior Vertical Accuracy Review Section*), and a thorough visual review for any anomalies or inconsistencies in assessing the quality of the DEM(s).

BARE-EARTH DEM TILE CHARACTERISTICS:

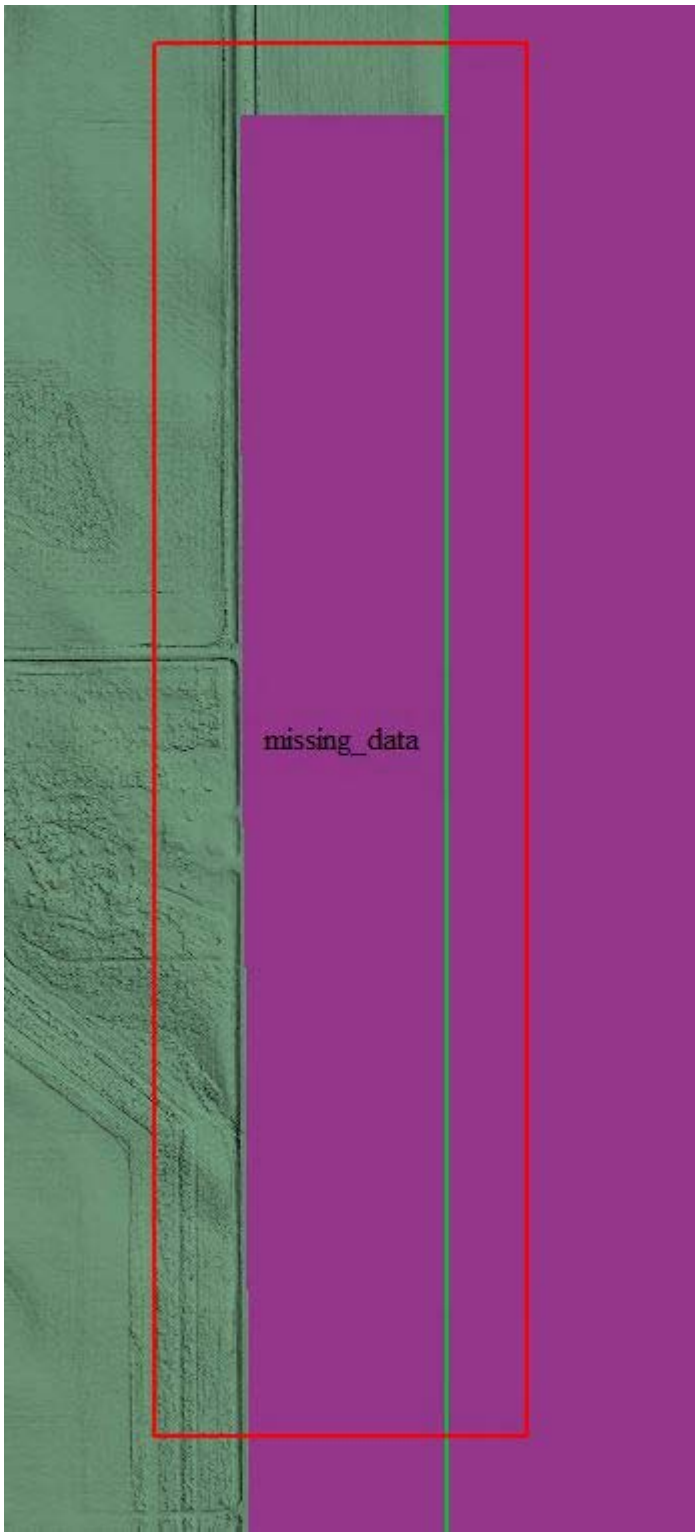
☑ Separate folder for bare-earth DEM files
Raster File Type: IMG
Raster Cell Size: 0.5 Meters
Tile bit depth/pixel Type: 32_BIT_FLOAT
Interpolation or Resampling Technique: Triangulated Irregular Network (TIN)

☑ DEM tiles do not overlap
☑ DEM tiles conform to Project Tiling Scheme
☑ Quantity of DEM files conforms to Project Tiling Scheme
☑ DEM tiles are uniform in size

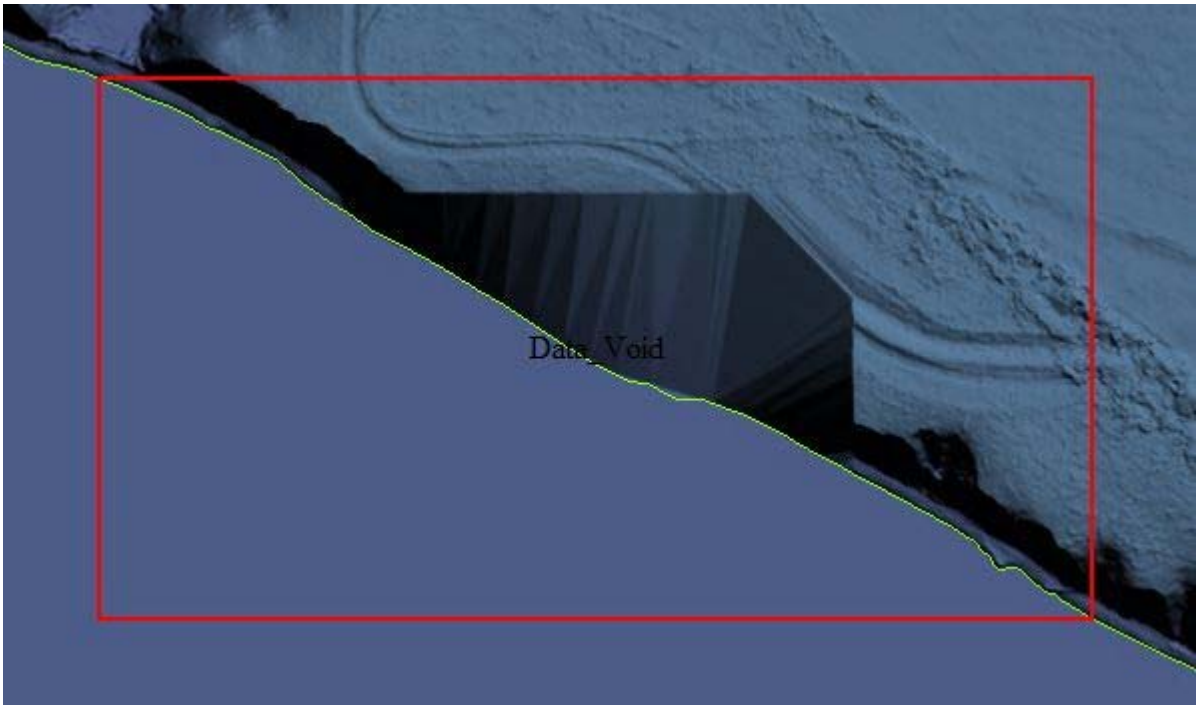
☑ DEM tiles properly edge match and free of edge artifacts
☑ Tiles are free from Spikes and Pits
☐ Tiles are free from Data Holidays (*voids due to processing or collection errors*)

Data does not extend out to the project boundary along the Eastern and Southern extent of Block 8. (6/18/2018)

Dewberry states the data does extend to the project boundary but USGS was not delivered this boundary shapefile and can only judge based on the delivery block diagram shapefile that was delivered. Please deliver the project boundary shapefile that was used to create your data boundaries. (9/14/2018)


missing_data

One data void along a lake in block 8 was found. (6/18/18) **Corrected (9/14/2018)**



☑ Tiles do not exhibit systematic sensor error or cornrowing

Hydro Treatment: hydro-flattened

DEM tiles are properly Hydro Flattened ◉ Yes ○ No

☐ Waterbodies 2 Acres or greater are flattened

2 hydroflattening errors were found in block 8, waterbodies greater than 2 acres are not hydroflattened. Examples of this type of error can be seen below. (6/18/18) **Corrected (9/14/2018)**

☑ Streams 100 ft. or greater are flattened in a downstream manner

☑ Tidal Boundaries/Shorelines are flattened

☑ No missing islands 1 Acre or larger

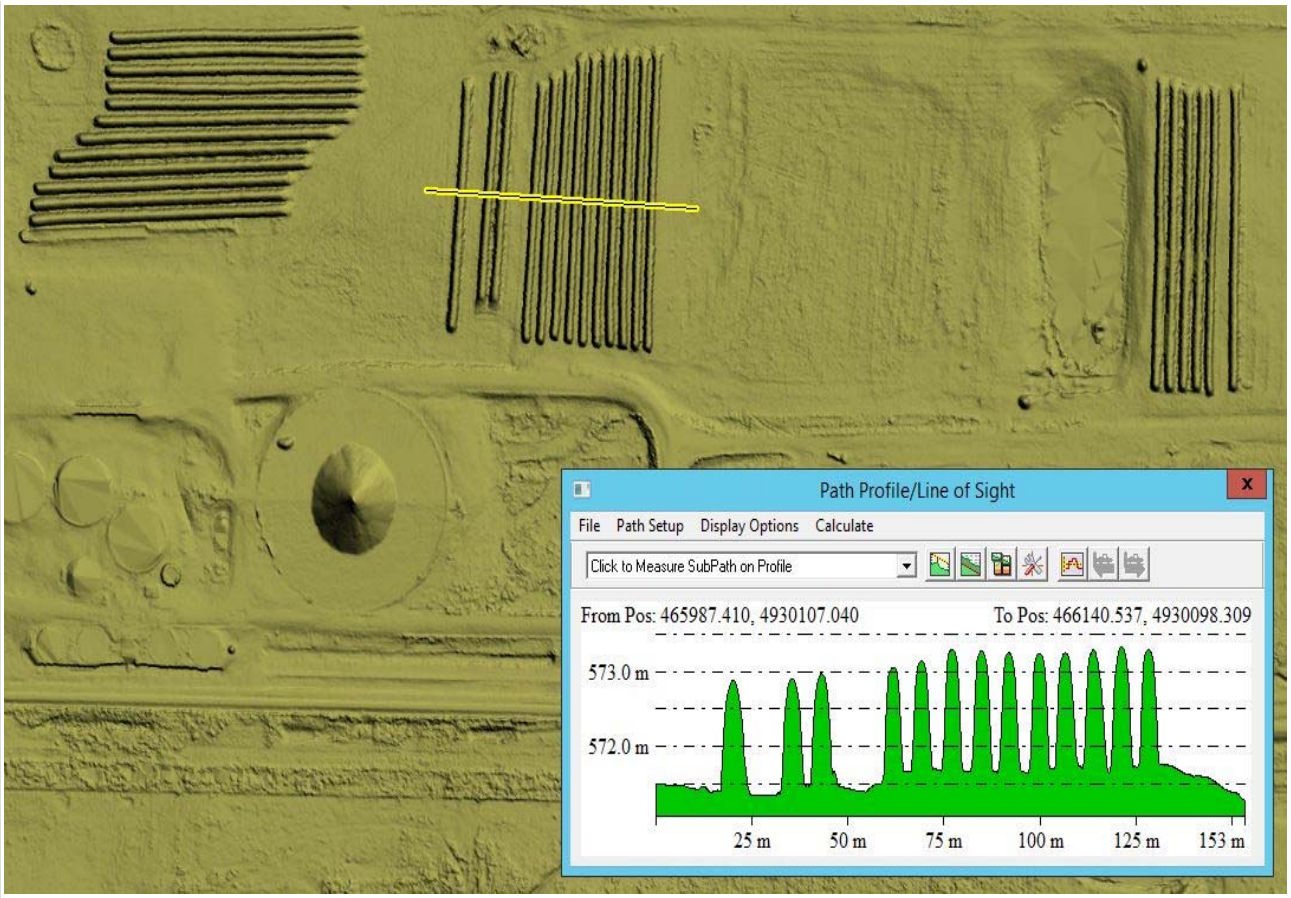
☑ Bridges/Overpasses are properly removed

☑ Culverts are maintained (Not Hydro Enforced)

☑ Depressions, Sinks, are not filled in (Not Hydro Conditioned)

☐ Vegetation properly removed

1 error of manmade vegetation (hay rows?). (6/18/2018) **Corrected (9/14/2018)**



☑ Manmade structures properly removed

Tiles recommended for NED 1/3rd: ◉ Yes. ○ No.
Tiles recommended for NED 1/9th: ○ Yes. ○ No.
Tiles recommended for NED 1 Meter: ◉ Yes. ○ No.
LAS dataset recommended for distribution: tile classified

Based on this review, the USGS does not accept the DEM tiles.

End of DEM Review

Based on this review, the provided delivery Does Not Meet the Contract and/or Task Order requirements.
Additional Comments:

INTERNAL COMMENTS

END OF REPORT (v2.4.0)