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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 - Block3

NGTOC
2018-06-12
Sarah Klaas
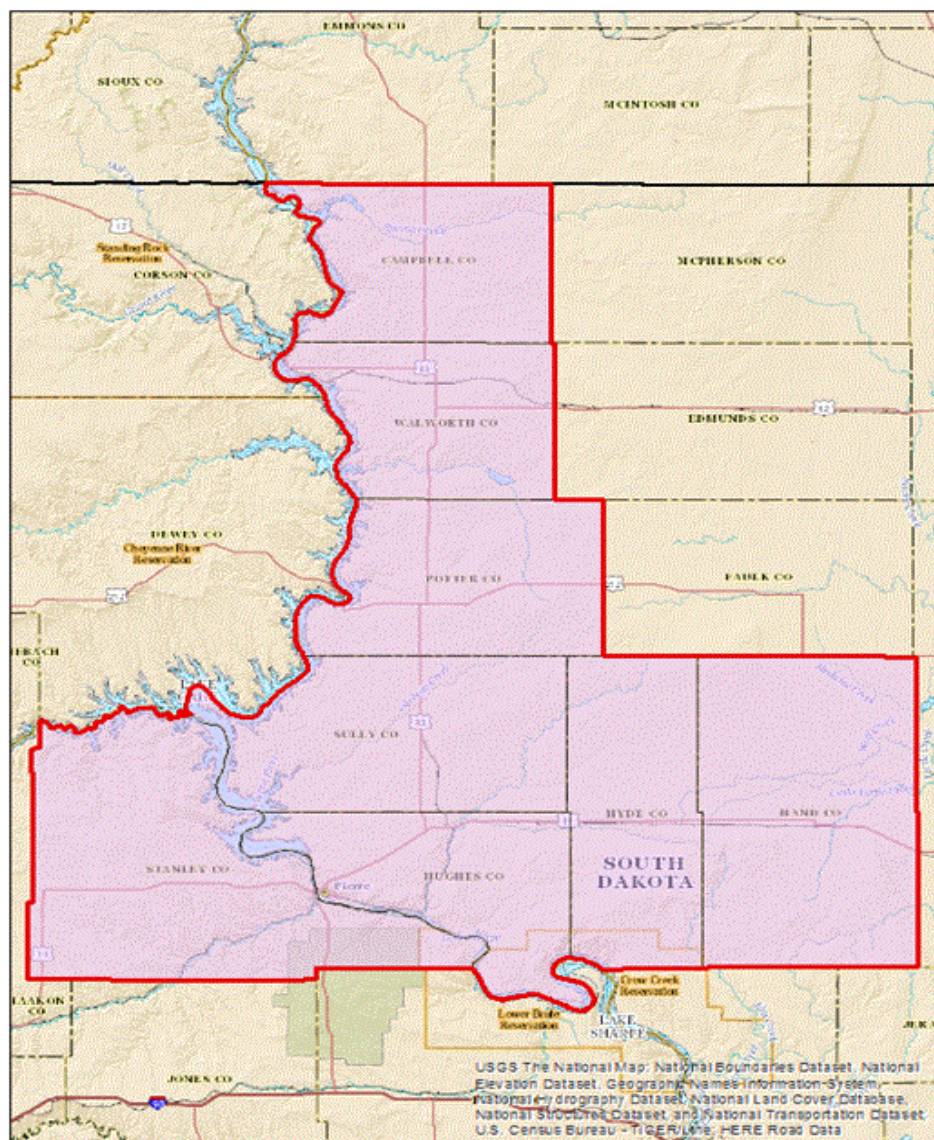
Project Information

Project: SD_Missouri River Lidar Dewberry_2016_D16 - Block3

Contractor: Dewberry

Project Type: *Applicable Specification:*

   GPSC   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:
6/12/2018		9/12/2018
9/18/2018		

Review Complete:

6/12/2018

Dates Project Worked:

Start:	6/7/2018	9/18/2018
End:	6/12/2018	9/18/2018

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*	

Deliverables	Delivered	XML Metadata	Required	Format	Quantity	Additional Details
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	418	Block 3
Additional Comments:						

DERIVED DELIVERABLES

Deliverables	Delivered	XML Metadata	Required	Format	Quantity	Additional Details
DEM Tiles:	☑	☑	☑	IMG	418	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   <u>NAD83</u>   ● Meters
Datum: ○ U.S. Feet
                                                                                  ○ Int'l Feet

Vertical   <u>NAVD88</u>   ● Meters
Datum: ○ U.S. Feet
                                                                                  ○ Int'l Feet

THIS PROJECTION COORDINATE REFERENCE SYSTEM IS CONSISTENT ACROSS THE FOLLOWING DELIVERABLES

- ☑ *Project Extent*
- ☑ *Project Extent XML Metadata*
- ☑ *Project Tile Scheme*
- ☑ *Project Tile Scheme XML Metadata*
- ☑ *Control Points*
- ☑ *Control Points XML Metadata*
- ☑ *Checkpoints*
- ☑ *Checkpoint XML Metadata*

- ☑ *Tiled/Classified XML Metadata*
- ☑ *Tiled/Classified LiDAR*
- ☑ *DEM(s)*
- ☑ *DEM XML Metadata*
- ☑ *Breakline(s)*
- ☑ *Breakline XML Metadata*

Additional Comments:

Collection Information

Quality Level: <u>1</u>
Configured Nominal Pulse Spacing:

0.35   <u>Meters</u>

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 <u>without</u> errors.

Check if 'Best Use' metadata for NED: ☐

The Project Tile Scheme XML Metadata parsed <u>without</u> errors.

Check if 'Best Use' metadata for NED: ☐

The Control Point XML Metadata parsed <u>without</u> errors.

Check if 'Best Use' metadata for NED: ☐

The Check Point XML Metadata parsed <u>*without*</u> *errors.*

Check if 'Best Use' metadata for NED: ☐

The Classified XML Metadata parsed <u>*without*</u> *errors.*

Check if 'Best Use' metadata for NED: ☐

<mark>*The DEM XML Metadata parsed* <u>*without*</u> *errors.*

Check if 'Best Use' metadata for NED: ☑</mark>

The Breakline XML Metadata parsed <u>*without*</u> *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 <u>accepts</u> 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

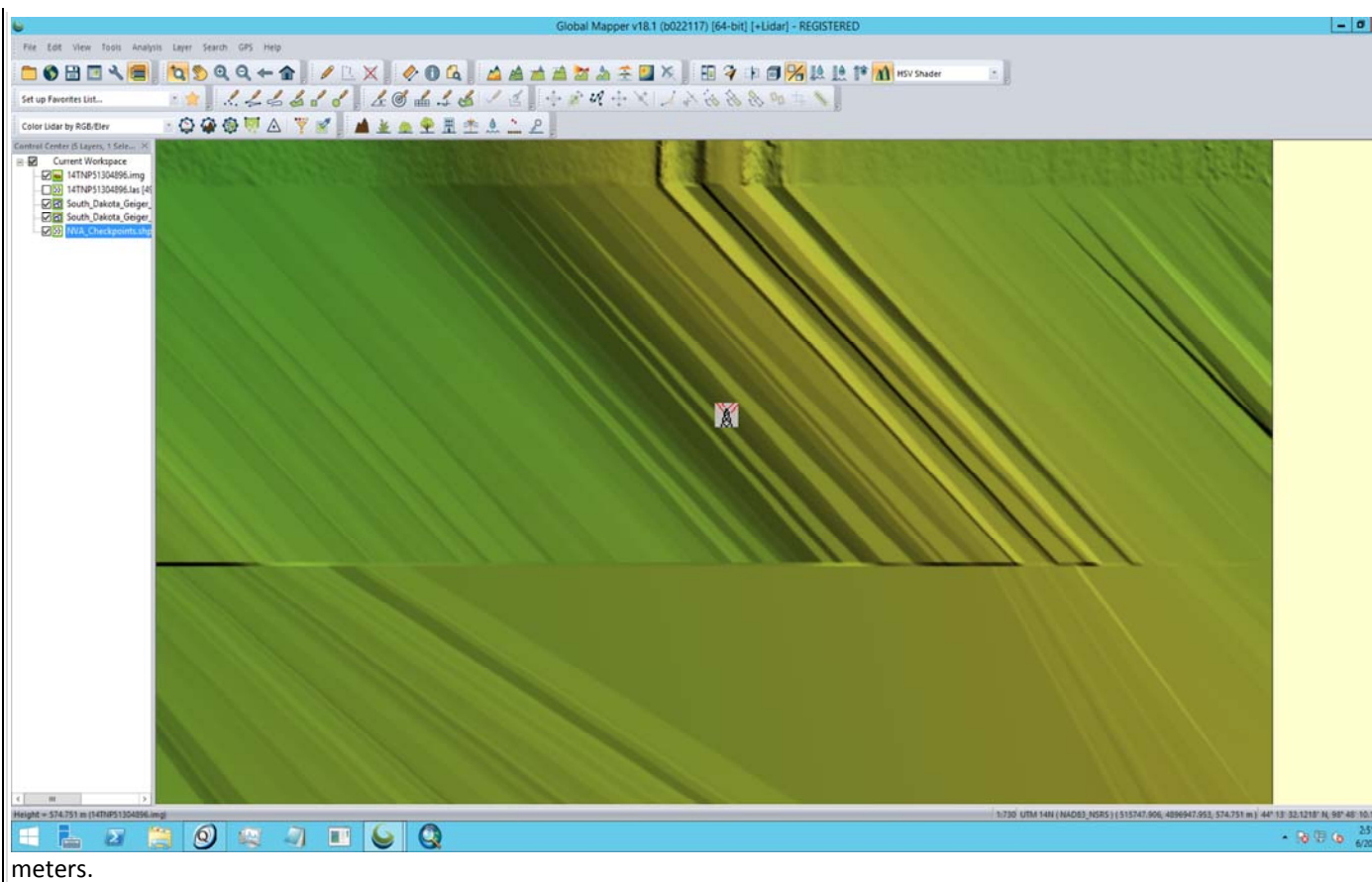Checkpoint Distribution Image
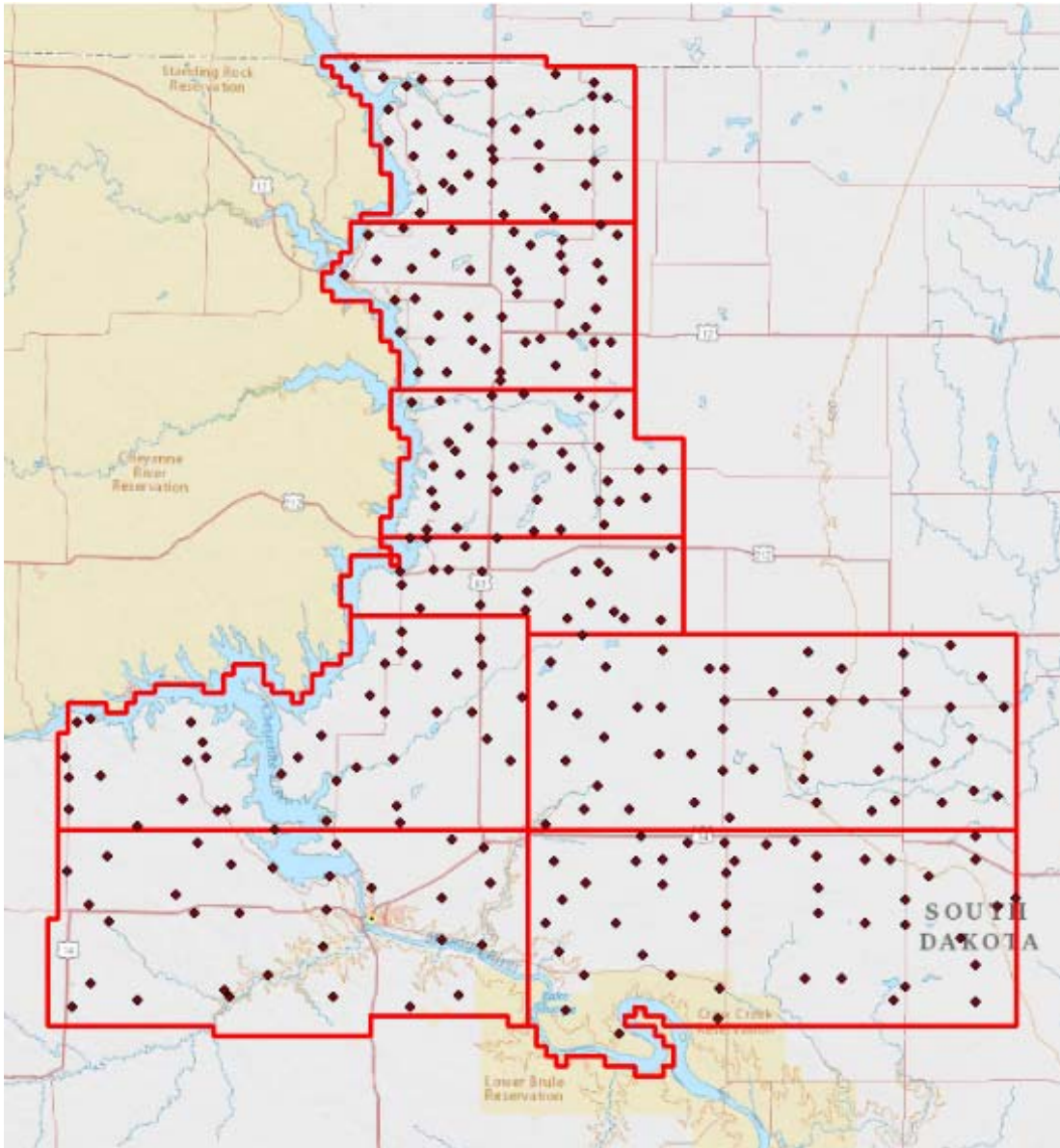
Vertical Accuracy Results:

VVA testing failed to meet USGS specifications. Three of the worst points are pictured below, showing the checkpoint below the ground surface.
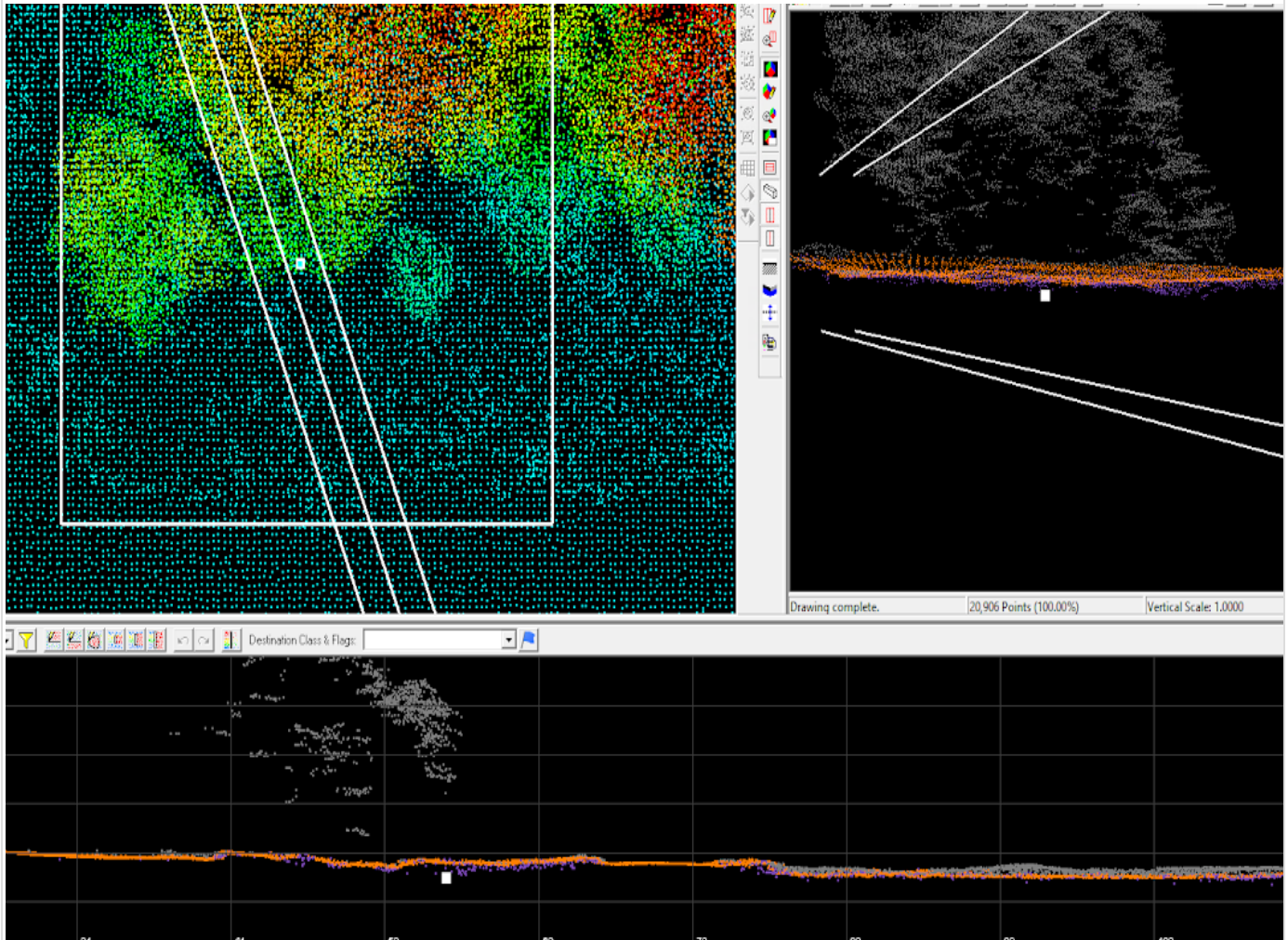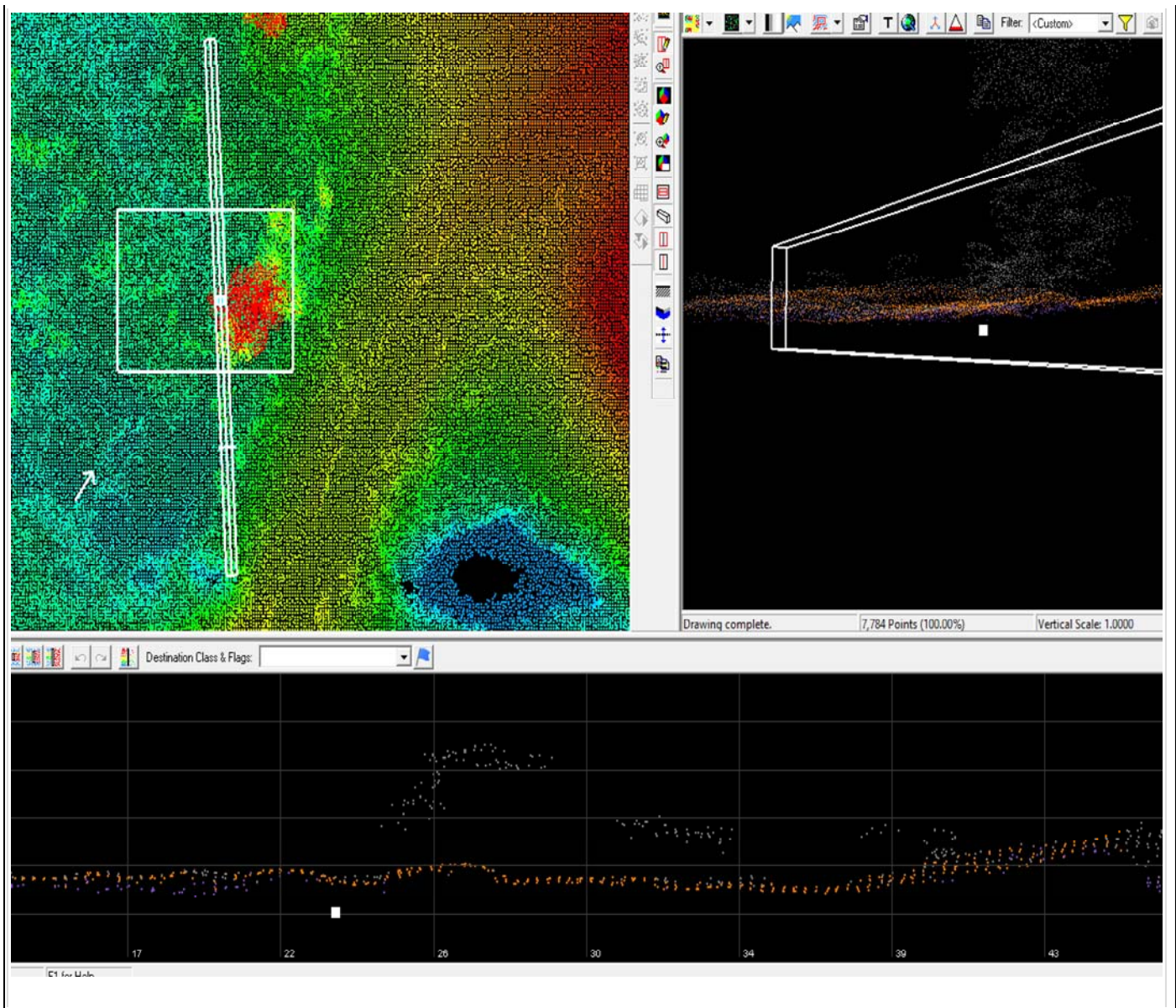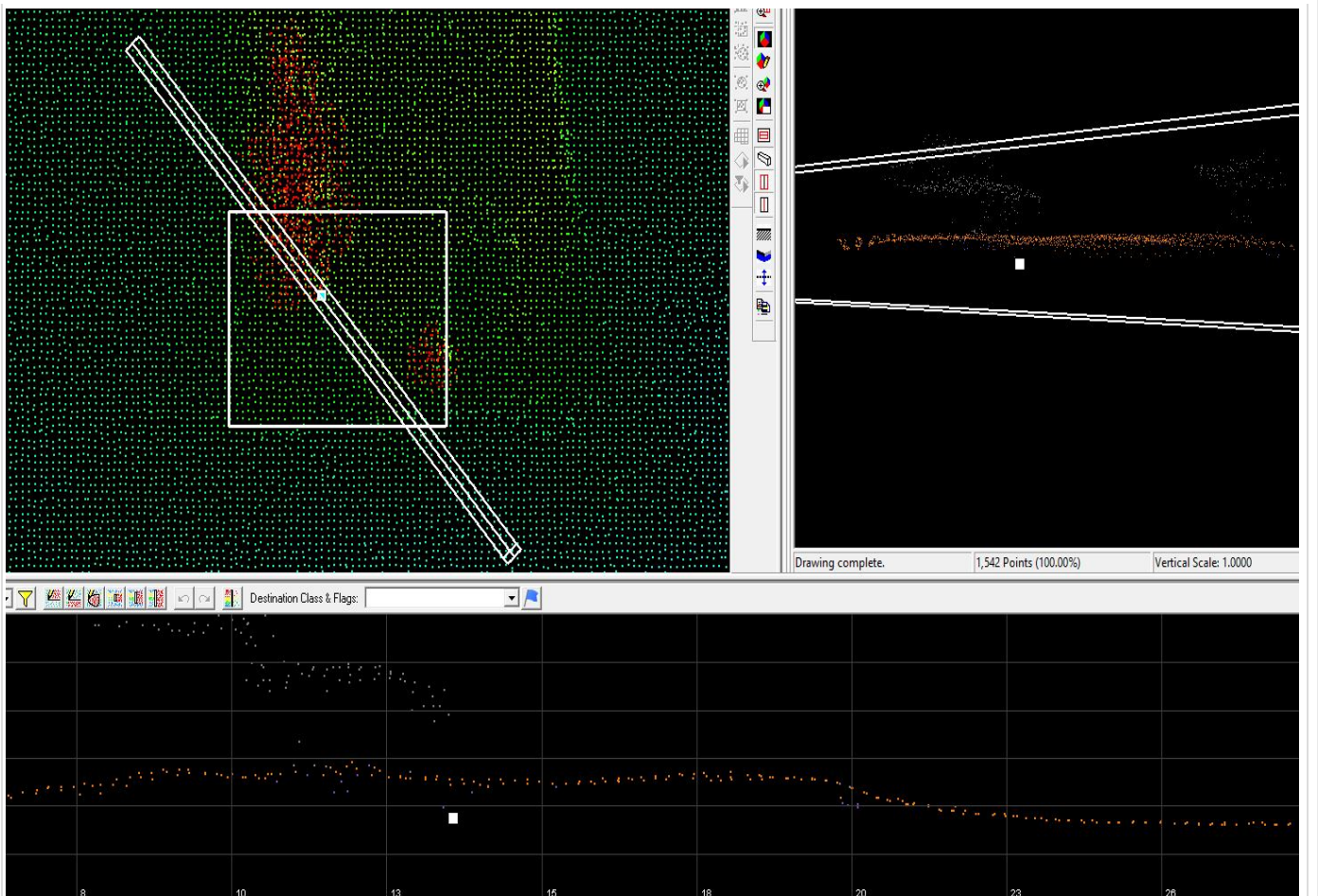
NVA point 171 was removed from DEM vertical testing. It was found that this point was in an area of data void which was causing a dz value of -1.

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 <u>does not accept</u> 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: <u>1.4</u>

Point Record Format: <u>6</u>

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

☑ *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:

Examples of possible classification issues: ground noise points interchange in the first picture which brings to question which is the true ground surface?
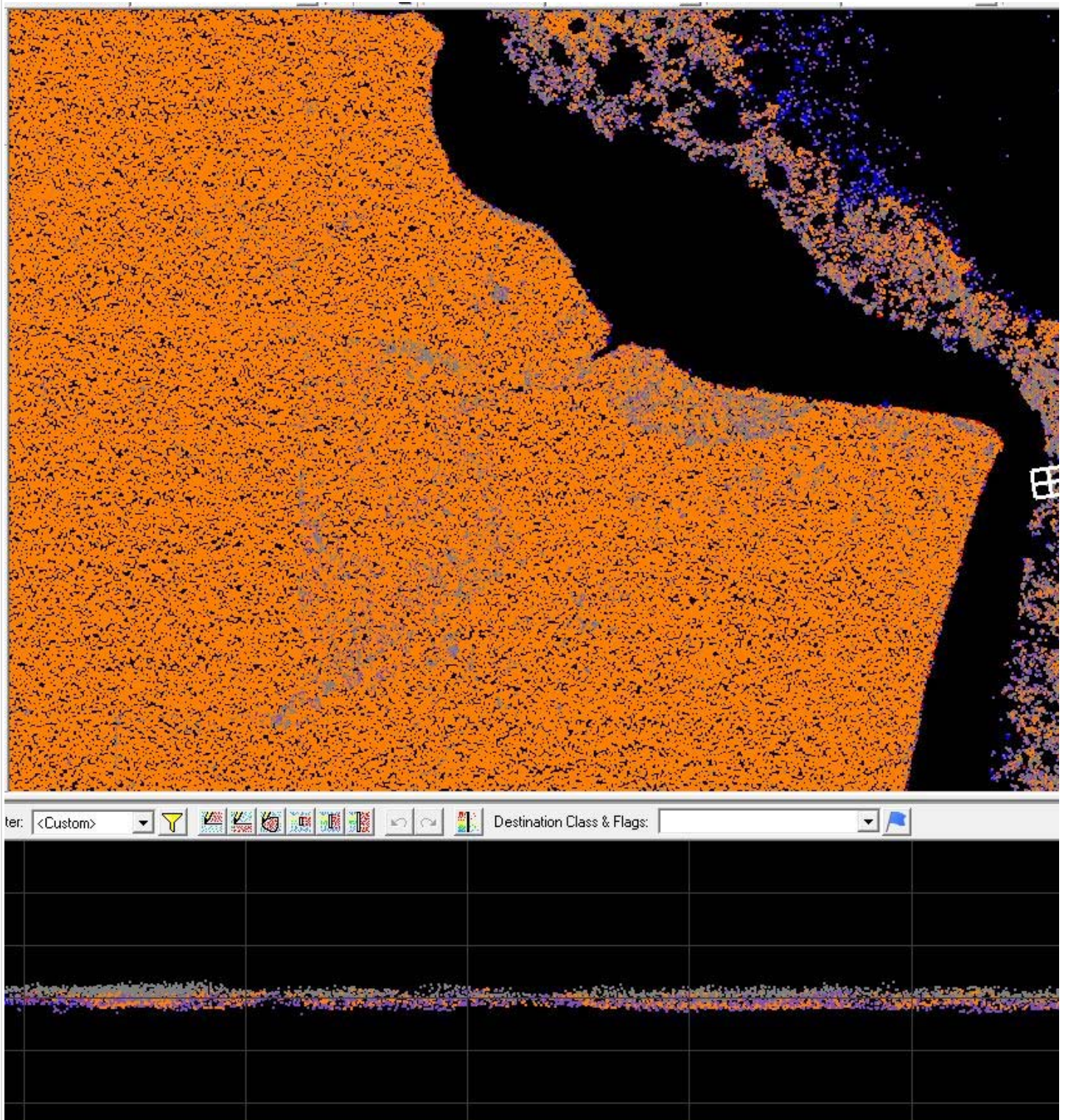
Picture two showing area of dense noise in relation to ground points.
Picture three is showing a large lake with ground points within the lake body, possible algae?
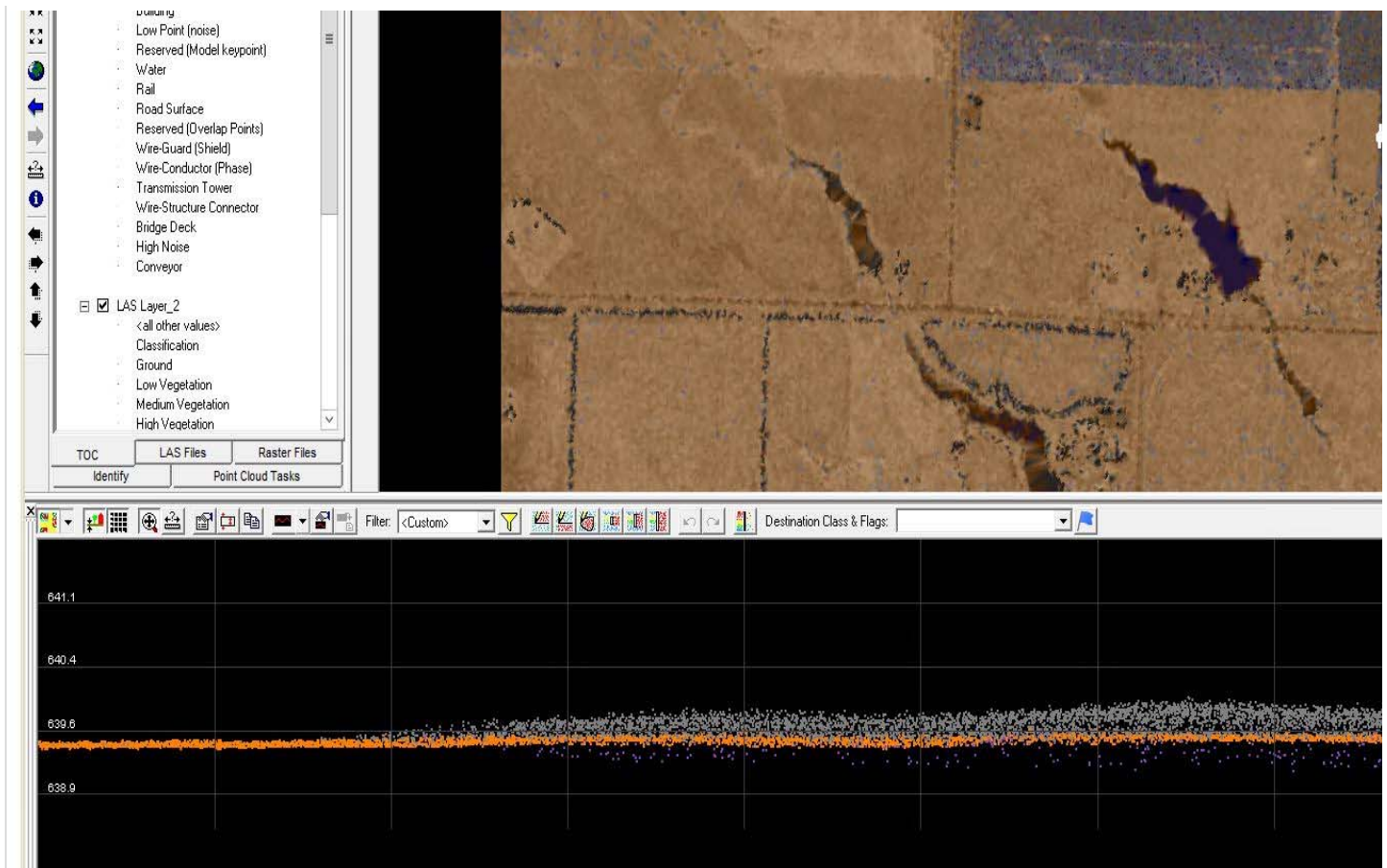
Not Corrected (9/20/2018)
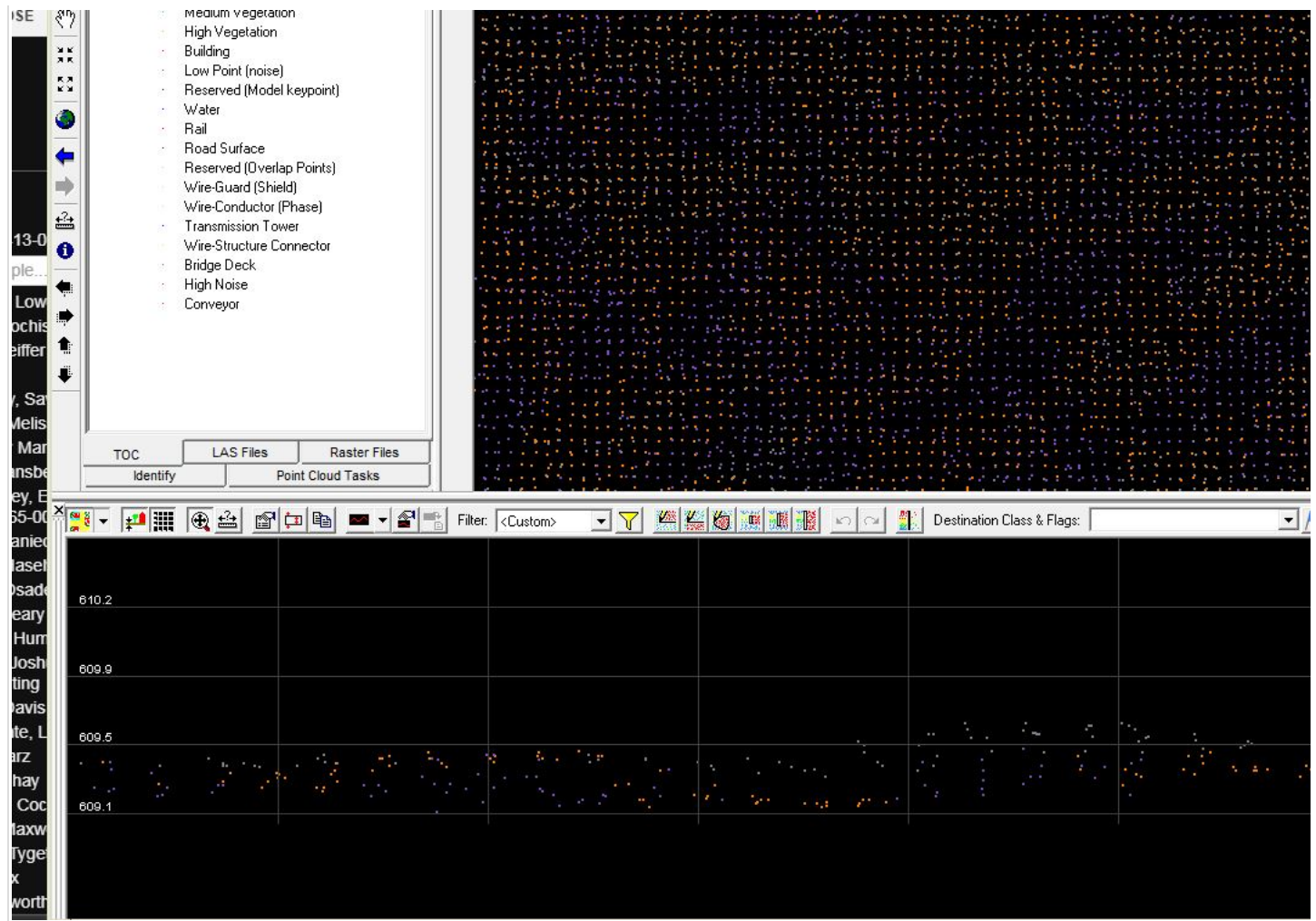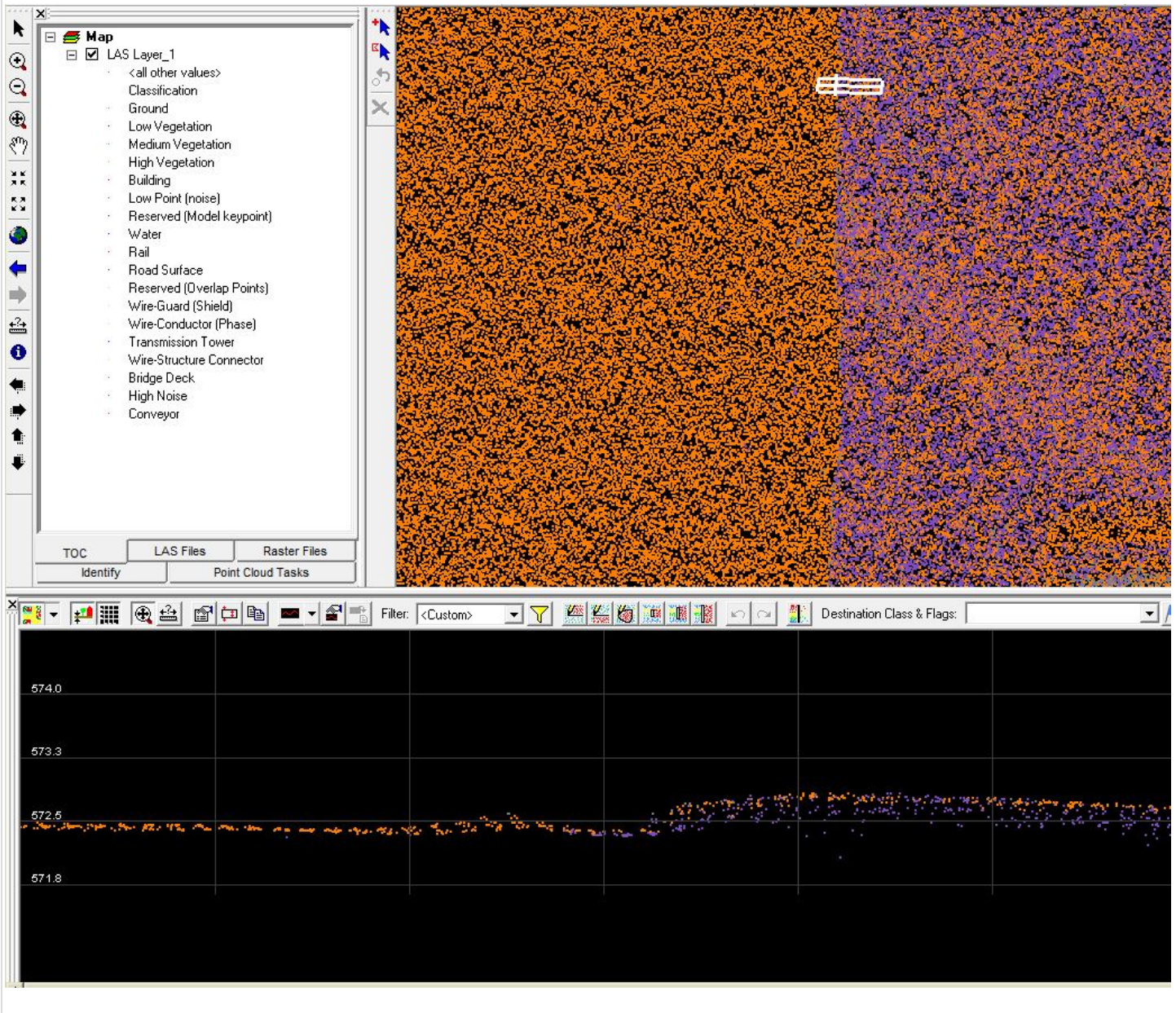
example of ground classification in an area of vegetation in another block that appears correct.

Based on this review, the USGS __does not accept__ 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 Geometery (ZEnabled)   .

Units: Meters

☑ 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 <u>accepts</u> the breakline files.

<center>End of Breakline Review</center>

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: <u>IMG</u>

Raster Cell Size: 0.5 <u>Meters</u>

Tile bit depth/pixel Type: 32_BIT_FLOAT

Interpolation or Resampling Technique: <u>Triangulated Irregular Network (TIN)</u>

☑ 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*)

One small void was found in Block 3 DEM. (6/11/2018) **Corrected (9/18/2018)**
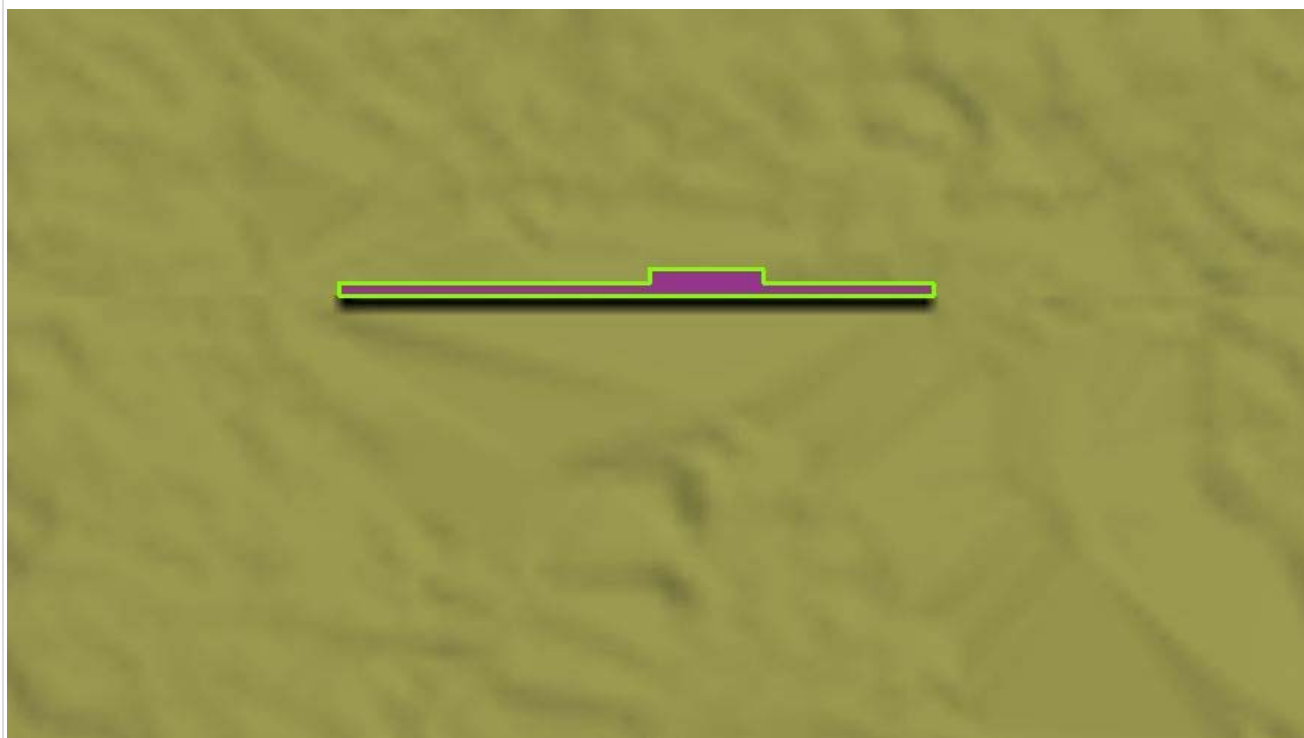
Data does not extend out to the project boundary along the entire East and West extents of Block

3. (6/11/2018)

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)

Project Boundary was downloaded from PTS. Data delivered cover this AOI.
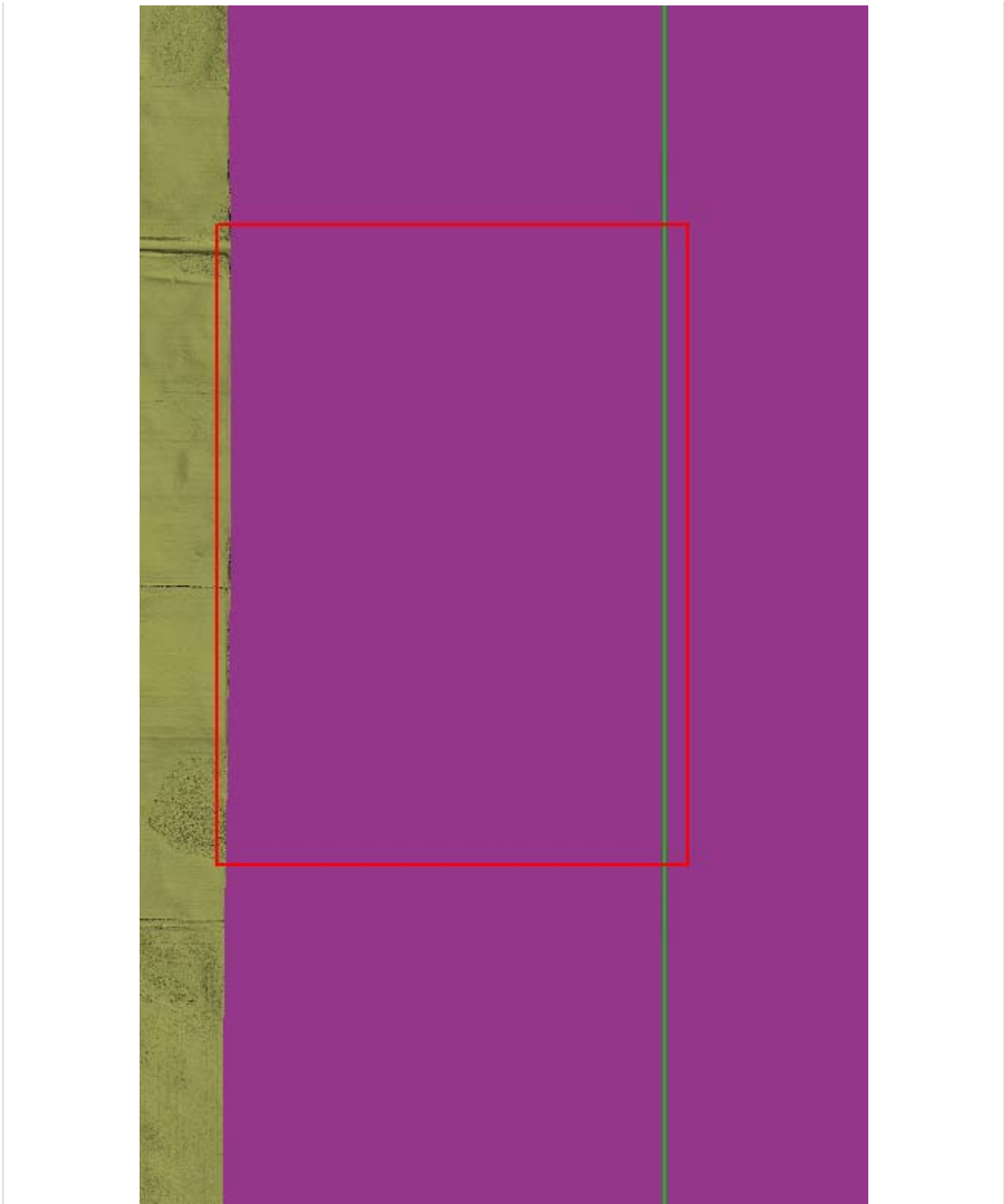
☐ Tiles do not exhibit systematic sensor error or cornrowing

4 anomalous errors probably related to the geiger mode sensor were found. (6/11/2018)

Corrected (9/18/2018)

Street in a small town looks like it's been scraped off also there is a pit in the roadway in two places

Ramp features and pits that are not on the actual surface of the earth as far as can be seen in imagery.
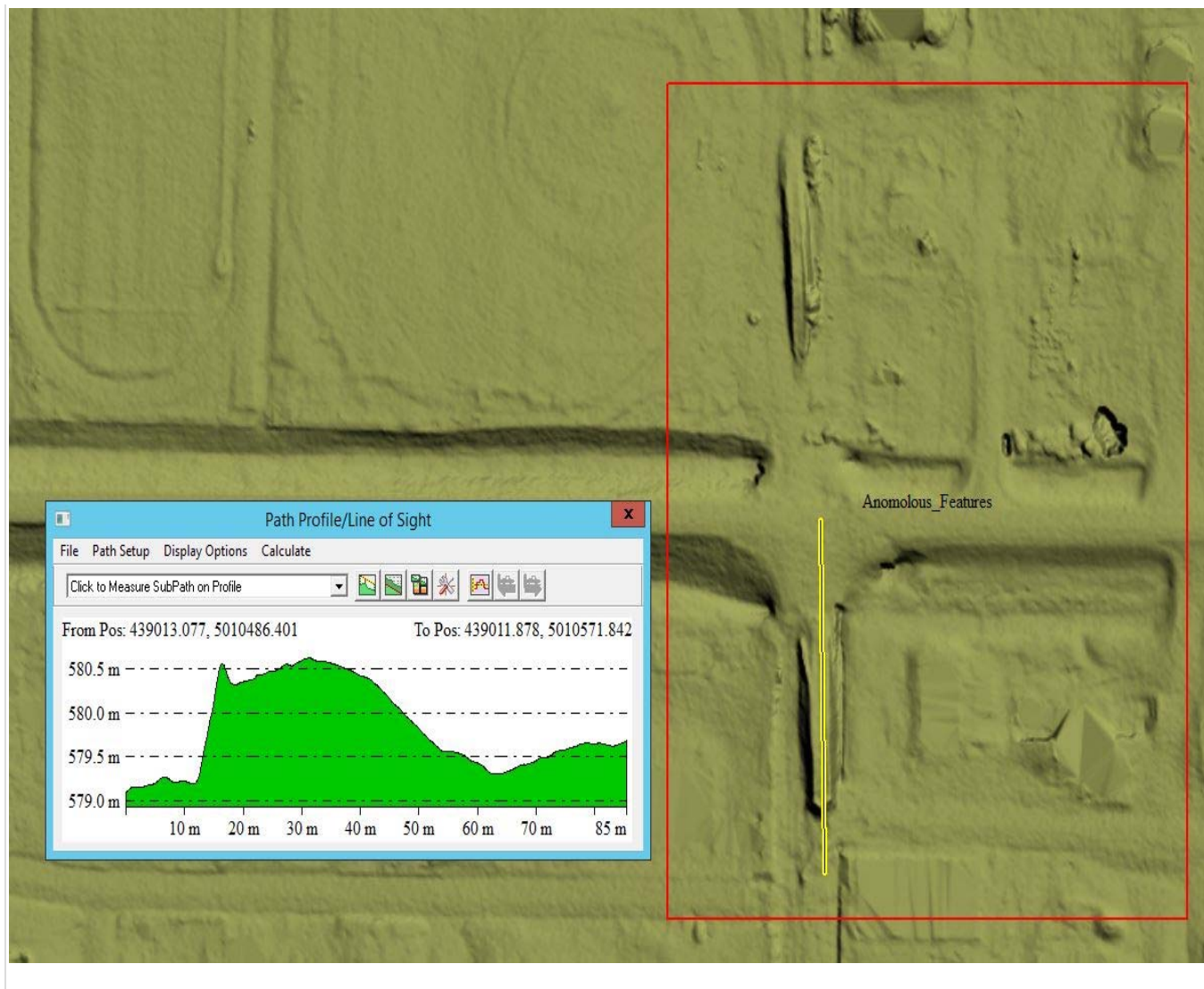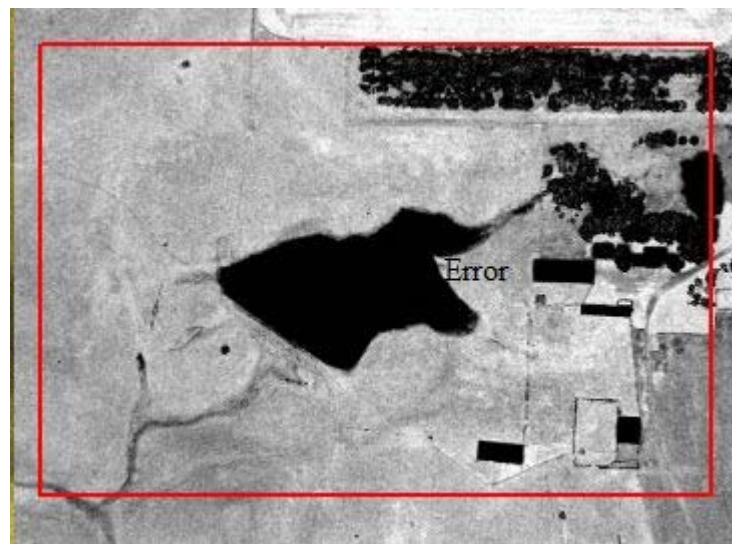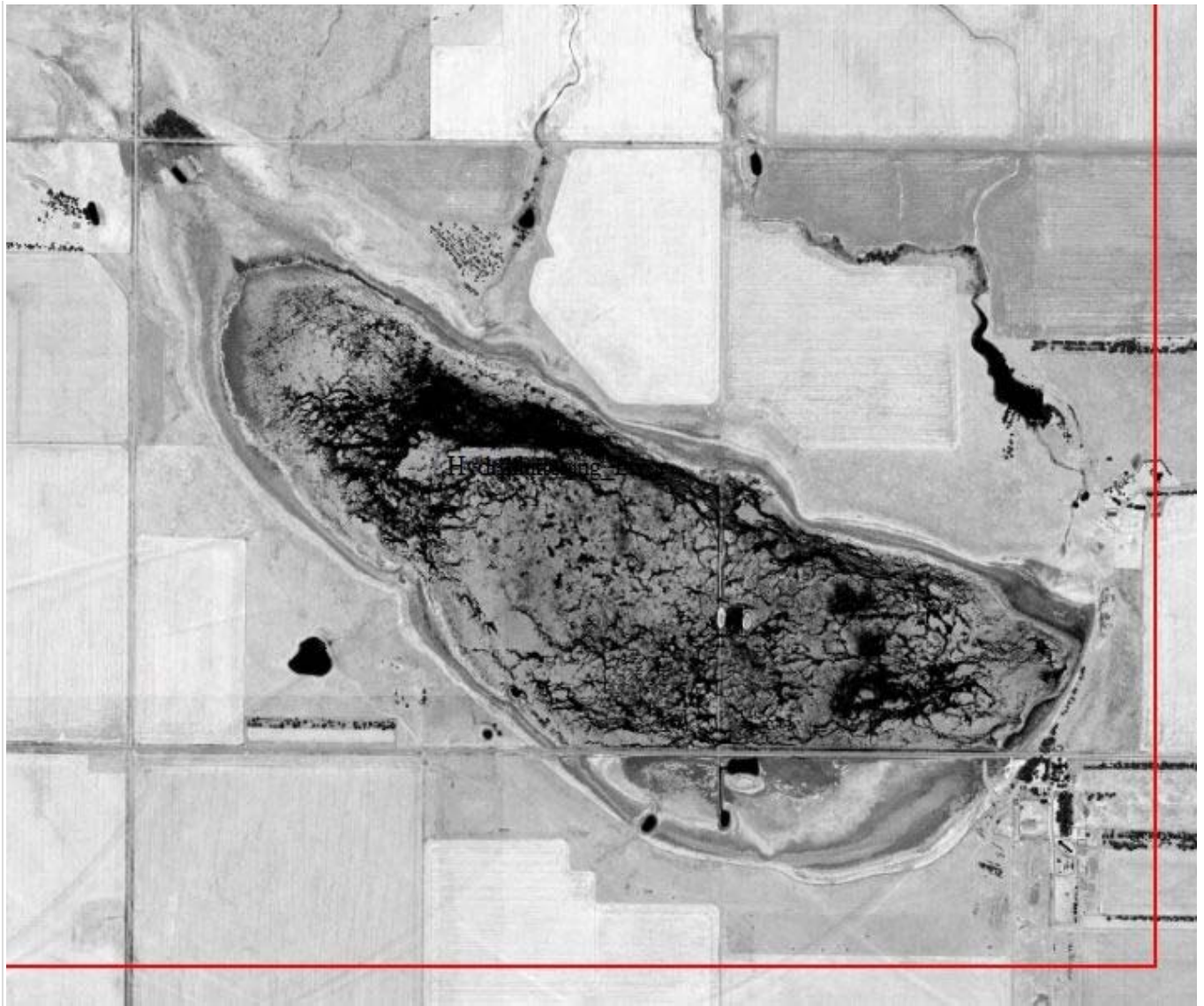
Hydro Treatment: hydro-flattened

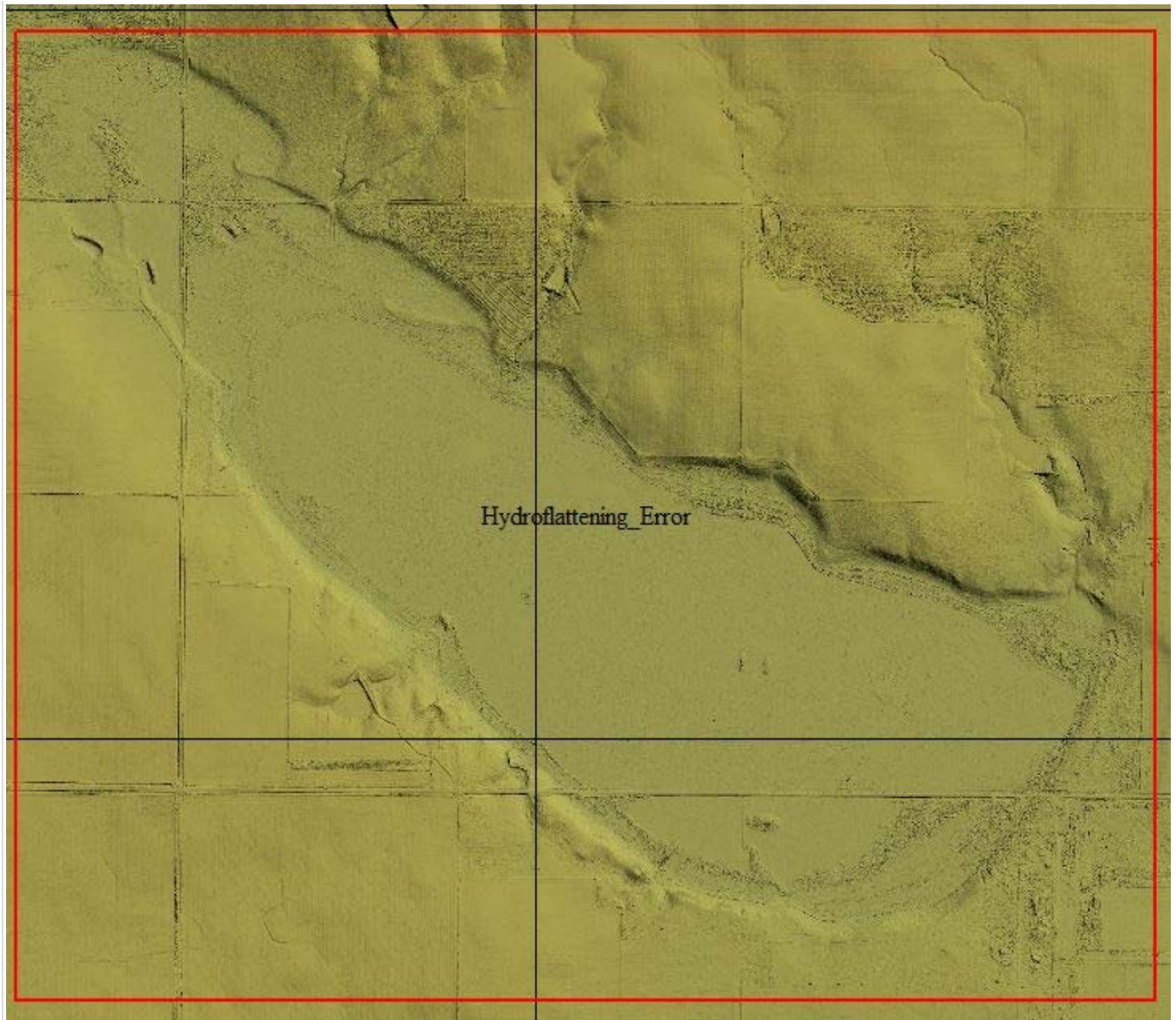DEM tiles are properly Hydro Flattened ⦿ Yes ◯ No

☐ Waterbodies 2 Acres   or greater are flattened

9 hydroflattening errors were found in block 3, waterbodies greater than 2 acres are not hydroflattened. Examples of this type of error can be seen below. (6/11/18)\
Corrected (9/18/2018)

Hydro flattening

Hydroflattening_Error

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

☑ Tidal Boundaries/Shorelines are flattened

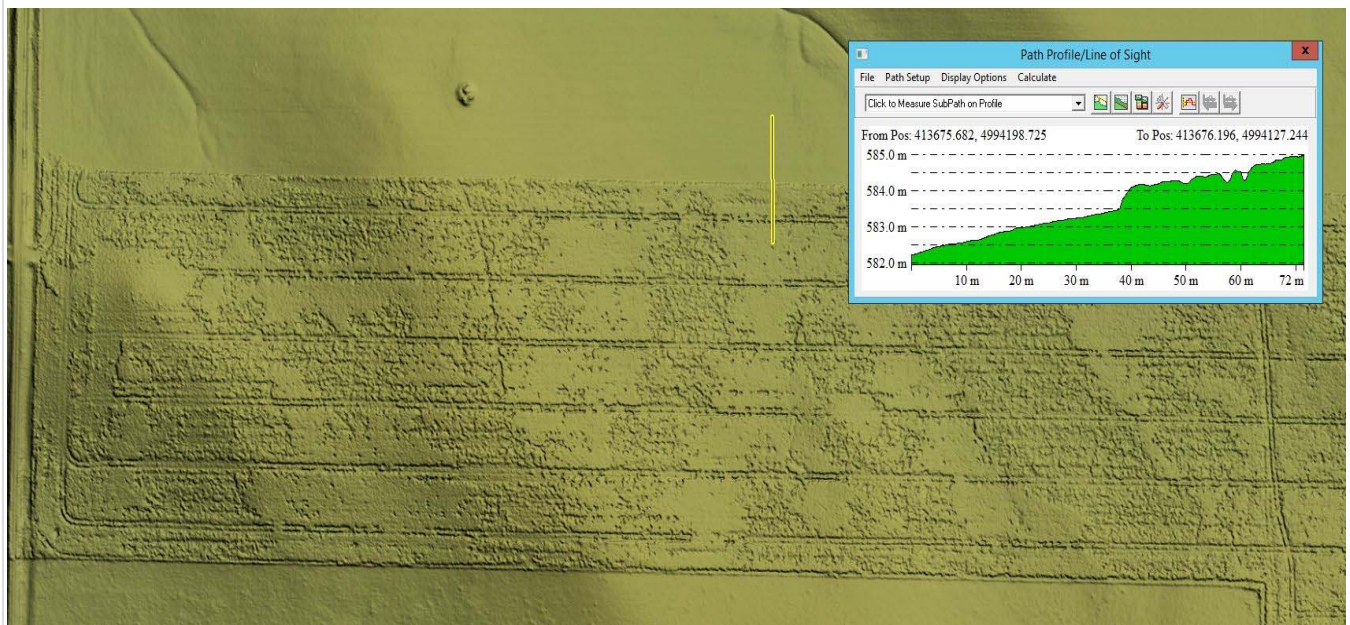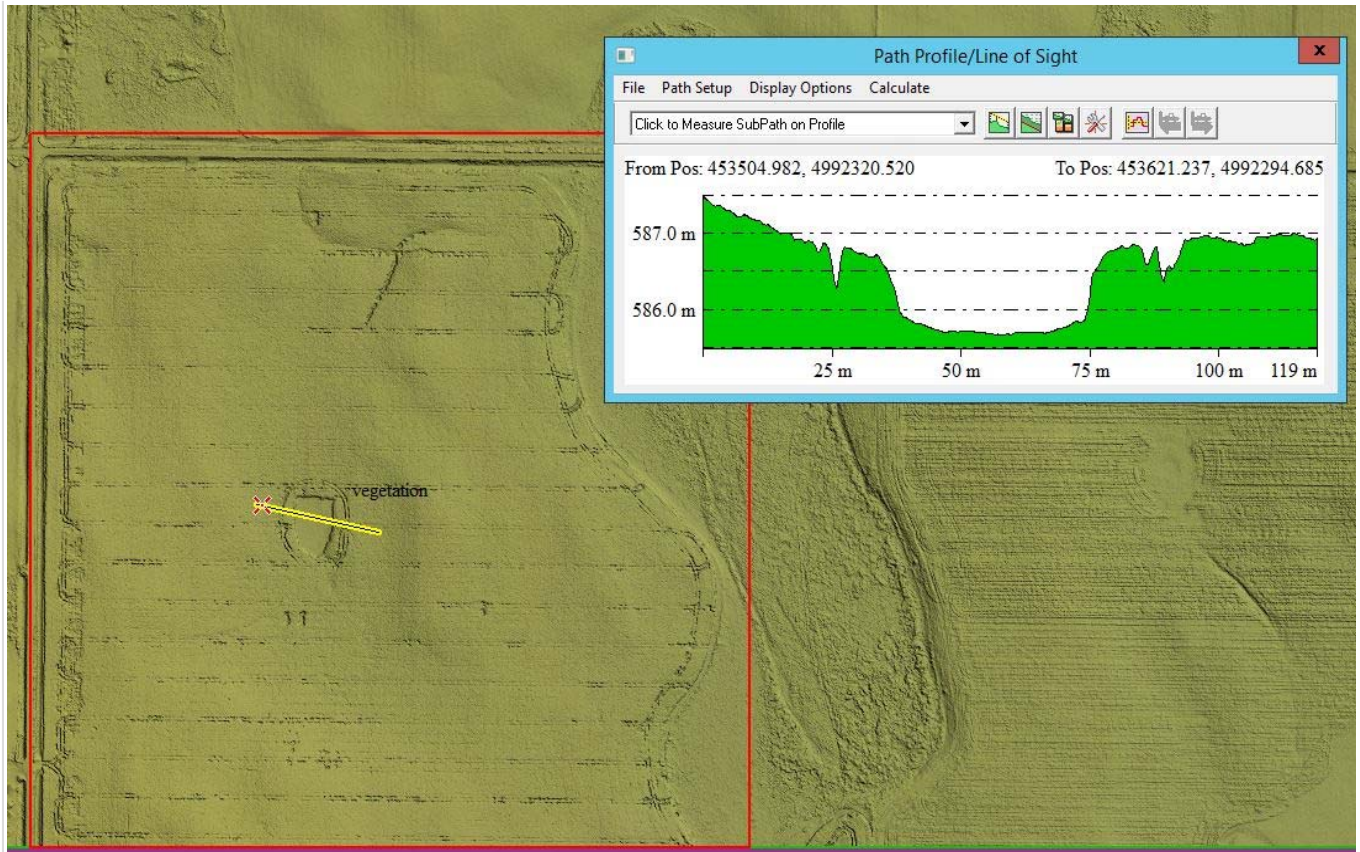☑ No missing islands 1 Acre or larger

☑ Bridges/Overpasses are properly removed

☑ Culverts are maintained (Not Hydro Enforced)

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

☐ Vegetation properly removed

3 errors related to 1 meter tall vegetation in the DEM were found in Block 3, examples can be seen below. (6/11/2018) **Not Corrected (9/18/2018)**

☑ 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 <u>does not accept</u> the DEM tiles.

End of DEM Review

Based on this review, the provided delivery <u>Does Not Meet</u> the Contract and/or Task Order requirements.

Additional Comments:

INTERNAL COMMENTS

END OF REPORT (v2.4.0)