



## 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 and the Center for LiDAR Information Coordination and Knowledge. 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 or NGTOCooperations@usgs.gov.

Materials Received:

5/10/2012

Project Type: Donated Data

Project ID:

AL\_Tri-County\_2010

Project Description:

**LIDAR generated point cloud acquired in winter 2010 and 2011 for a 2062-square mile area encompassing St. Clair, Talladega, and Calhoun Counties in Alabama. his data was collected at a nominal point spacing to support flood plain analysis, hydrological modeling, and general land use planning.**

Project Alias(es):

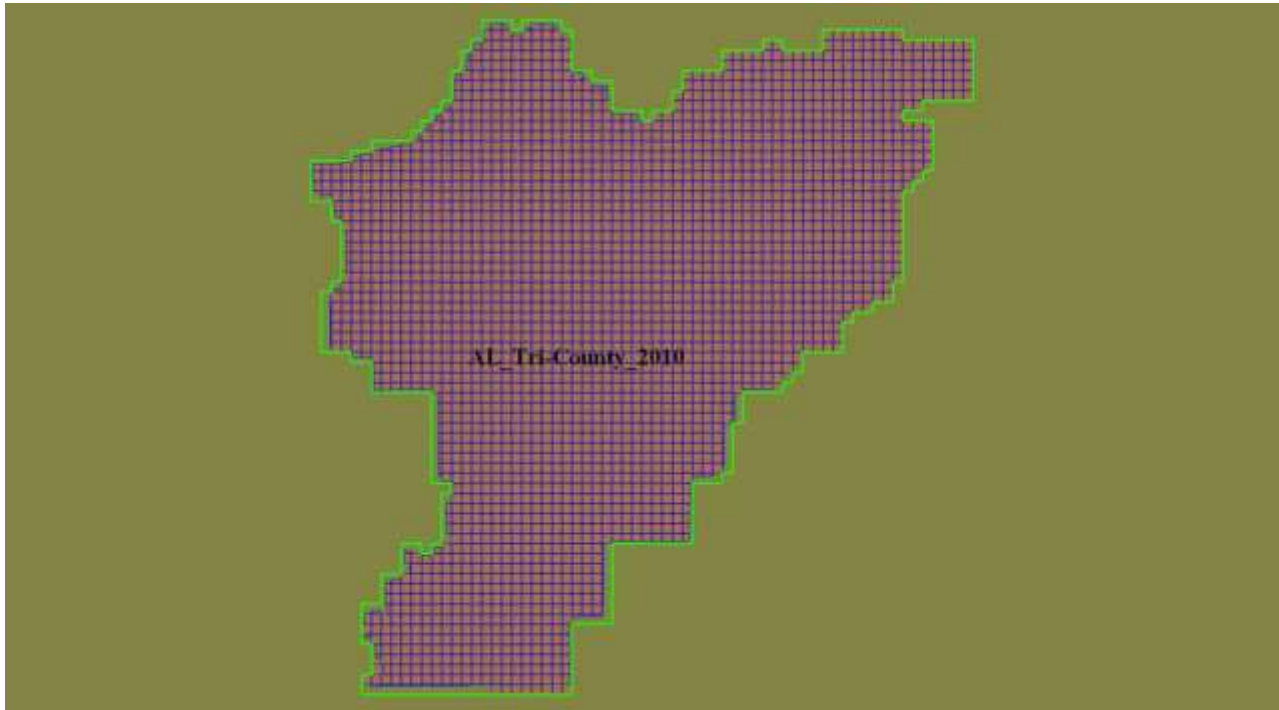
Tri-Counties (St. Clair County, Calhoun ...

Year of Collection: 2010

Lot 1 of 1 lots.

Project Extent:

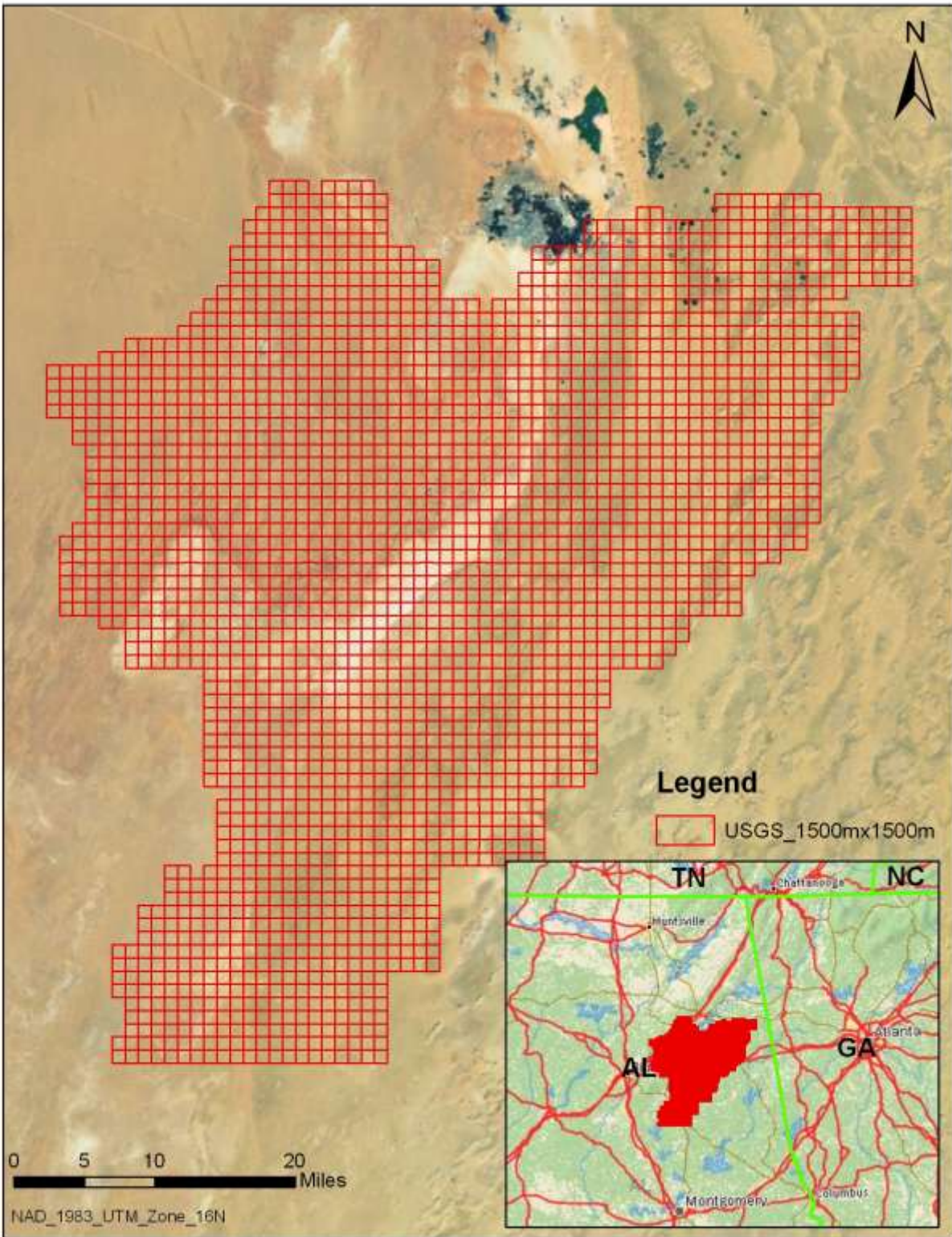
Project Extent image?



Project Tiling Scheme:

- Project Tiling Scheme image?

# AL\_Tri-County\_2010



Contractor:  
Atlantic Group

Applicable Specification:  
Custom

Licensing Restrictions:

Third Party Performed QA?

Project Points of Contact:

<b>POC Name</b>	<b>Type</b>	<b>Primary Phone</b>	<b>E-Mail</b>
George Heleine	NSDI Liaison	601-933-2950	gheleine@usgs.gov
Clay Phillips	St. Clair County	205-594-2190	cphillips@stclaircount...
Paul Weyant	Atlantic Group	256-971-9991	prweyant@theatlgrp.c...
Greg Butler	Hamilton County		
Bryan Daniel	Atlantic Group	256-971-9991	bpdaniel@theatlgrp.com

# Project Deliverables

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/Orthoimagery Section supervisor and informed of the problem. Processing will resume after the COTR has coordinated the deposition of remaining deliverables.

- |   |   |
|---|---|
| <input type="checkbox"/> Collection Report              | <input checked="" type="checkbox"/> Project Tiling Scheme Shapefile/Gdb |
| <input type="checkbox"/> Survey Report                  | <input checked="" type="checkbox"/> Breakline Shapefile/Gdb             |
| <input type="checkbox"/> Processing Report              | <input type="checkbox"/> Project XML Metadata                           |
| <input type="checkbox"/> QA/QC Report                   | <input type="checkbox"/> Swath LAS XML Metadata                         |
| <input type="checkbox"/> Control and Calibration Points | <input checked="" type="checkbox"/> Classified LAS XML Metadata         |
| <input type="checkbox"/> Project Shapefile/Geodatabase  | <input type="checkbox"/> Breakline XML Metadata                         |
| <input type="checkbox"/> Control Point Shapefile/Gdb    | <input checked="" type="checkbox"/> Bare-Earth DEM XML Metadata         |

## Multi-File Deliverables

File Type	Quantity
<input checked="" type="checkbox"/> Swath LAS Files	312
<input type="checkbox"/> Intensity Image Files	1
<input checked="" type="checkbox"/> Tiled LAS Files	2548
<input checked="" type="checkbox"/> Breakline Files	2
<input checked="" type="checkbox"/> Bare-Earth DEM Files	2548

## Additional Deliverables

Item
<input checked="" type="checkbox"/> Contours File Geodatabases (3) by County

Errors, Anomalies, Other Issues to document?  Yes  No

Original Delivery had incomplete set of LAS Tile Files, they complete set was redelivered 07/10/2012, the extra Tiled LAS File issue was resolved. Swath Data was also delivered.

# Project Geographic Information

Areal Extent:

2061.9

Sq Mi

Grid Size:

1.0

meters

Tile Size:

1500 x 1500

meters

Nominal Pulse Spacing:   meters

Vertical Datum:  meters

Horizontal Datum:  meters

Project Projection/Coordinate Reference System:  meters.

This Projection Coordinate Reference System is consistent across the following deliverables:

- |   |  |
|---|--|
| <input type="checkbox"/> Project Shapefile/Geodatabase                  | <input checked="" type="checkbox"/> Breaklines XML Metadata File     |
| <input checked="" type="checkbox"/> Project Tiling Scheme Shapefile/Gdb | <input checked="" type="checkbox"/> Bare-Earth DEM XML Metadata File |
| <input type="checkbox"/> Checkpoints Shapefile/Geodatabase              | <input checked="" type="checkbox"/> Swath LAS Files                  |
| <input type="checkbox"/> Project XML Metadata File                      | <input checked="" type="checkbox"/> Classified LAS Files             |
| <input type="checkbox"/> Swath LAS XML Metadata File                    | <input checked="" type="checkbox"/> Breaklines Files                 |
| <input checked="" type="checkbox"/> Classified LAS XML Metadata File    | <input checked="" type="checkbox"/> Bare-Earth DEM Files             |

# Review Cycle

This section documents who performed the QA Review on a project as well as when QA reviews were started, actions passed, received, and completed.

Review Start Date:

6/18/2012

Action to Contractor Date	Issue Description	Return Date
7/10/2012	Fix DEMs (From DEM Error Tags)	
6/25/2012	Deliver Complete Set of LAS Tiled Files and Vertical Accuracy Checkpoints (Received Complete Set of LAS Tiled Files, but no checkpoints.)	7/10/2012

Review Complete: 2/20/2013

## Metadata Review

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.

The Project XML Metadata file parsed witherrors.

"Project XML Not Provided" See DEM or LAS for best fit Project Metadata.

The Classified LAS XML Metadata file parsed withouterrors.

The Breakline XML Metadata file parsed withouterrors.

The Bare-Earth DEM XML Metadata file parsed withouterrors.





# Project QA/QC Report Review

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.

Checkpoint Shapefile or Geodatabase:

Checkpoint Distribution Image?

The following land cover classes are represented in this dataset (uncheck any that do not apply):

- Bare Earth
- Tall Weeds and Crops
- Brush Lands and Low Trees
- Forested Areas Fully Covered by Trees
- Urban Areas with Dense Man-Made Structures

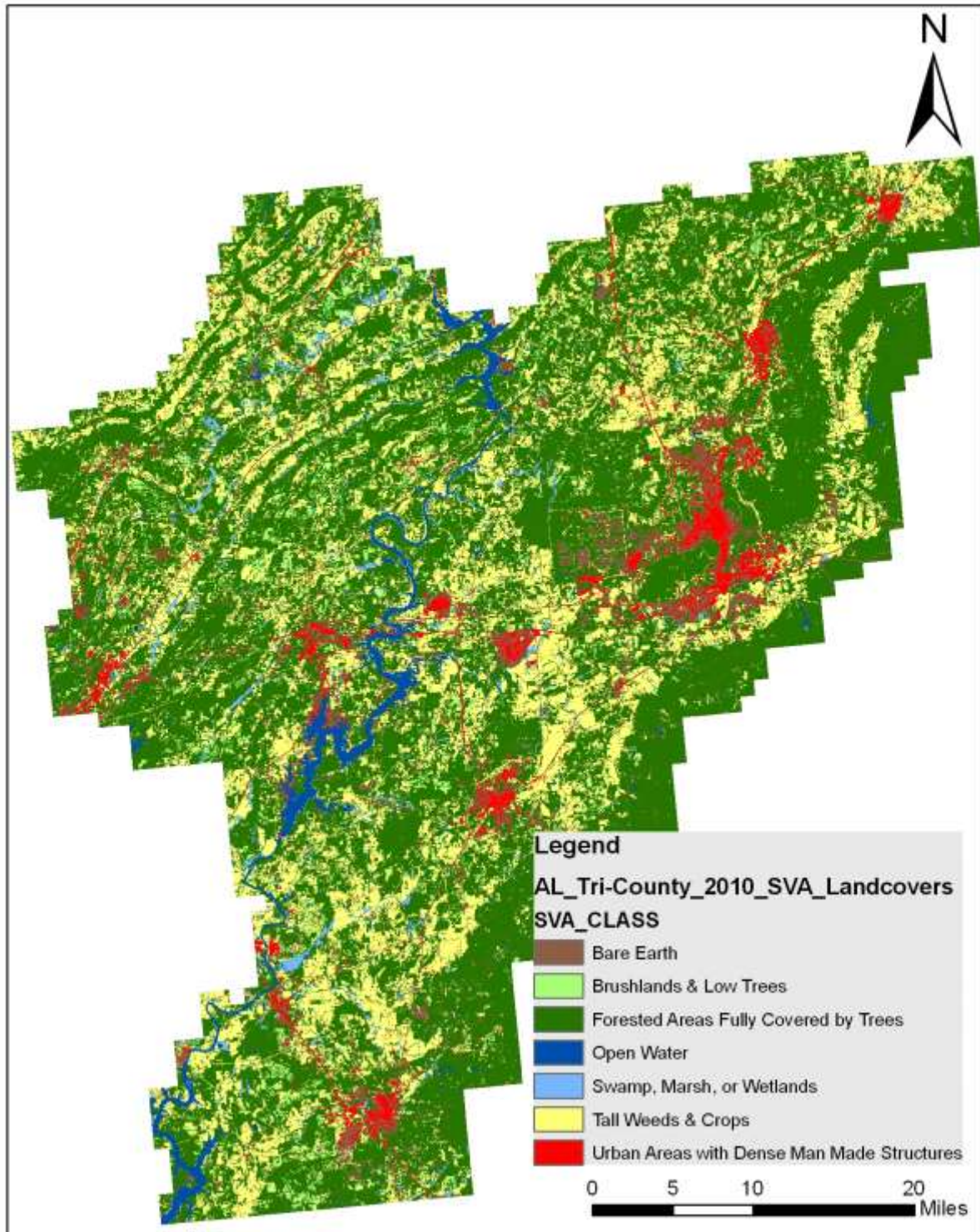
There are a minimum of 20 checkpoints for each land cover class represented. Points

within each class are uniformly distributed throughout the dataset. USGS was notable to locate independent checkpoints for this analysis. USGS accepts the quality of the checkpoint data for these LiDAR datasets.

Errors, Anomalies, Other Issues to document?  Yes  No

Image?

# SVA\_Landcovers



Landcovers (from Aggregated NLCD 2006)

Image?

-----SVA Landcover Class Report-----

For USGS LiDAR Base Specification Projects each landcover type representing 10% or more of the total project area must be tested and reported as a Supplemental Vertical Accuracy.

- Bare Earth Comprises 7.68519702445% of Landcover for this Project.
- Tall Weeds & Crops Comprises 23.0054965873% of Landcover for this Project.
- Brushlands & Low Trees Comprises 3.49098793449% of Landcover for this Project.
- Forested Areas Fully Covered by Trees Comprises 59.1256919762% of Landcover for this Project.
- Urban Areas with Dense Man Made Structures Comprises 2.69485743153% of Landcover for this Project.
- Open Water Comprises 2.35524097676% of Landcover for this Project.
- Swamp, Marsh, or Wetlands Comprises 1.64252806931% of Landcover for this Project.

Landcover Percentages, see AL\_Tri-County-2010\_SVA\_Landcover\_Report.txt

Accuracy values are reported in terms of Fundamental Vertical Accuracy (FVA), Supplemental Vertical Accuracy(s) (SVA), and Consolidated Vertical Accuracy (CVA).

Accuracy values are reported in:

Required FVA Value is  U.S. feet or less.

Target SVA Value is  U.S. feet or less.

Required CVA Value is  U.S. feet or less.

The reported FVA of the LAS Swath data is  U.S. feet.

The reported FVA of the Bare-Earth DEM data is  U.S. feet.

SVA are required for each land cover type present in the data set with the exception of

bare-earth. SVA is calculated and reported as a 95th Percentile Error.

Land Cover Type	SVA Value	Units
Tall Weeds and Crops	Not Reported	U.S. feet
<i>Brush Lands and Low Trees</i>		U.S. feet
Forested Areas Fully Covered by Trees	Not Reported	U.S. feet
<i>Urban Areas with Dense Man-Made Structur...</i>		U.S. feet

The reported CVA of this data set is: **Not Reported** U.S. feet.

## LAS Swath File 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 Fundamental Vertical Accuracy using ground control checkpoints measured in clear open terrain. The following was determined for LAS swath data for this project:

### LAS Version

- LAS 1.2       LAS1.3       LAS 1.4

### Swath File Characteristics

- Separate folder for LAS swath files  
 Each swath files <= 2GB  
 \*If specified, \*.wdp files for full waveform have been provided

The reported FVA of the LAS swath data is 0.33 U.S. feet.

Based on this review, the USGS accepts the LAS swath file data.

Errors, Anomalies, Other Issues to document?  Yes  No

Image?

Swath not present., \*Sent in Redelivery

Image?

The following Strips are larger than 2GB:  
01157.las, 04201.las, 04200.las, 01161.las, 01163.las

## LAS Tile File Review

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. The following was determined for classified LAS files for this project:

### Classified LAS Tile File Characteristics

- Separate folder for Classified LAS tile files
- 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
- Classified LAS tile files have no points classified as '12'
- Point classifications are limited to the standard values listed below:

Code	Description
1	Processed, but unclassified
2	Bare-earth ground
7	Noise (low or high, manually identified, if needed)
9	Water
10	Ignored ground (breakline proximity)
11	Withheld (if the "Withheld" bit is not implemented in processing software)

- Buy up?

Based on this review, the USGS accepts the classified LAS tile file data.

Errors, Anomalies, Other Issues to document?  Yes  No

- Image?

\* Fixed in Redelivery\* "Unknown Coordinate System" used in the LAS file headers

Image?

\*Fixed in Redelivery\* In the Redelivered LAS, 6075\_37395.las and 6075\_37395 (2).las are both present, the (2) file seems to be the correct one as the first has most points sitting on class 0. This accounts for the 1 extra las file as compared to the count of DEM tiles. The (2) file will be renamed and the other deleted for delivery to EROS.

Image?

Metadata States Class 11 Was used as Overlap/Reserved Class. If class was used as Overlap Class 12, this is an error.

Image?

Only partial tiles delivered 1300 of 2548. Update: Complete set was delivered 07/10/2012.

## Breakline File Review

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

### Breakline File Characteristics

- Separate folder for breakline files
- All breaklines captured as PolylineZ or PolygonZ features
- No missing or misplaced breaklines

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

Errors, Anomalies, Other Issues to document?  Yes  No

Image for error?

Possible missing and inaccurate breaklines. See DEM errors below for more information.

## Bare-Earth DEM Tile File Review

The derived bare-earth DEM file receives a review of the vertical accuracies provided by the data supplier, vertical accuracies calculated by USGS using supplied and independent checkpoints, and a manual check of the appearance of the DEM layer.

Bare-Earth DEM files provided in the following format:

### Bare-Earth DEM Tile File Characteristics

- Separate folder for bare-earth DEM files
- DEM files conform to Project Tiling Scheme
- Quantity of DEM files conforms to Project Tiling Scheme
- DEM files do not overlap
- DEM files are uniform in size
- DEM files properly edge match
- Independent check points are well distributed

All accuracy values reported in .

### Reported Accuracies

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Land Cover Category	# of Points	Fundamental Vertical Accuracy @95% Confidence Interval (Accuracy <sub>z</sub> ) Required FVA = 0.61 or less.	Supplemental Vertical Accuracy @95th Percentile Error Target SVA = 1.19 or less.	Consolidated Vertical Accuracy @95th Percentile Error Required CVA = 1.19 or less.
Open Terrain	1	0.33		
Tall Weeds and Crops	1		Not Reported	
Brush Lands and Low Trees	1		1	
Forested Areas Fully Covered by Trees	1		Not Reported	
Urban Areas with Dense Man-Made Structures	1		1	
Consolidated	0			Not Reported

QA performed Accuracy Calculations?

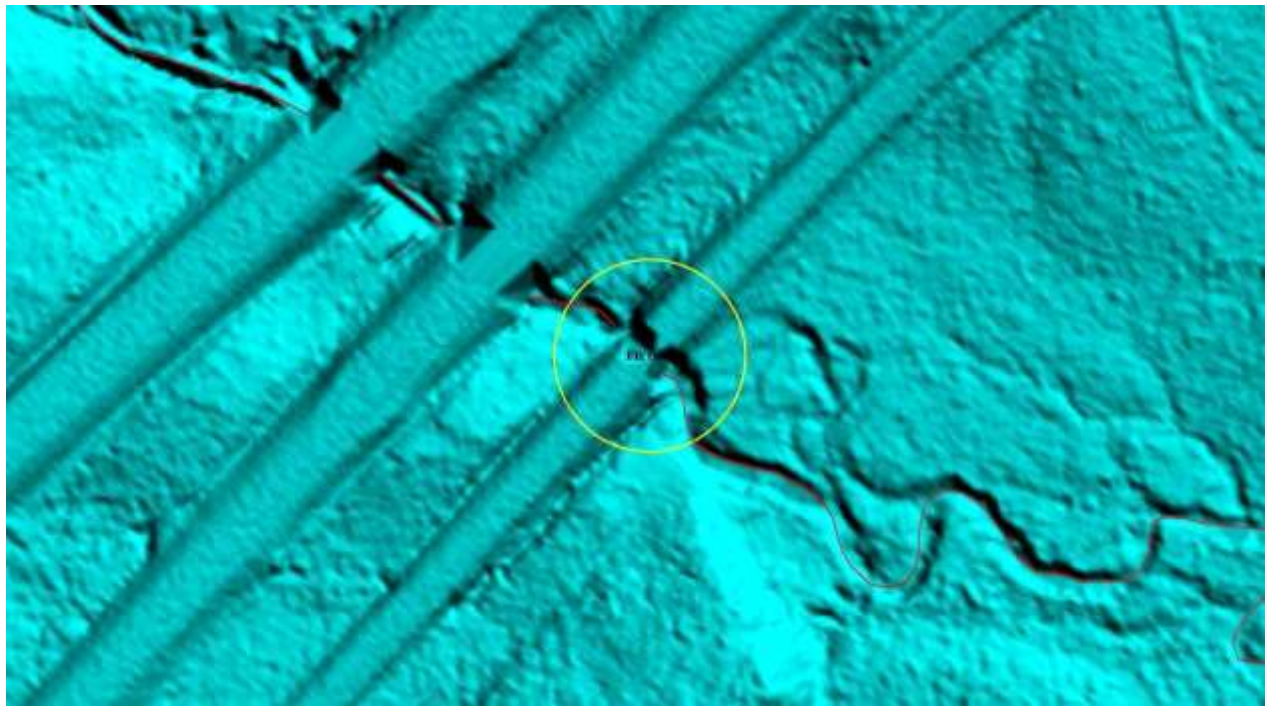
Based on this review, the USGS recommends the bare-earth DEM files for inclusion in the 1/3 Arc-Second National Elevation Dataset.

Based on this review, the USGS accepts the bare-earth DEM files.

Bare-Earth DEM Anomalies, Errors, Other Issues

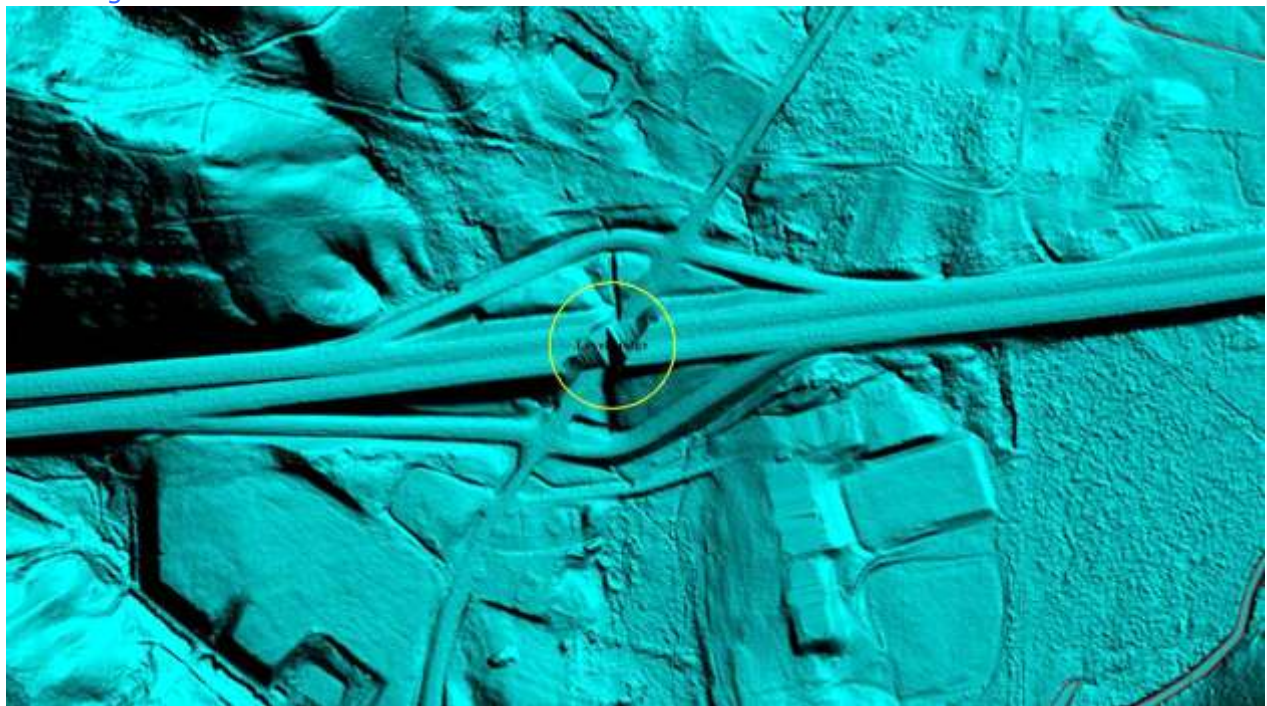
Errors, Anomalies, Other Issues to document?  Yes  No

Image?



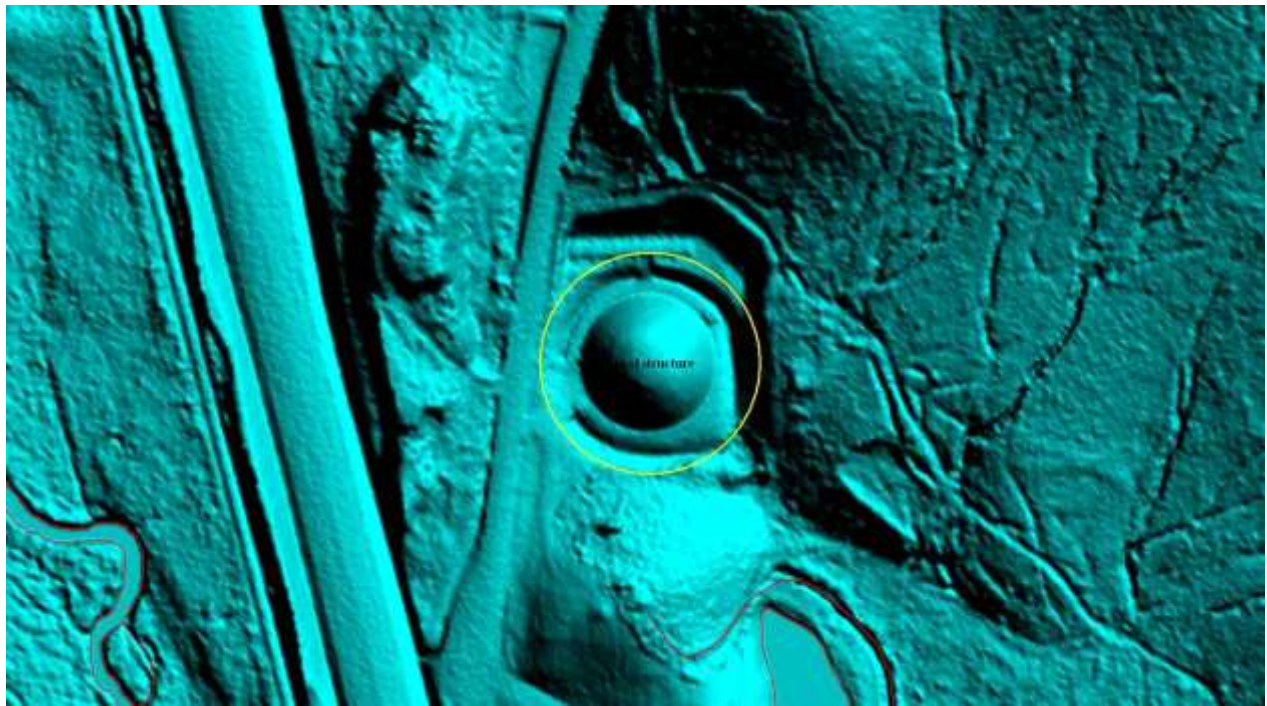
Fix road example (not fixed)

Image?



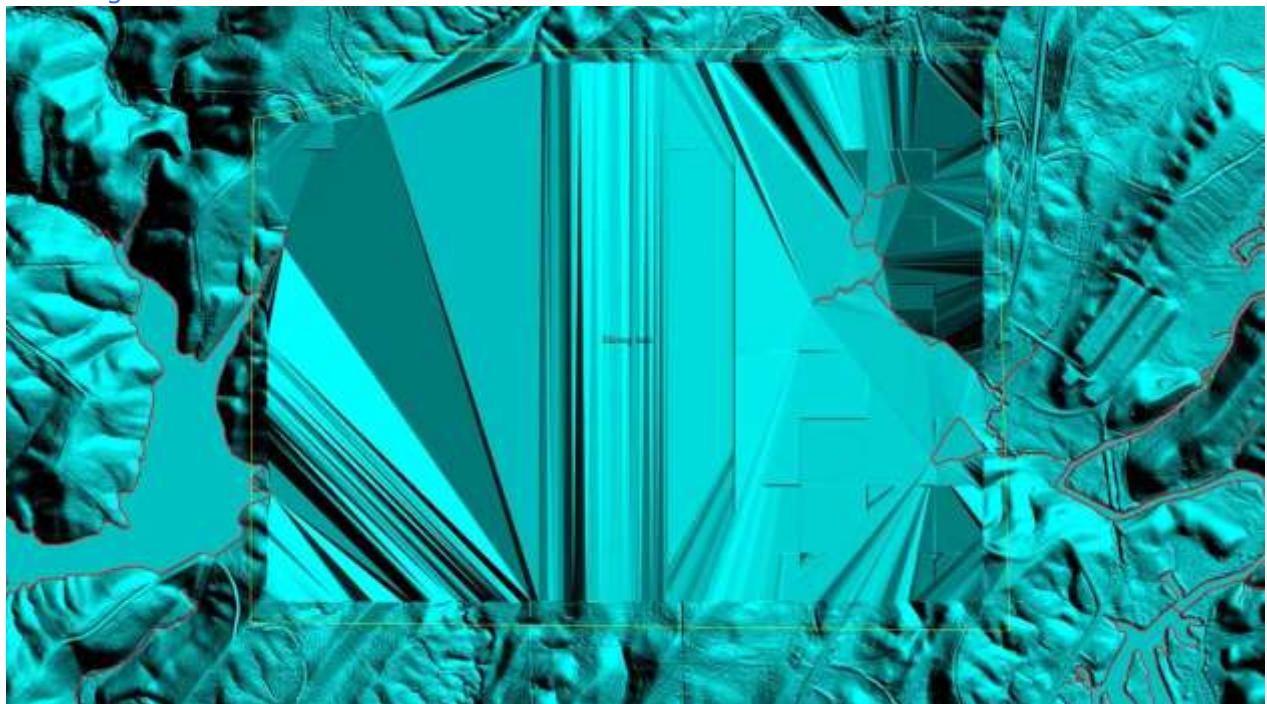
Level bridge. example (not fixed)

Image?



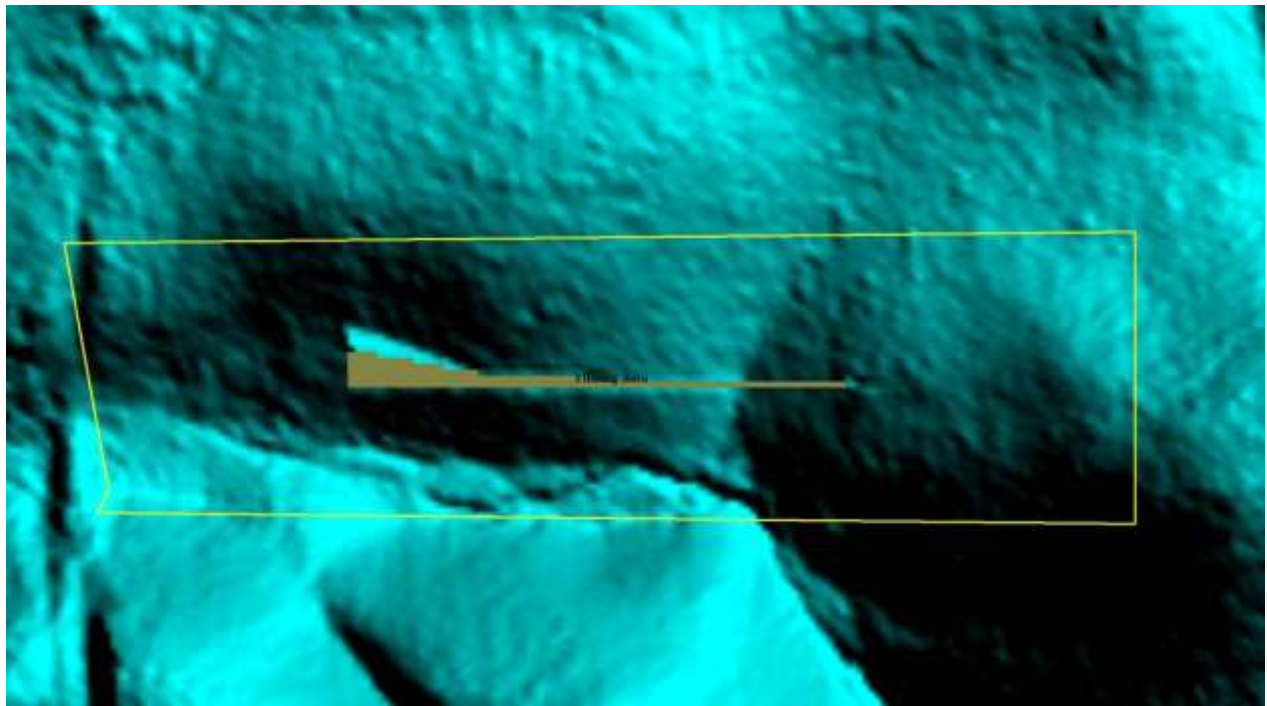
Level structure example (Fixed)

Image?



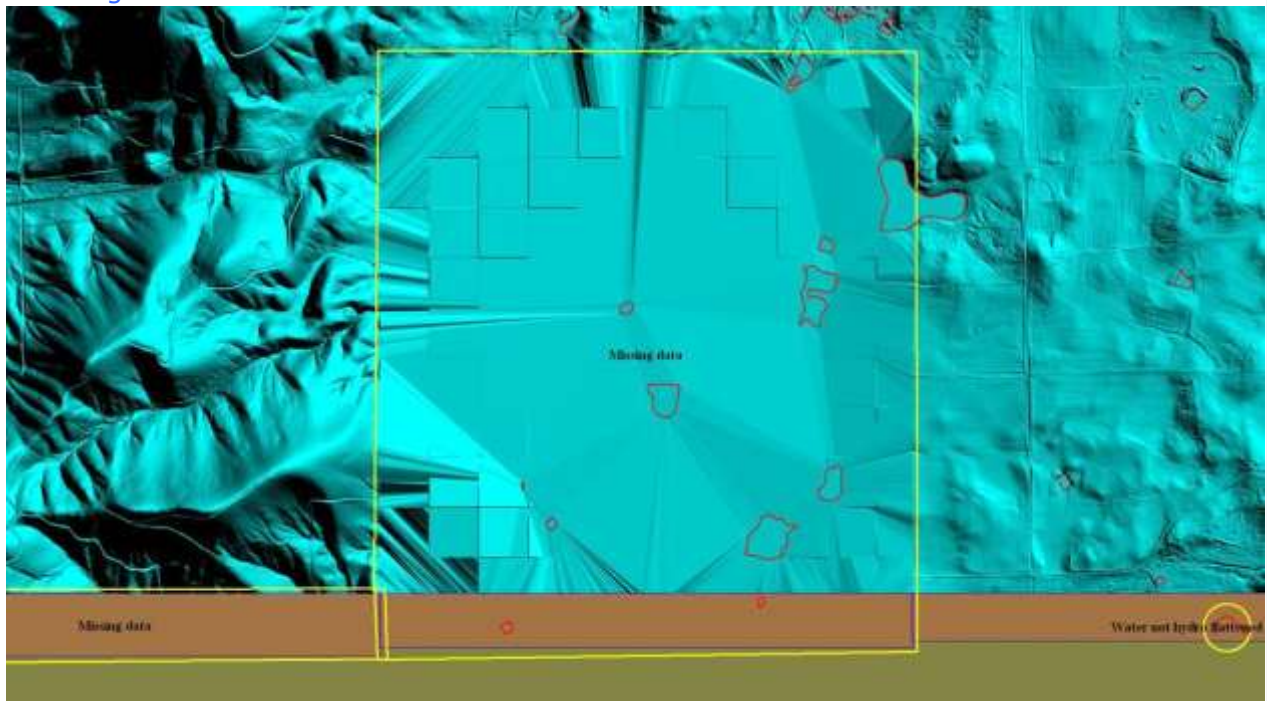
Missing data example (Fixed)

Image?



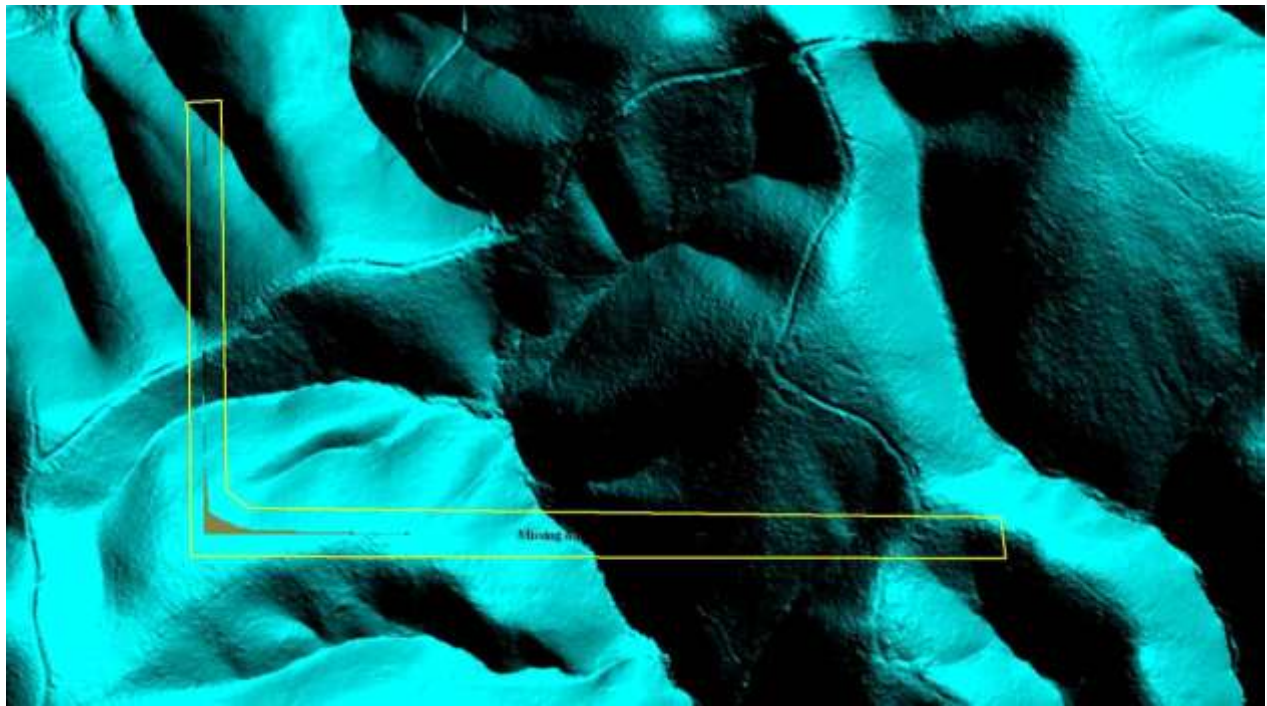
Missing data example (Fixed)

Image?



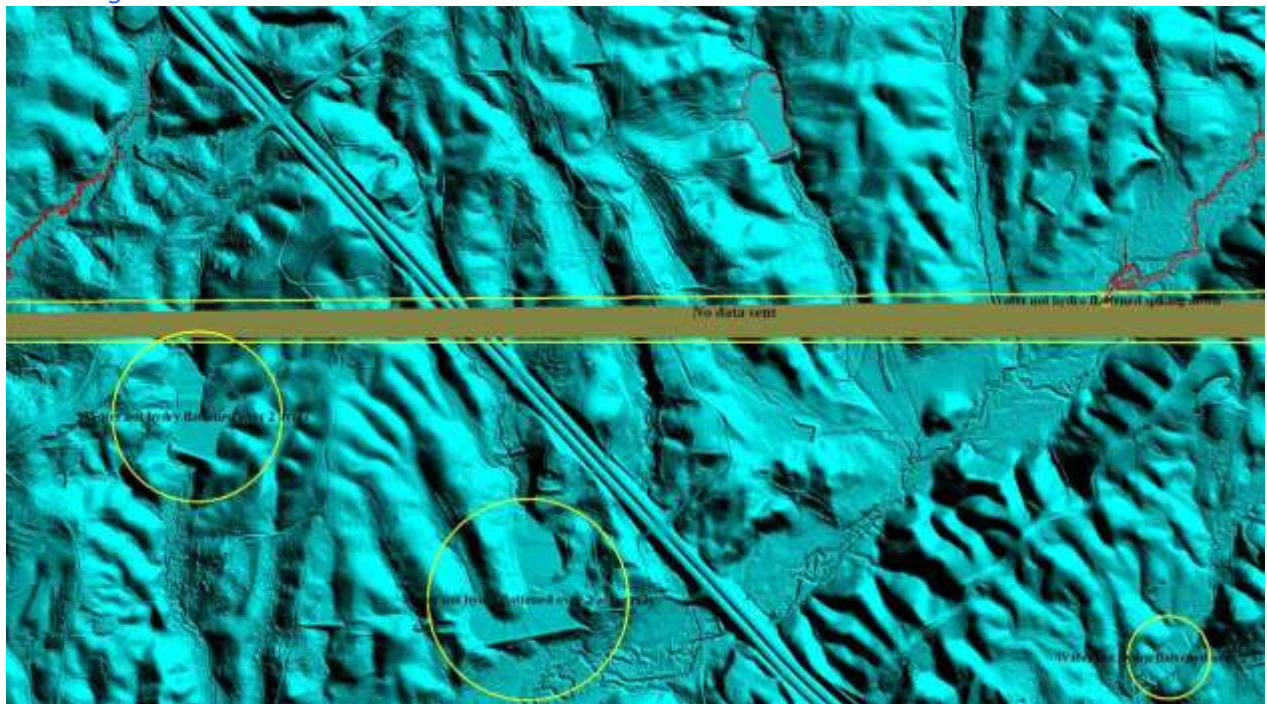
Missing data example (Fixed)

Image?



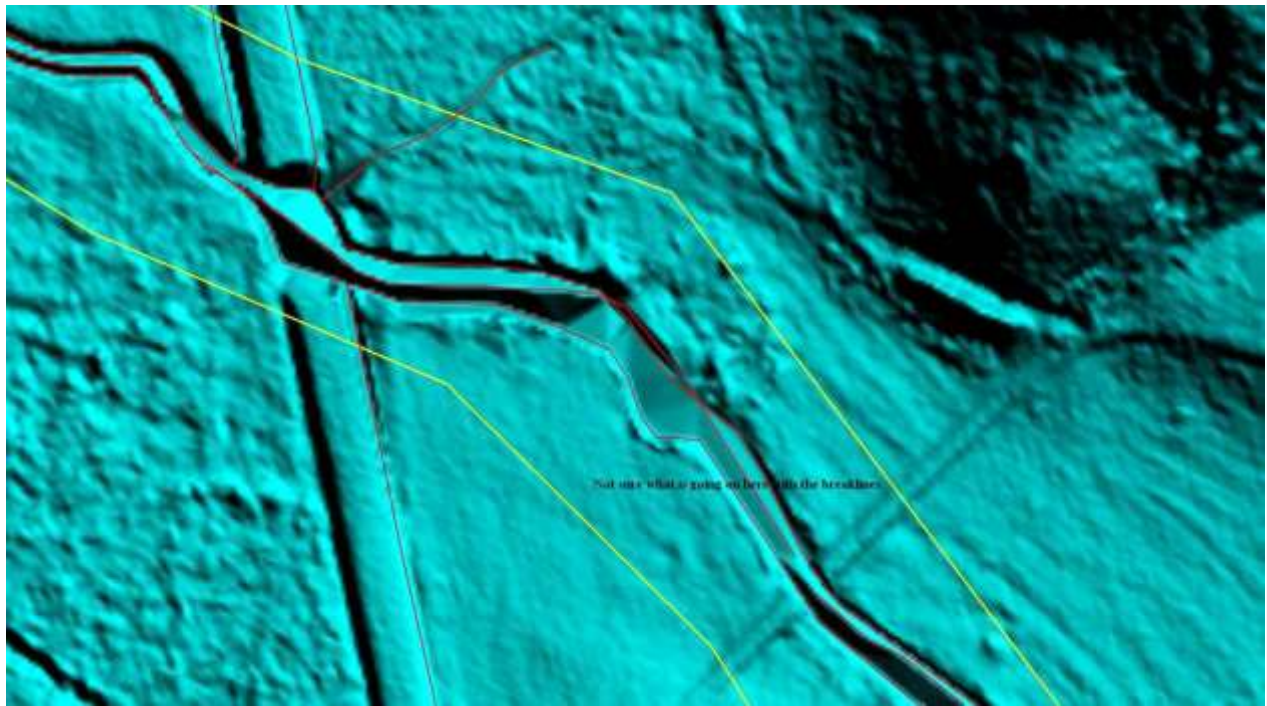
Missing data and seam lines example (Fixed)

Image?



No data sent example (Fixed)

Image?



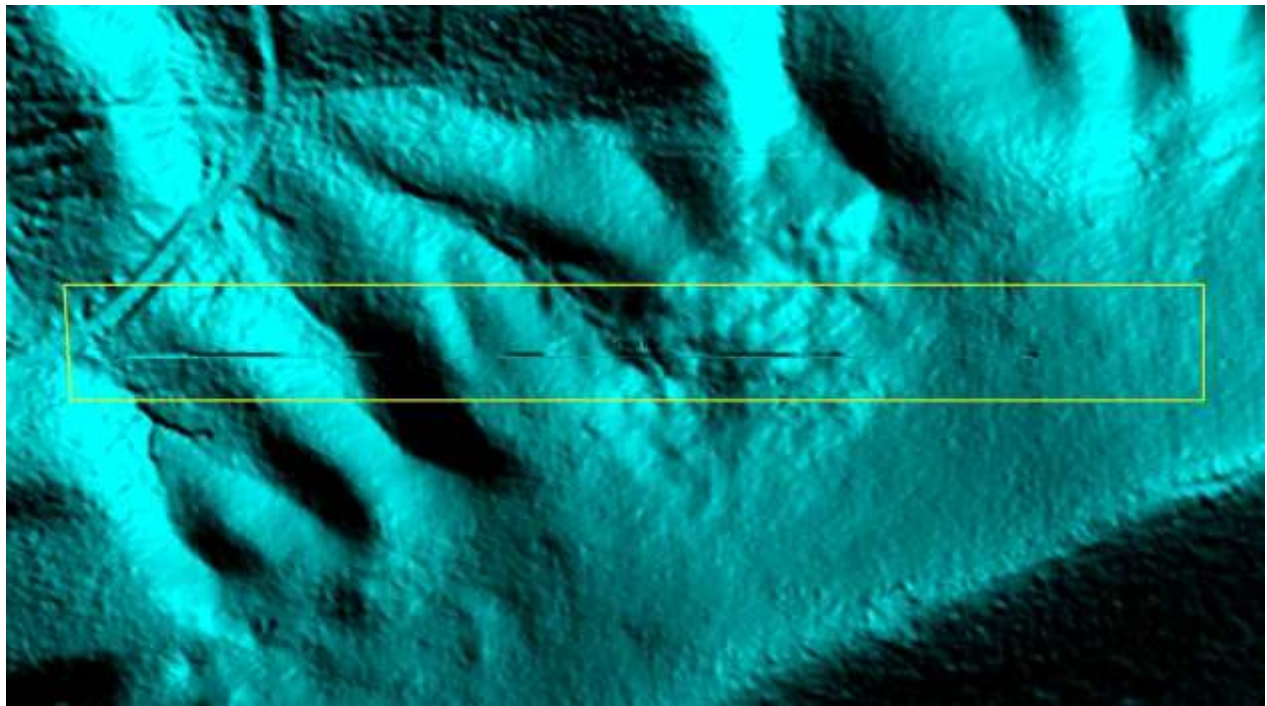
Not sure what is going on with these break lines example (Fixed)

Image?



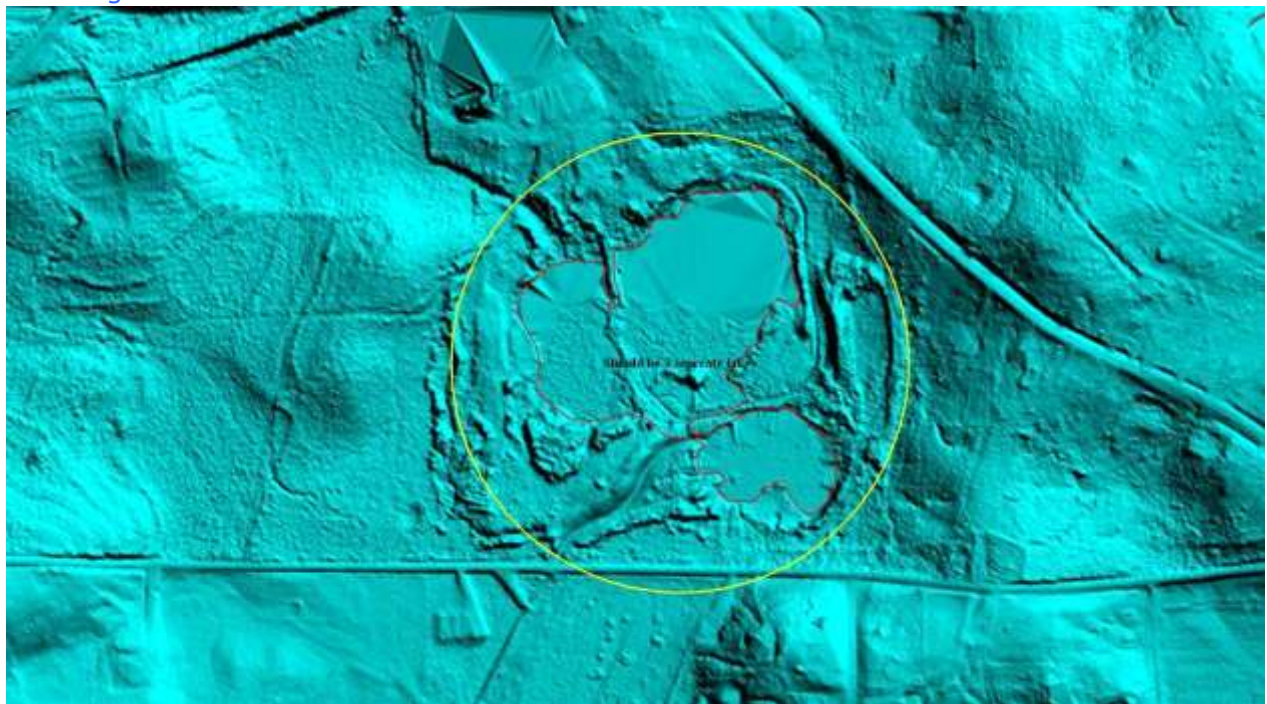
Remove bridges example (Fixed)

Image?



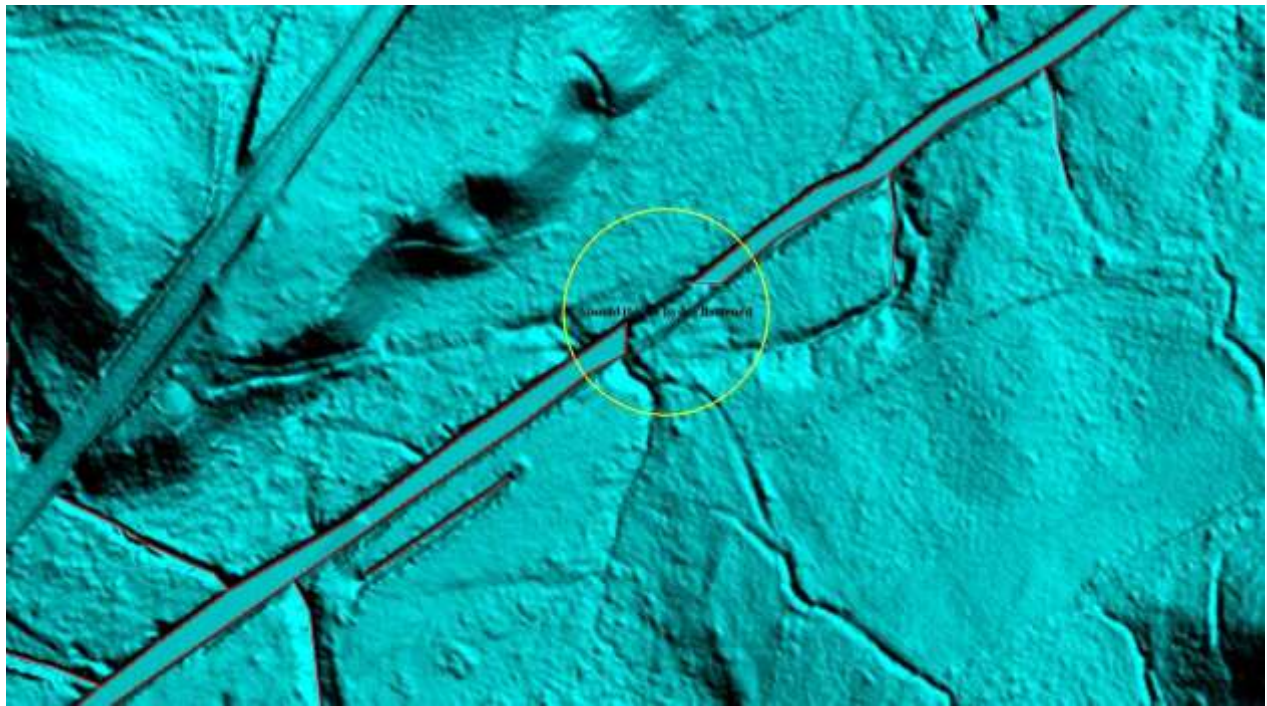
Seam line example (Fixed)

Image?



Should be 3 separate lakes, not hydro flattened, has 1 whole break line example (Fixed)

Image?



Should this be hydro flattened example (Fixed)

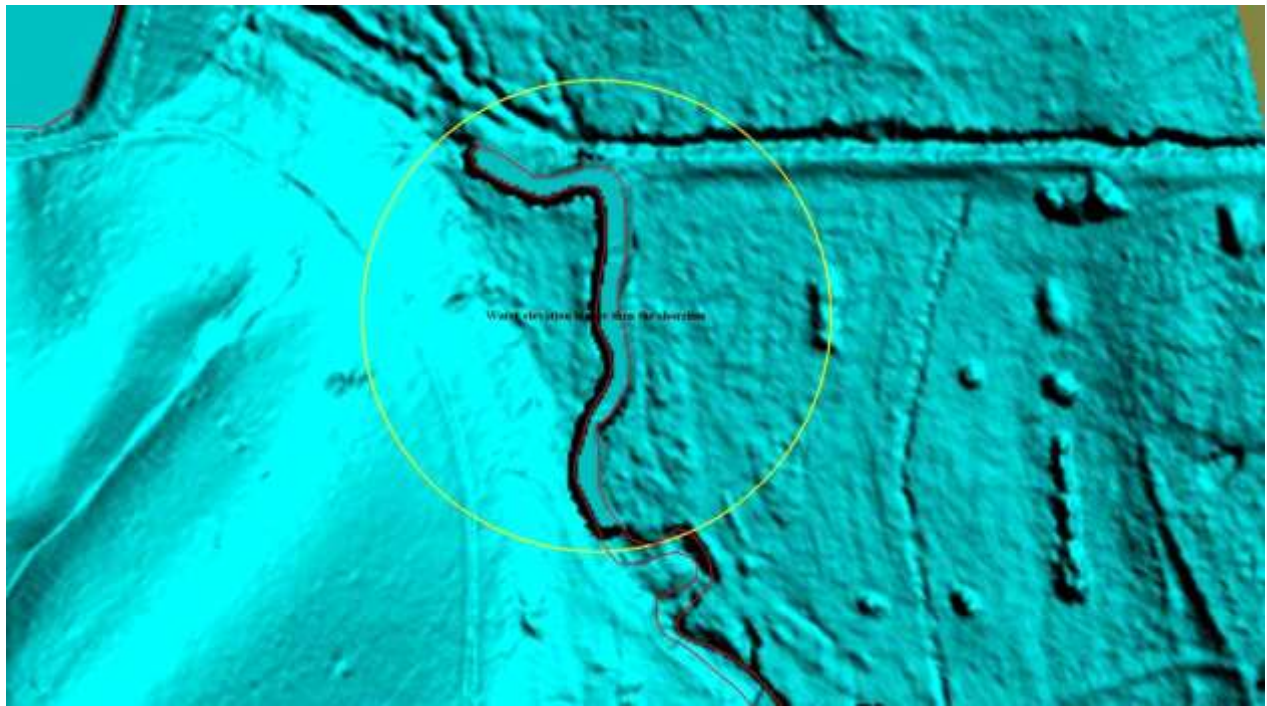
Image?



Should this be hydro flattened example (Fixed)

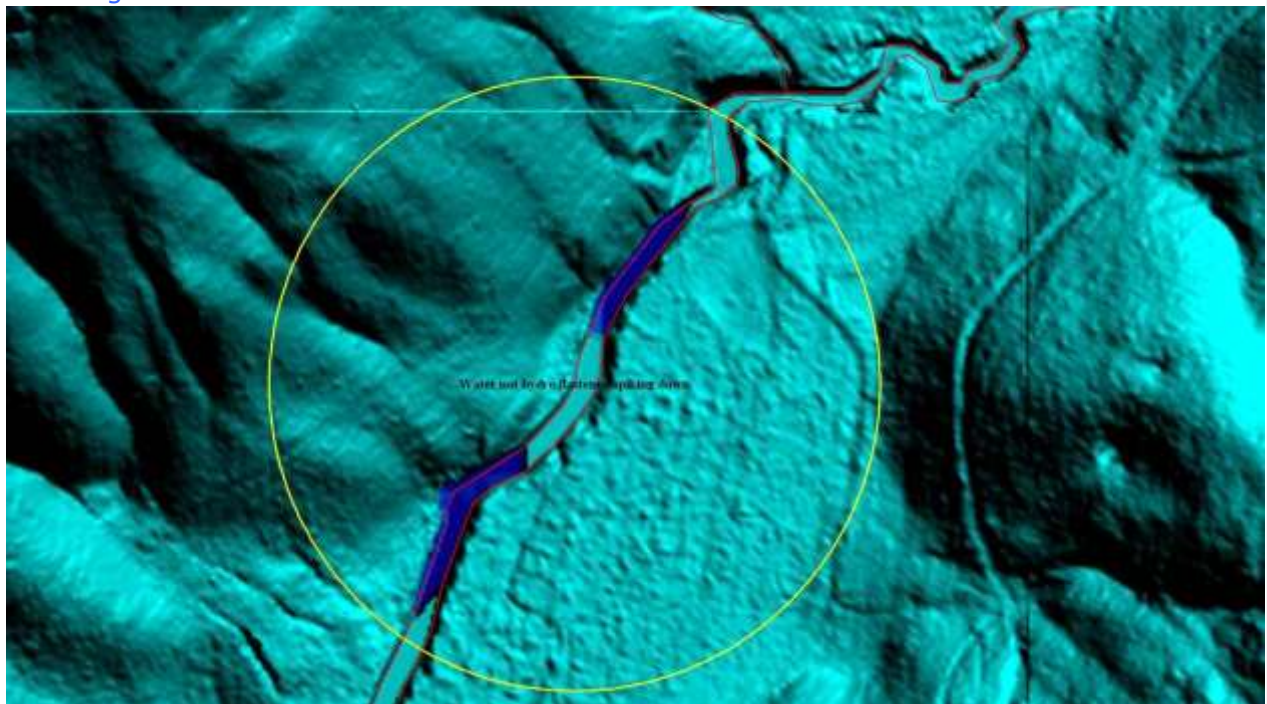
Image?





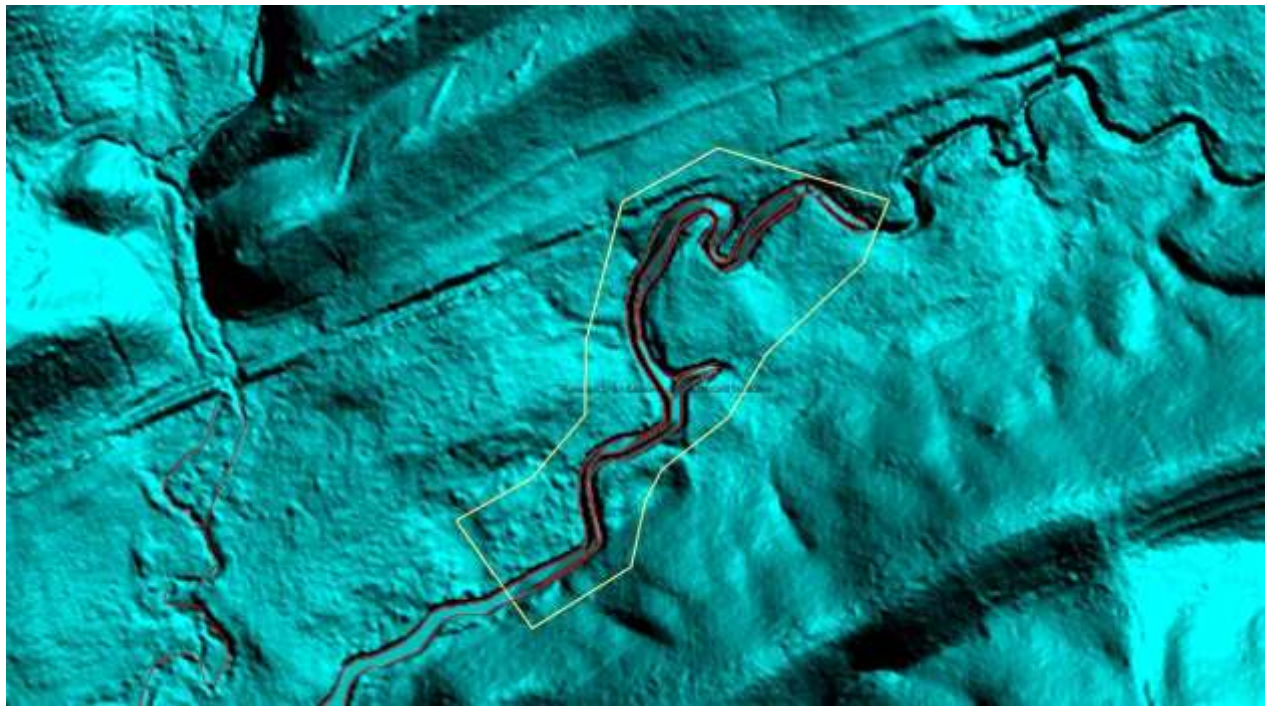
Water elevation higher than the shoreline example (Fixed)

Image?



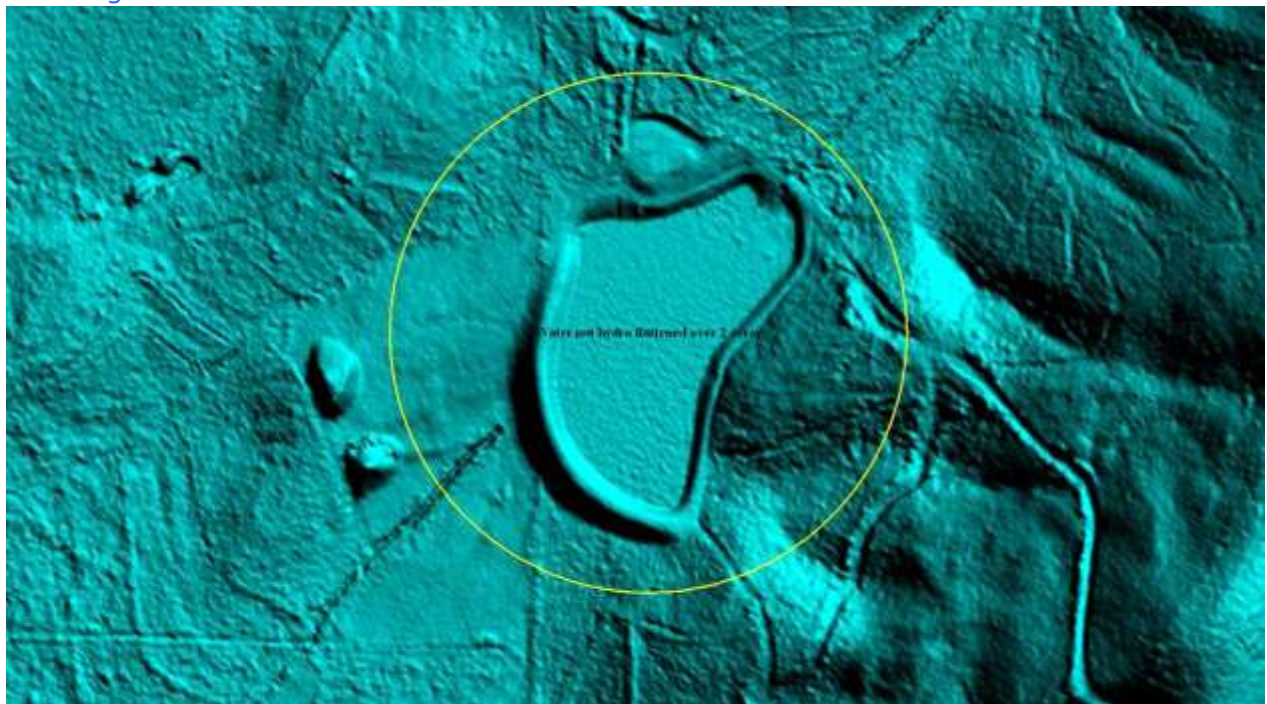
Water not hydro flattened and spiking down example (Fixed)

Image?



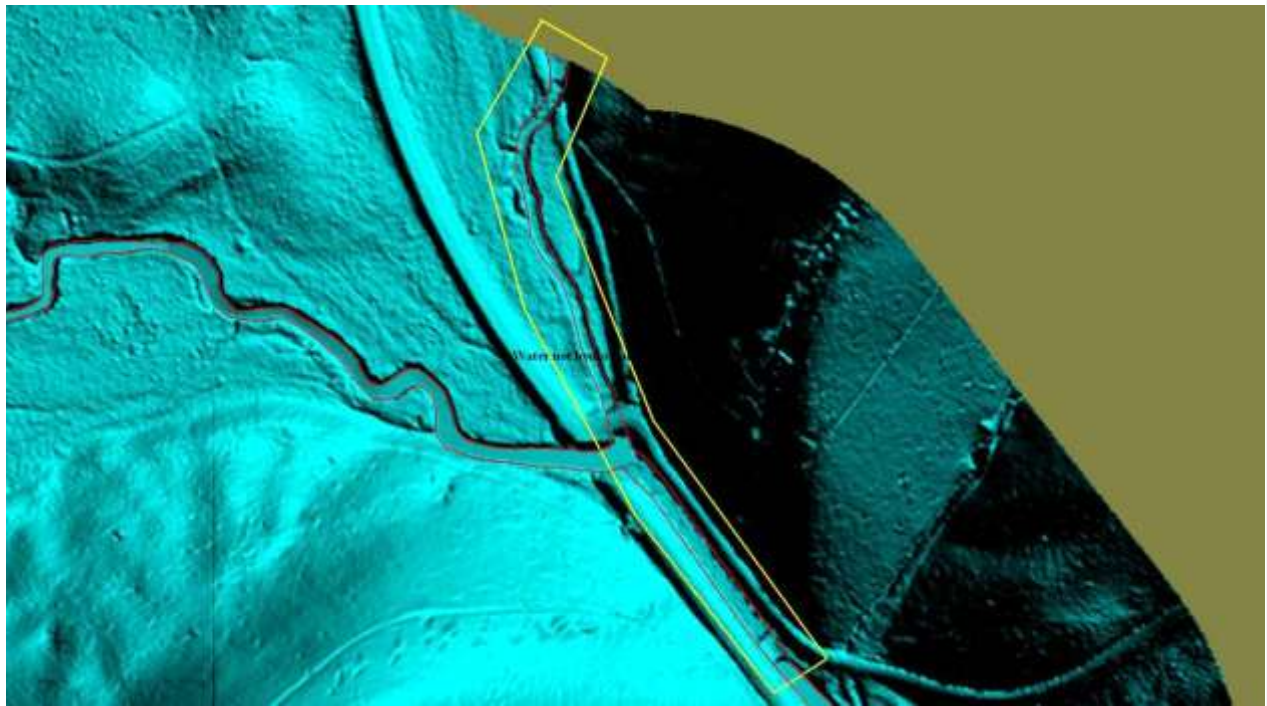
Water not hydro flattened don't understand break lines example (Fixed)

Image?



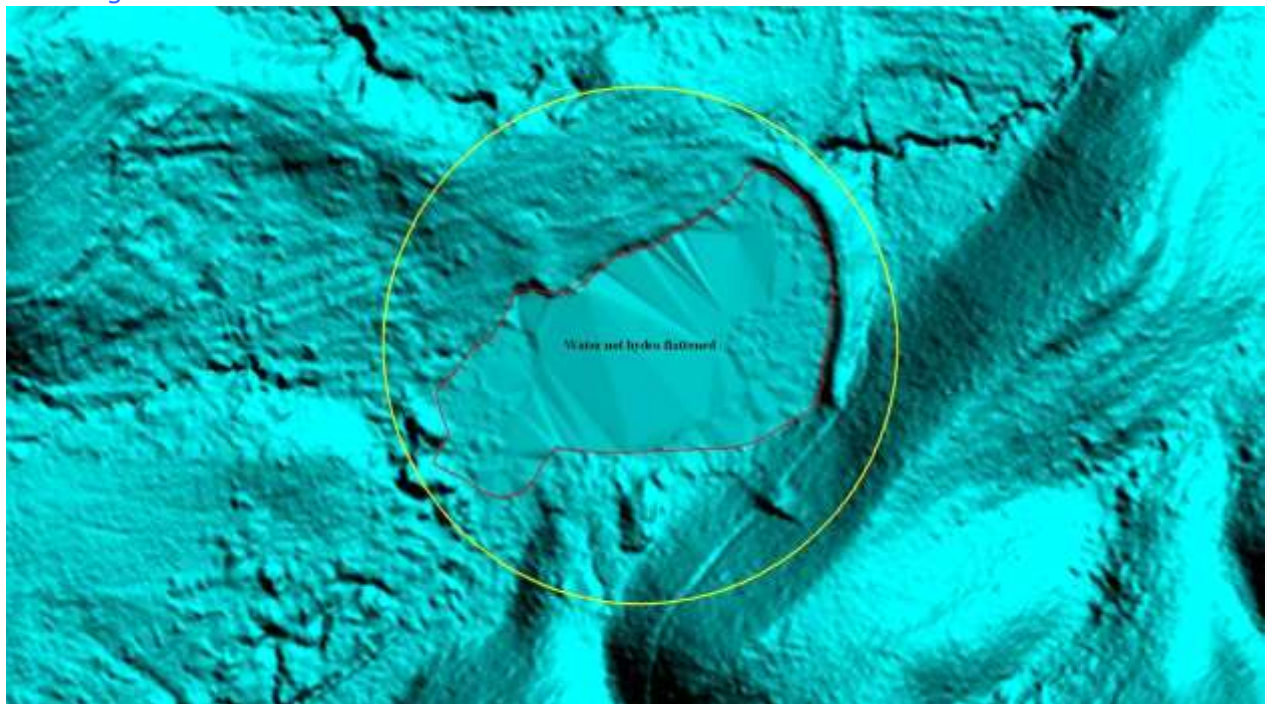
Water not hydro flattened over 2 acres example (Fixed)

Image?



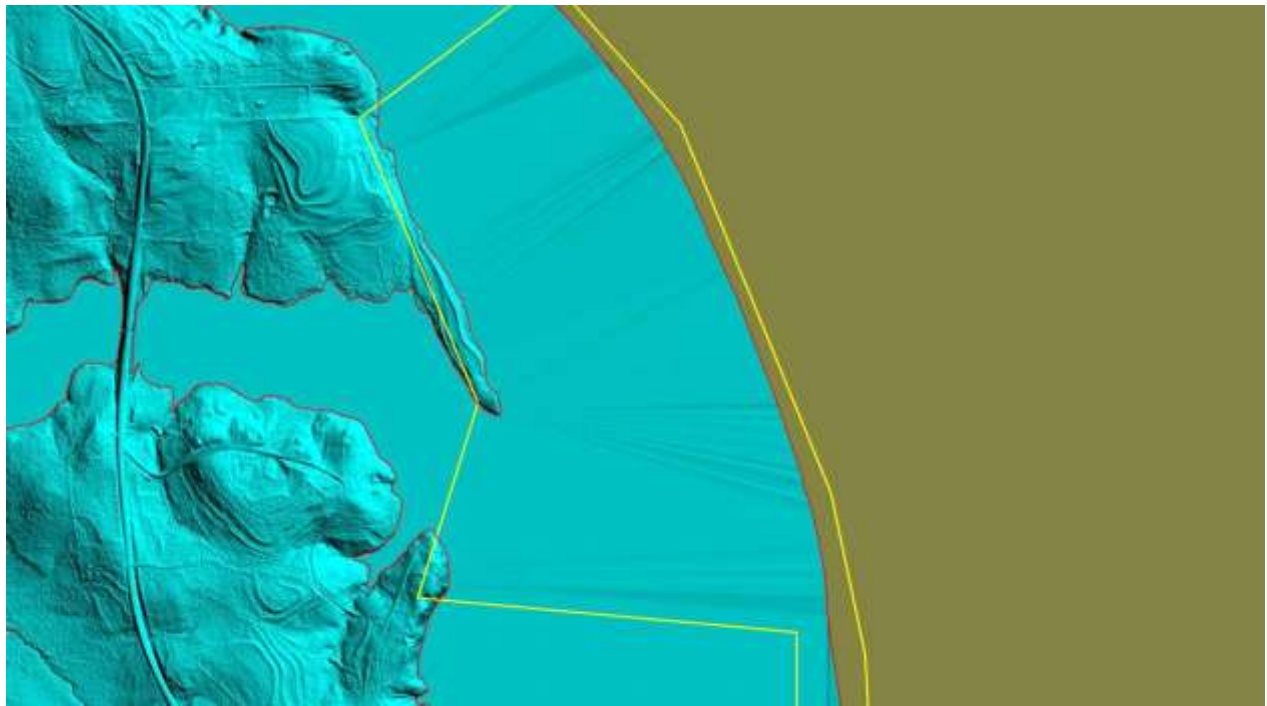
Water not hydro flattened example (Fixed)

Image?



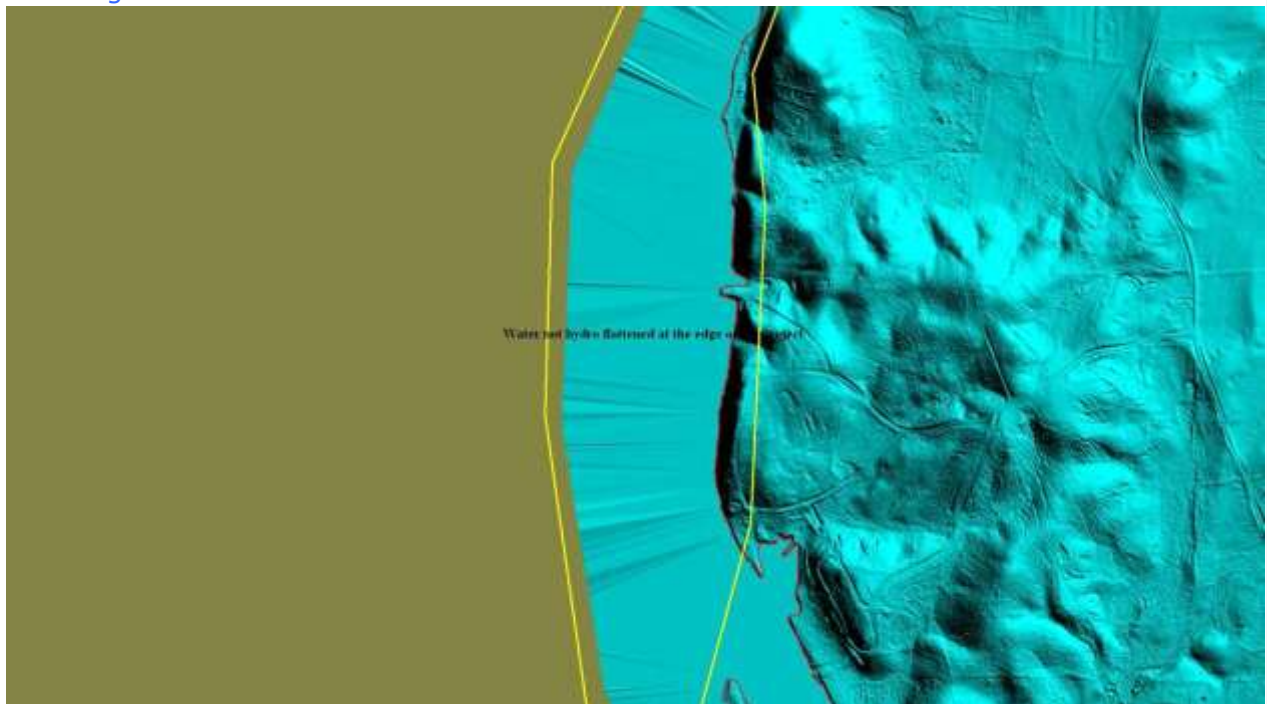
Water not hydro flattened has break line example (Fixed)

Image?



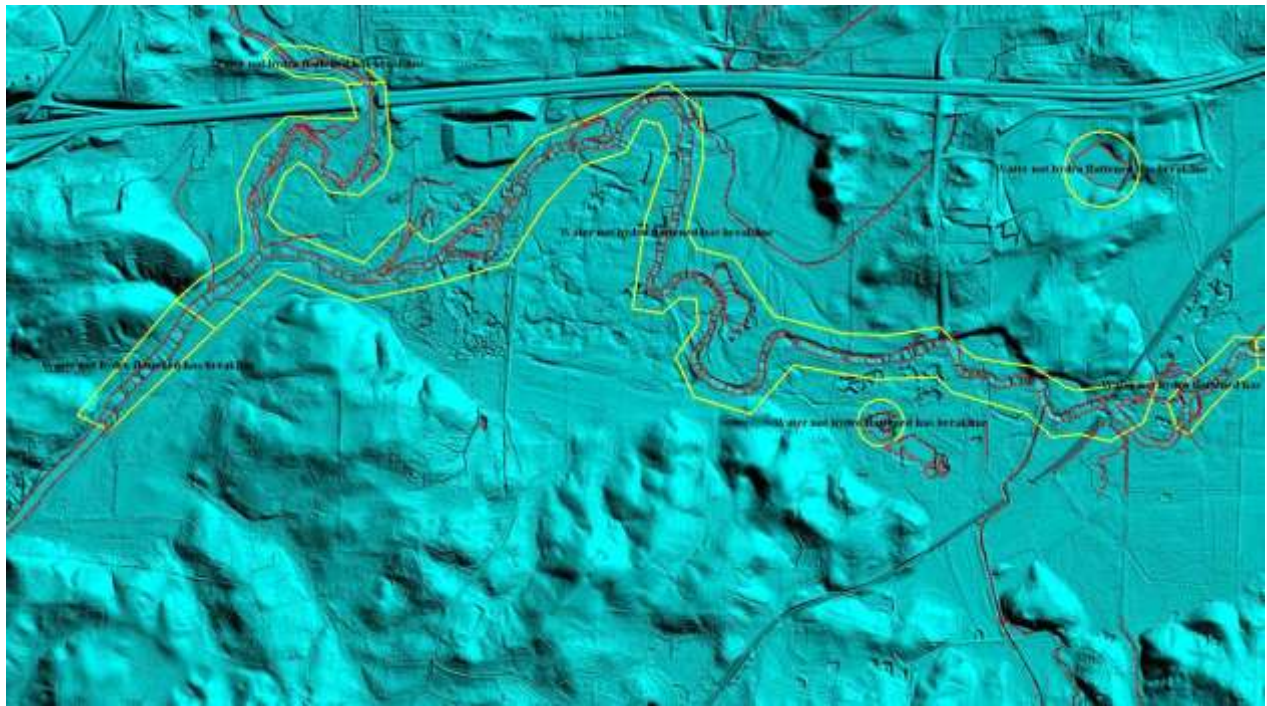
Water not hydro flattened has break line example (Fixed)

Image?



Water not hydro flattened has break line example (Fixed)

Image?



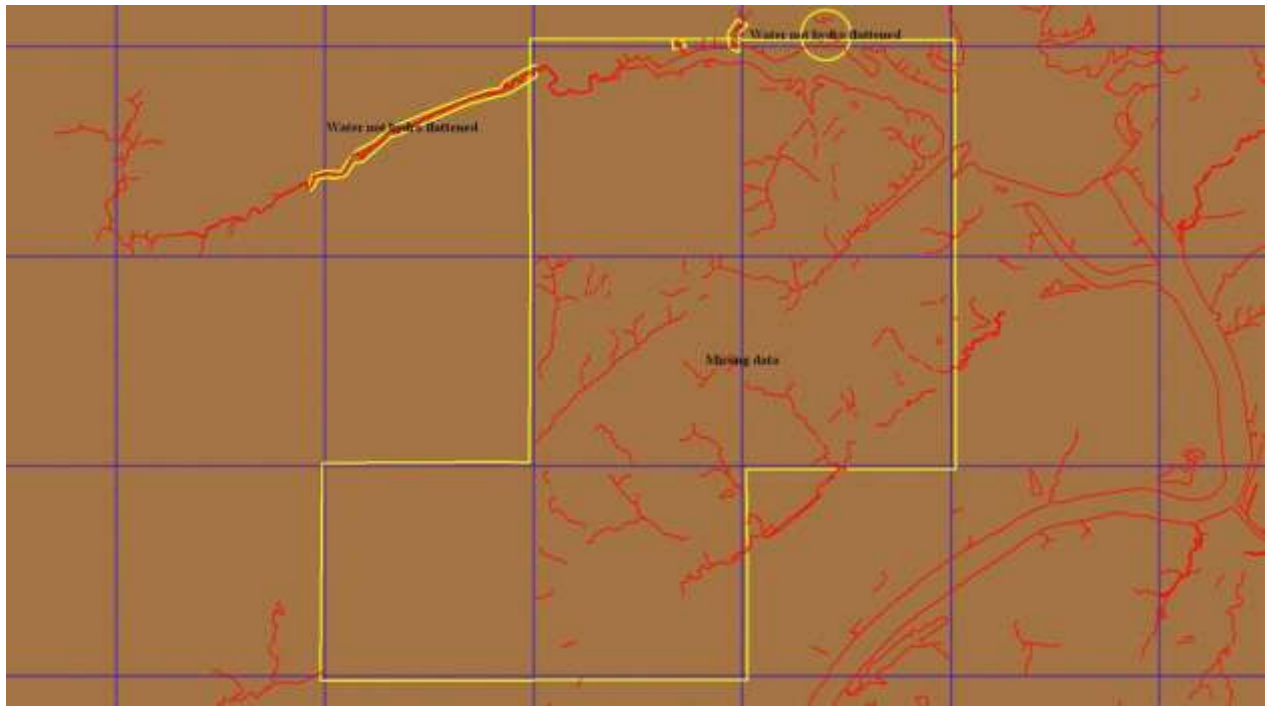
Water not hydro flattened has break line example (Fixed)

Image?



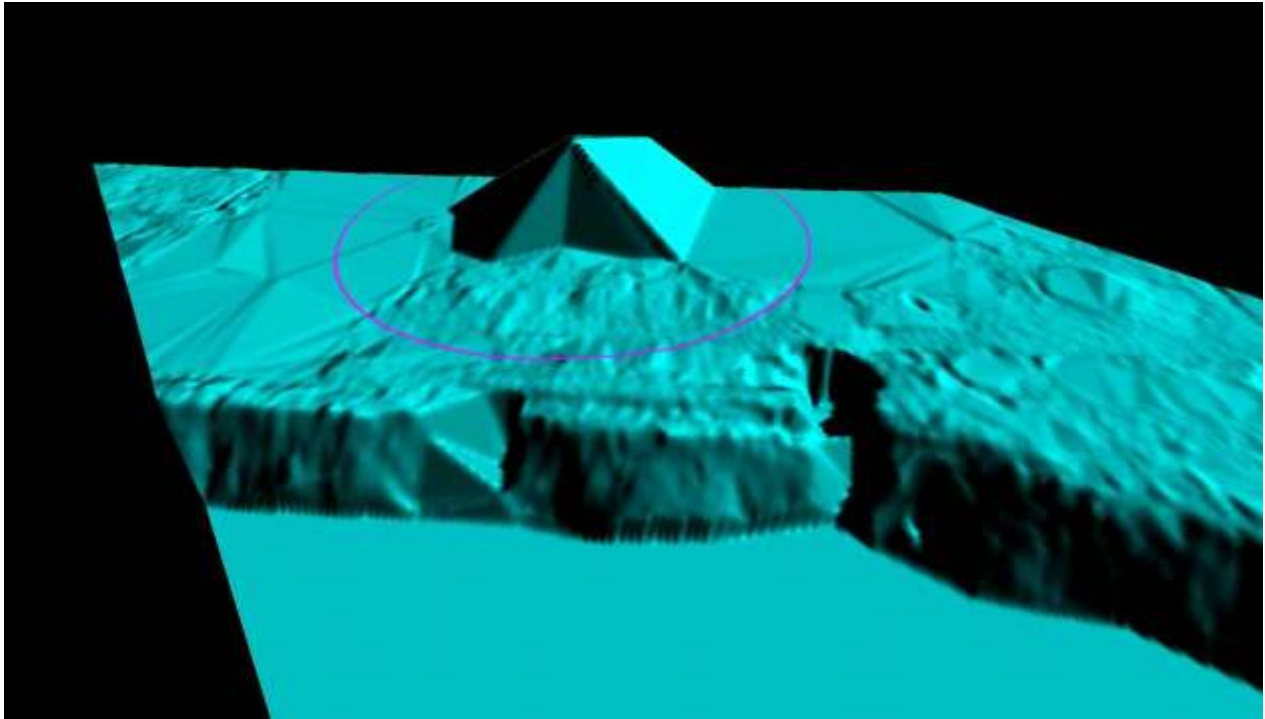
Water not hydro flattened has break line example (Fixed)

Image?



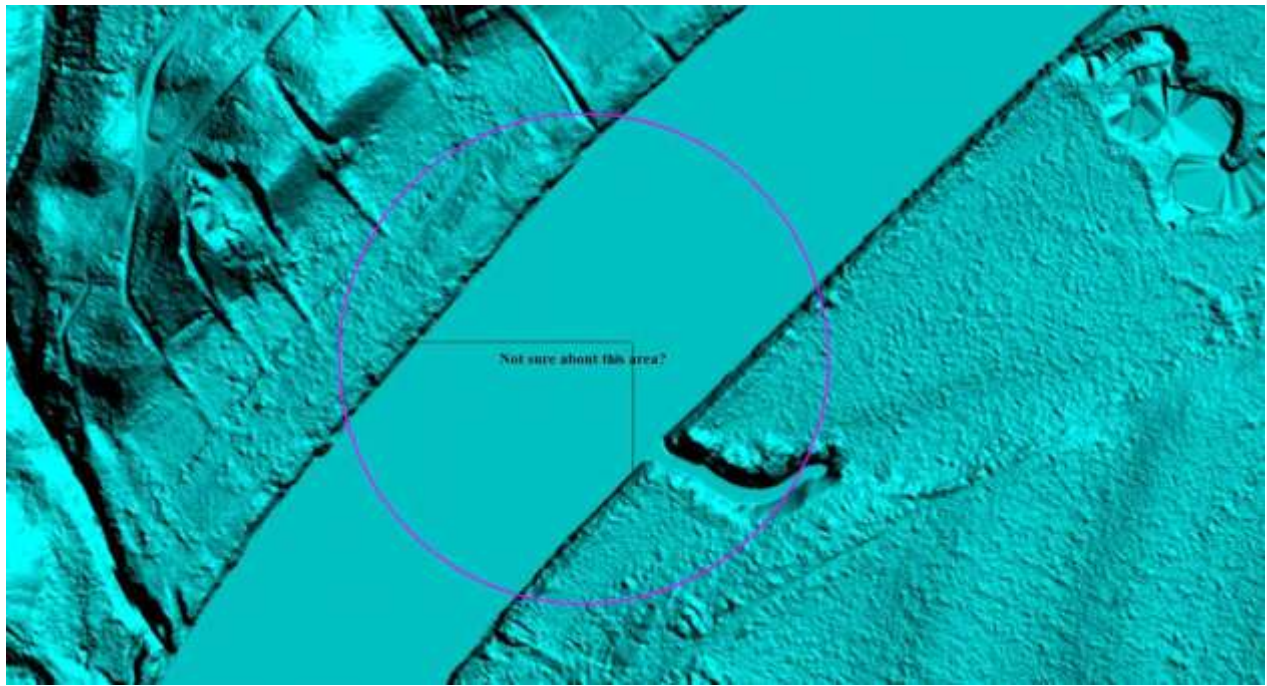
Missing data example (Fixed)

Image?



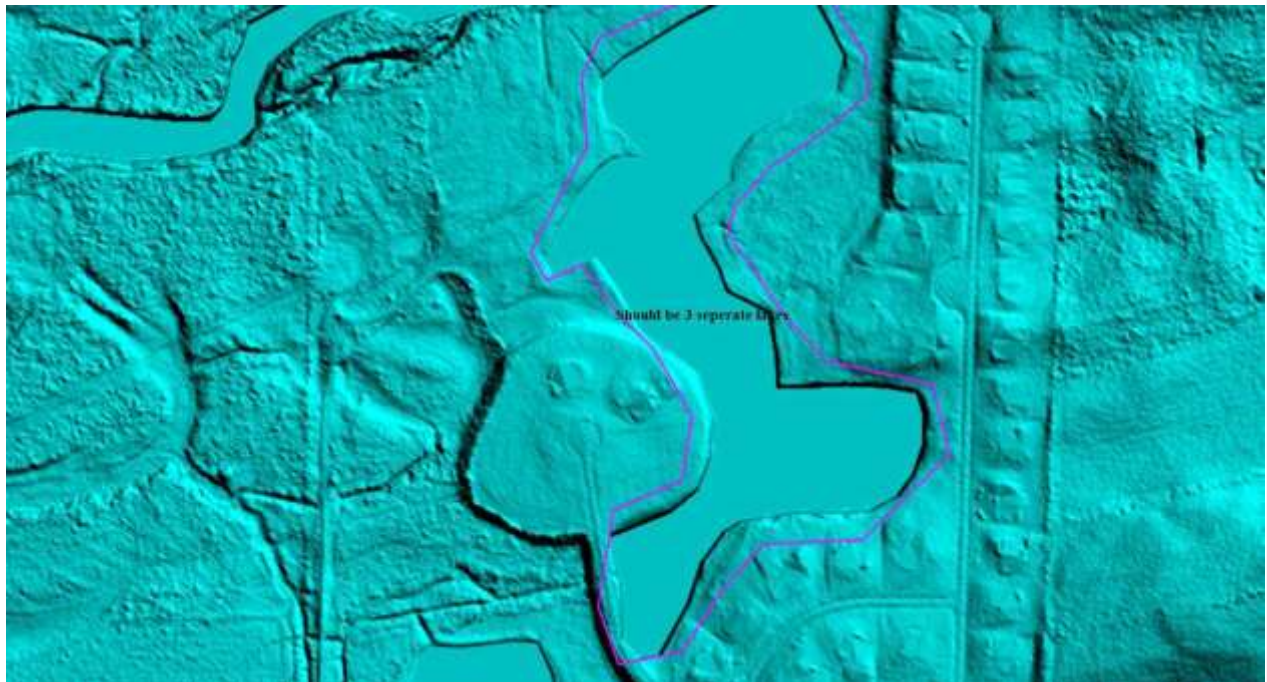
Bldg. not removed (Not fixed)

Image?



Not sure about this (Not fixed)

Image?



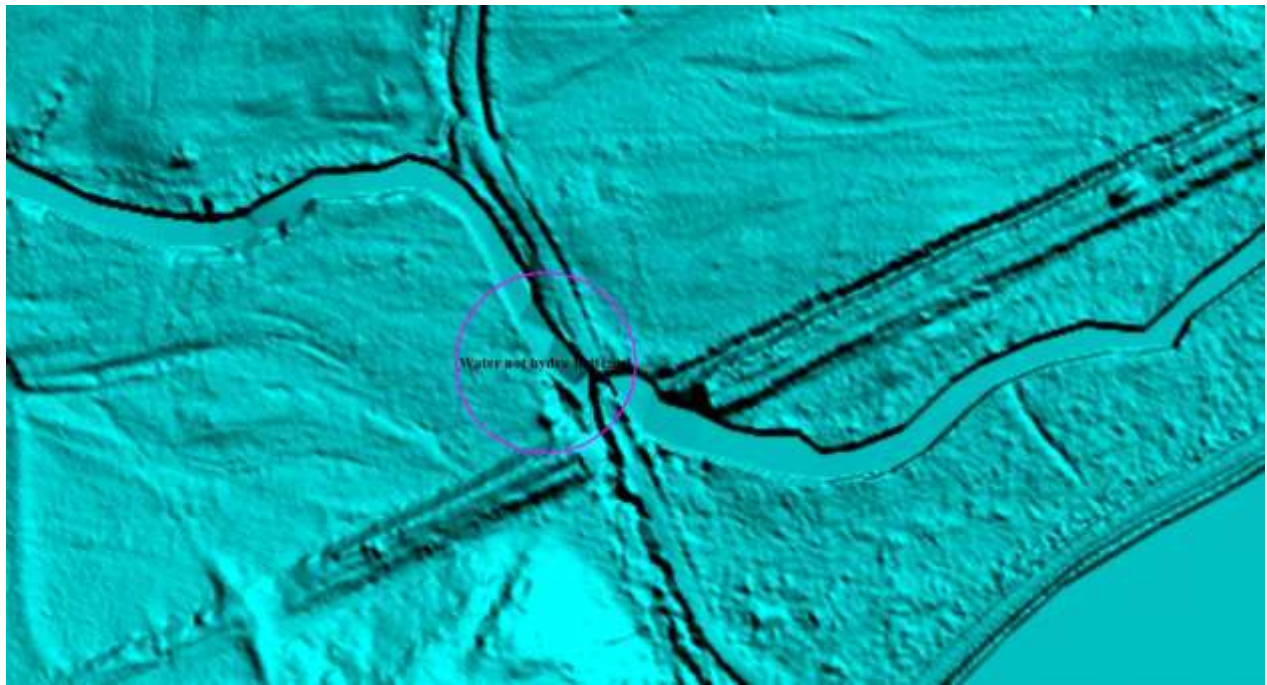
Should be 3 separate lakes (Not fixed)

Image?



Should be 3 separate lakes (Image) (Not fixed)

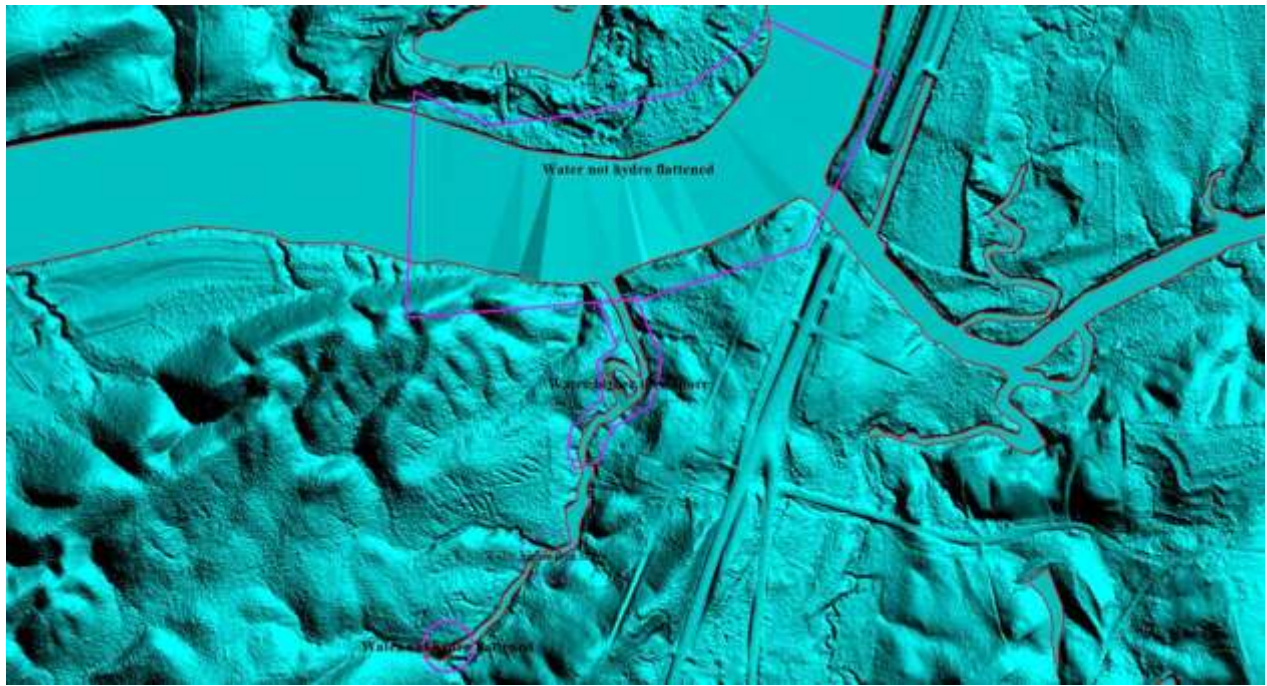
Image?



Water not hydro flattened (Not fixed)

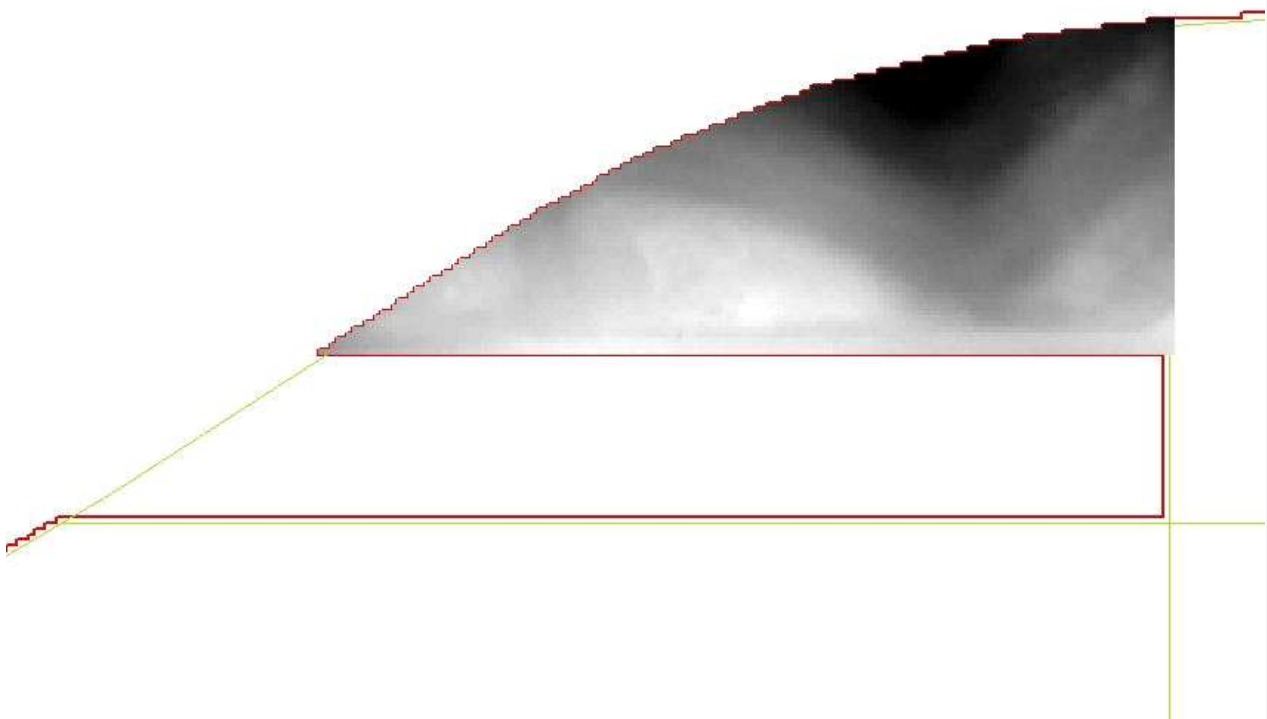
Image?





Water not hydro flattened (Not fixed)

Image?

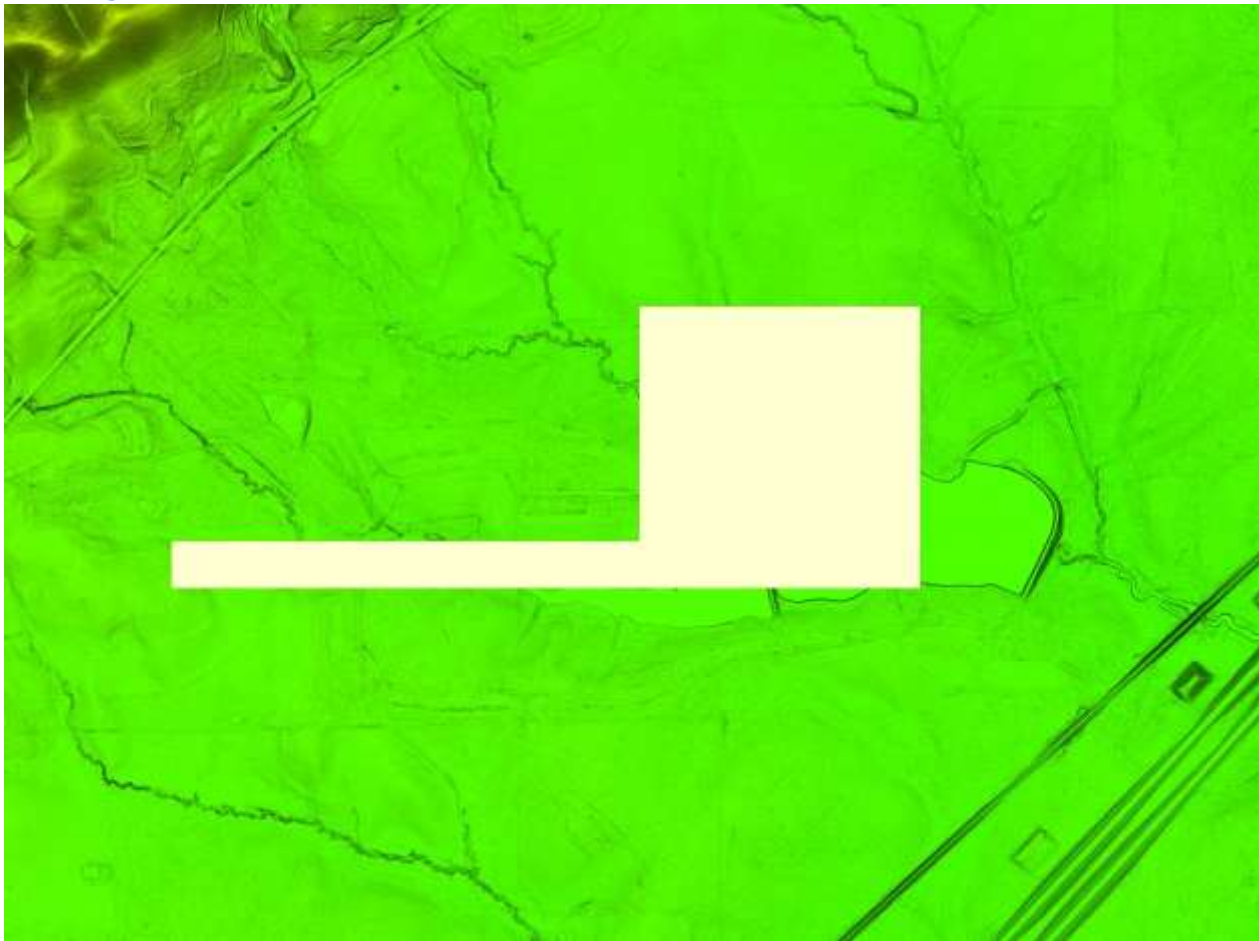


Several DEMs were corrupted; however, some of the data was usable for mosaicking in ArcMap for the final to NED project, the accompanying Final to NED Project Footprint in the NGTOC\_Created\_Metadata folder conforms to this mosaic. The following Tiles were not used in the mosaic at all:

6255\_37590, 5475\_36645, 5475-37425 (One of these tiles is shown above [it is missing data in the lower portion])

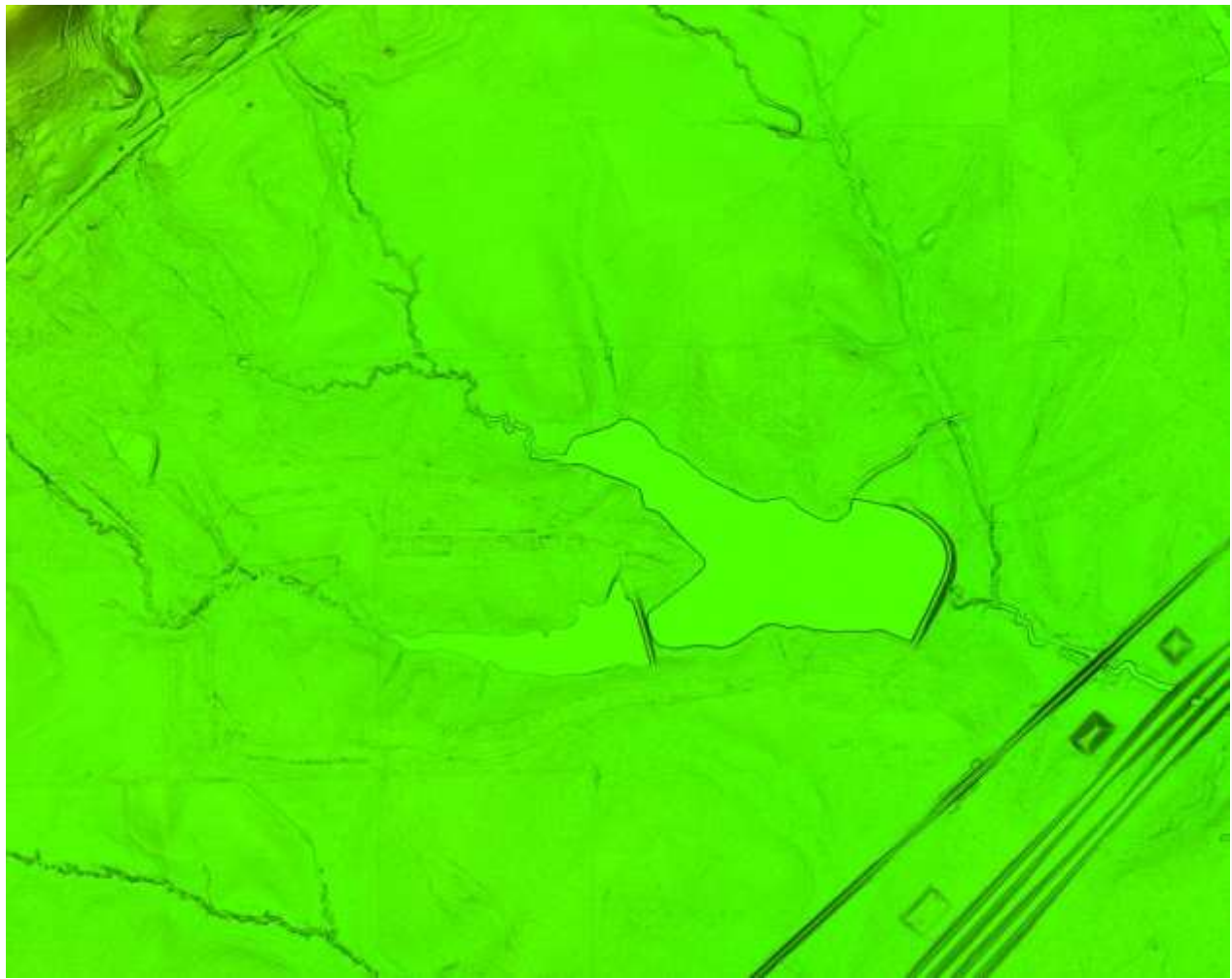
As these tiles all fell on the perimeter of the data they do not majorly impact the dataset. See the CorruptedDEMs.txt in the NGTOC\_Created\_Meatadata folder for more information.

Image?



(Pictured above), missing data from a tile. NGTOC was able to create a new tile (below) with the las and breaklines to repair the missing data, and used this in the Final to NED mosaic, the tile itself is available in the NGTOC\_Created\_Metadata Folder.

Image?



**This is the end of the report.**

QA Form V1.4 12OCT11.xsn