# 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 NGTOCoperations@usgs.gov.

Materials Received:
6/6/2012

Project ID:
SC_RichlandCo_2010

Project Alias(es):

Project Type: Partnership W/O Agreement

Project Description:
Richland County, South Carolina, Collection Dates: 03/23/2010 - 03/27/2010

Year of Collection: 2010

Lot 1 of 1 lots.

Project Extent:
☑ Project Extent image?

Legend

☐ DEM Extent Boundary

☐ Richland County Boundary
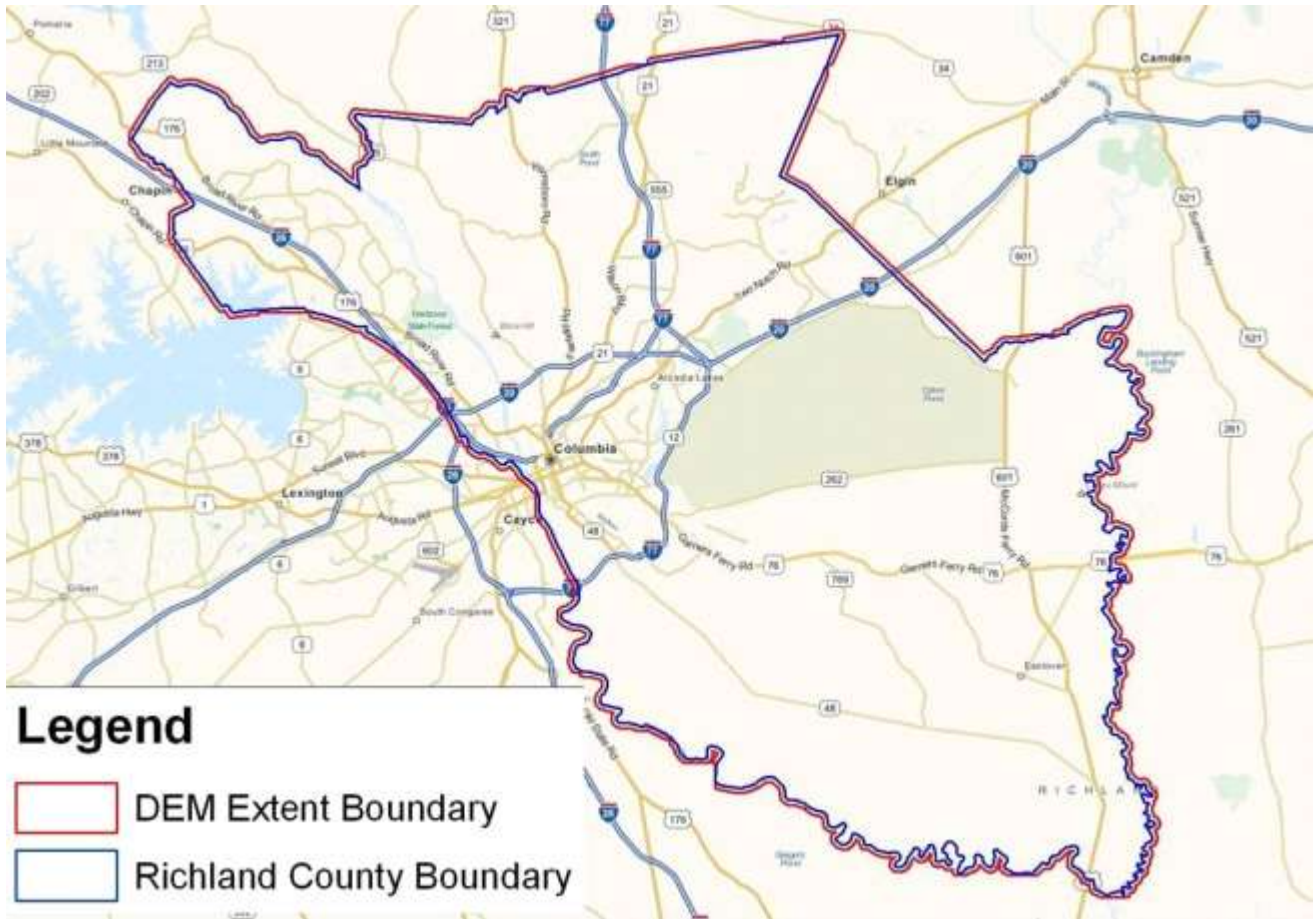
Project Tiling Scheme:
☑ Project Tiling Scheme image?

Legend

☐ Project Tiling Scheme

☐ Richland County Boundary
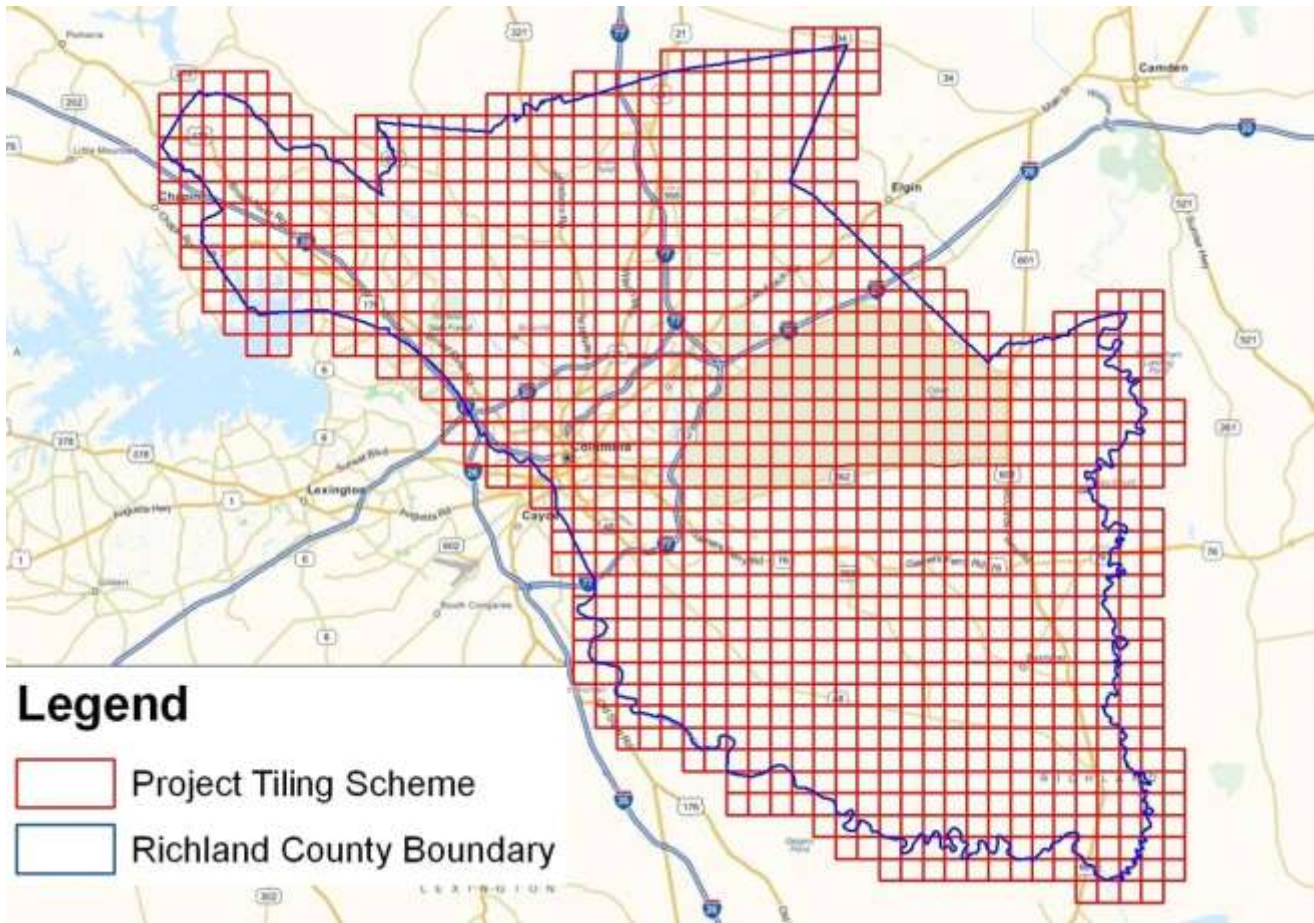
Contractor:

Sanborn

Applicable Specification:

V13

Licensing Restrictions:

None.

☑ Third Party Performed QA?

Third Party QA Performed By:

Dewberry

Project Points of Contact:

POC Name	Type	Primary Phone	E-Mail
Gary Merrill	USGS Geospatial Liai...	803-750-6124	glmerrill@usgs.gov

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.

☑ Collection Report ☑ Project Shapefile/Geodatabase
☐ Survey Report ☑ Project Tiling Scheme Shapefile/Gdb
☑ Processing Report ☐ Control Point Shapefile/Gdb
☑ QA/QC Report ☐ Breakline Shapefile/Gdb
☐ Control and Calibration Points ☐ Project XML Metadata

Multi-File Deliverables

File Type	Quantity
☐ Swath LAS Files ☐ Required? ☐ XML Metadata?	
☑ Intensity Image Files ☑ Required?	972
☑ Tiled LAS Files ☐ Required? ☑ XML Metadata?	1072
☐ Breakline Files ☐ Required? ☐ XML Metadata?	
☑ Bare-Earth DEM Files ☑ Required? ☑ XML Metadata?	1

Additional Deliverables

Errors, Anomalies, Other Issues to document? ⦿ Yes ○ No

No Survey Report, control and calibration points, or Control Point Shapefile/Gdb were received. A third party QA was performed by Dewberry using checkpoints collected by South Carolina Geodetic Survey, and their report was provided. No Breakline Shapefile/Gdb was provided; however, a folder entitled "Hydro" contains hydrographic feature shapefiles that appear to correspond to hydro-flattened areas of the DEM. Similar feature classes are present in a geodatabase entitled "Richland_Terrain", but again, since there is no breakline metadata, it is unclear if the features contained within them were used for purposes of deriving the submitted DEM. Additionally, no specific Project XML Metadata or Swath LAS files/Swath XML Metadata were provided.

Project Geographic Information

Areal Extent: 809 Sq Mi

Grid Size: 10 Int'l Feet

Tile Size: 5000 int'l feet

Nominal Pulse Spacing: 1.4 meters

Vertical Datum: NAVD88 U.S. feet

Horizontal Datum: NAD83_HARN int'l feet

Project Projection/Coordinate Reference System:

NAD_1983_HARN_StatePlane_South_Carolina_FIPS_3900 international feet.

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

- ☑ Project Shapefile/Geodatabase
- ☑ Project Tiling Scheme Shapefile/Gdb
- ☐ Checkpoints Shapefile/Geodatabase
- ☐ Project XML Metadata File
- ☐ Swath LAS XML Metadata File
- ☑ Classified LAS XML Metadata File

- ☐ Breaklines XML Metadata File
- ☑ Bare-Earth DEM XML Metadata File
- ☐ Swath LAS Files
- ☑ Classified LAS Files
- ☐ Breaklines Files
- ☑ Bare-Earth DEM Files

Check Point Shapefile/Geodatabase CRS

None Provided.

Project XML Metadata CRS

None Provided.

Swath LAS XML Metadata CRS

None Provided.

Breakline XML Metadata CRS

None Provided.

Swath LAS Files CRS

None Provided.

Breakline Files CRS

None Provided.

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.

Reviewer:

A. Lowe

Review Start Date:

6/7/2012

Action to Contractor Date	Issue Description	Return Date

Review Complete: 6/11/2012

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 <u>with</u>errors.

> None Provided.

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

The Bare-Earth DEM XML Metadata file parsed <u>without</u>errors.

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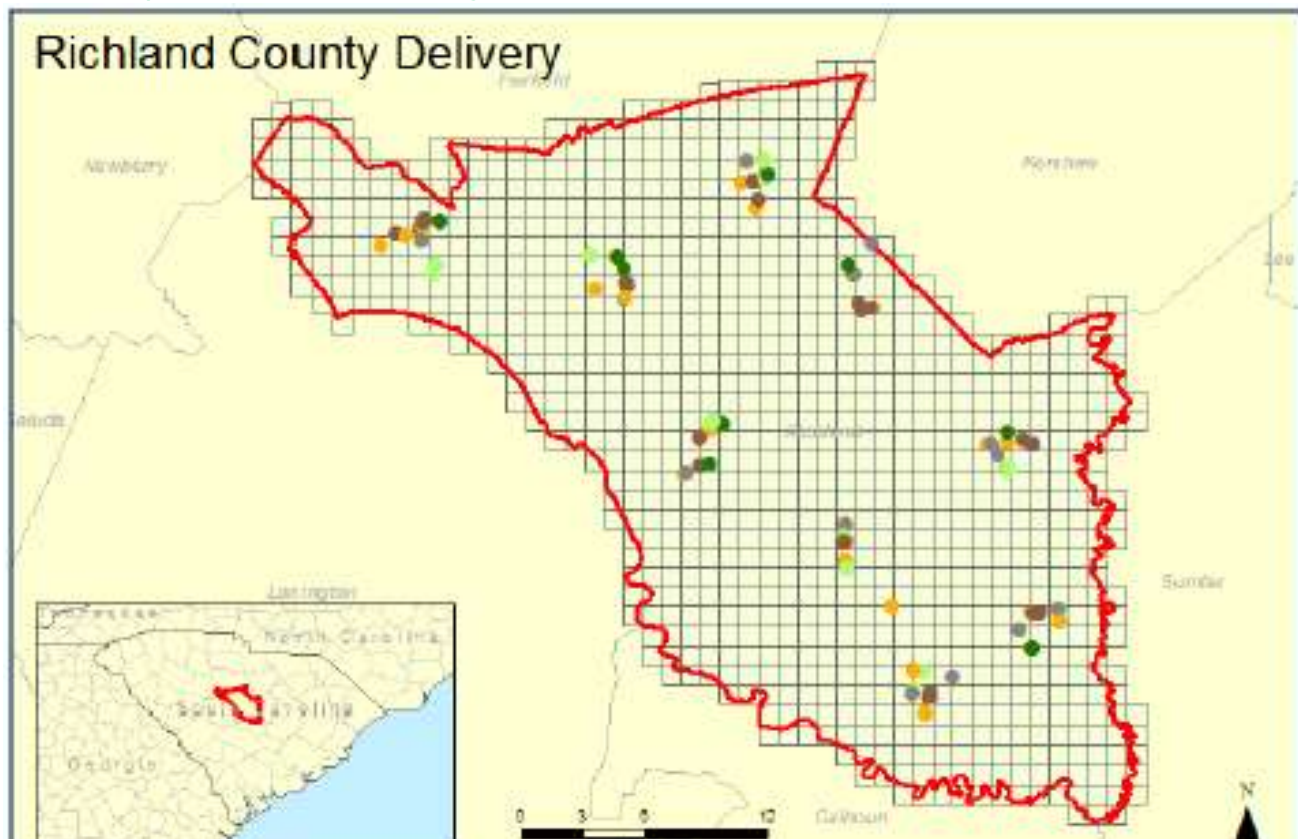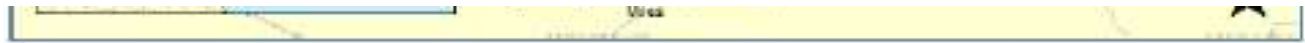
The following land cover classes are represented in this dataset (uncheck any that do not apply):

☑ 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 not able 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?

Land Cover Category	# of Points
Consolidated	133
Open Terrain	38
High Grass	20
Brush	17
Forest	31
Urban	27

There were only 17 points provided for the "Brush" land cover category.

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: U.S. feet

Required FVA Value is 0.804 U.S. feet or less.
Target SVA Value is 1.19 U.S. feet or less.
Required CVA Value is 1.19 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 0.77 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		1.00	U.S. feet
Brush Lands and Low Trees		0.00	U.S. feet
Forested Areas Fully Covered by Trees		0.92	U.S. feet
Urban Areas with Dense Man-Made Structur...		0.71	U.S. feet

The reported CVA of this data set is: 0.95 U.S. feet.

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: ArcGrid

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 U.S. feet.

Reported Accuracies

Land Cover Category	# of Points	Fundamental Vertical Accuracy @95% Confidence Interval (Accuracy$_z$) Required FVA = 0.804 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	38	0.77		
Tall Weeds and Crops	20		1.00	

Brush Lands and Low Trees	17		0.00	
Forested Areas Fully Covered by Trees	31		0.92	
Urban Areas with Dense Man-Made Structures	27		0.71	
Consolidated	133			0.95

☐ QA performed Accuracy Calculations?

Based on this review, the USGS does not recommend the bare-earth DEM files for inclusion in the 1/3 Arc-Second National Elevation Dataset.
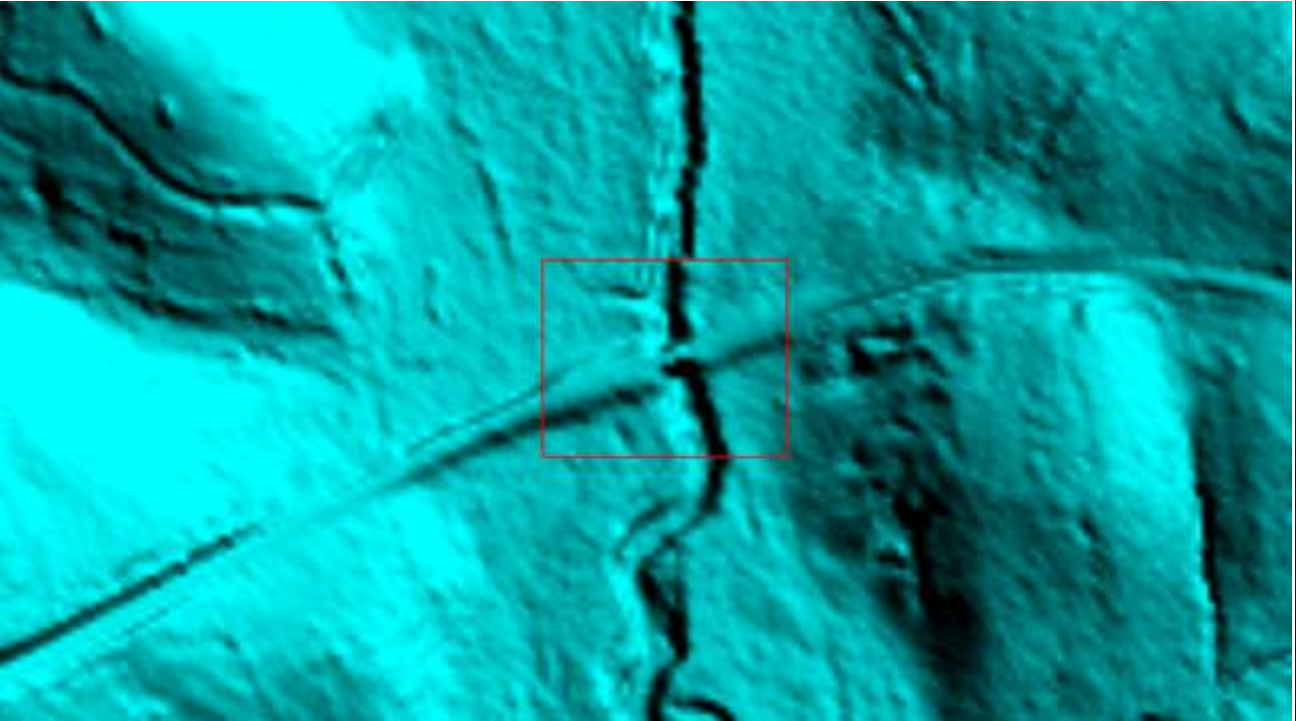
Based on this review, the USGS does not accept at this time the bare-earth DEM files.

Bare-Earth DEM Anomalies, Errors, Other Issues

Errors, Anomalies, Other Issues to document? ⦿ Yes ○ No

☑ Image?

There are two bridges that were not removed from the Bare-Earth DEM. (Bridge_Removal_01)
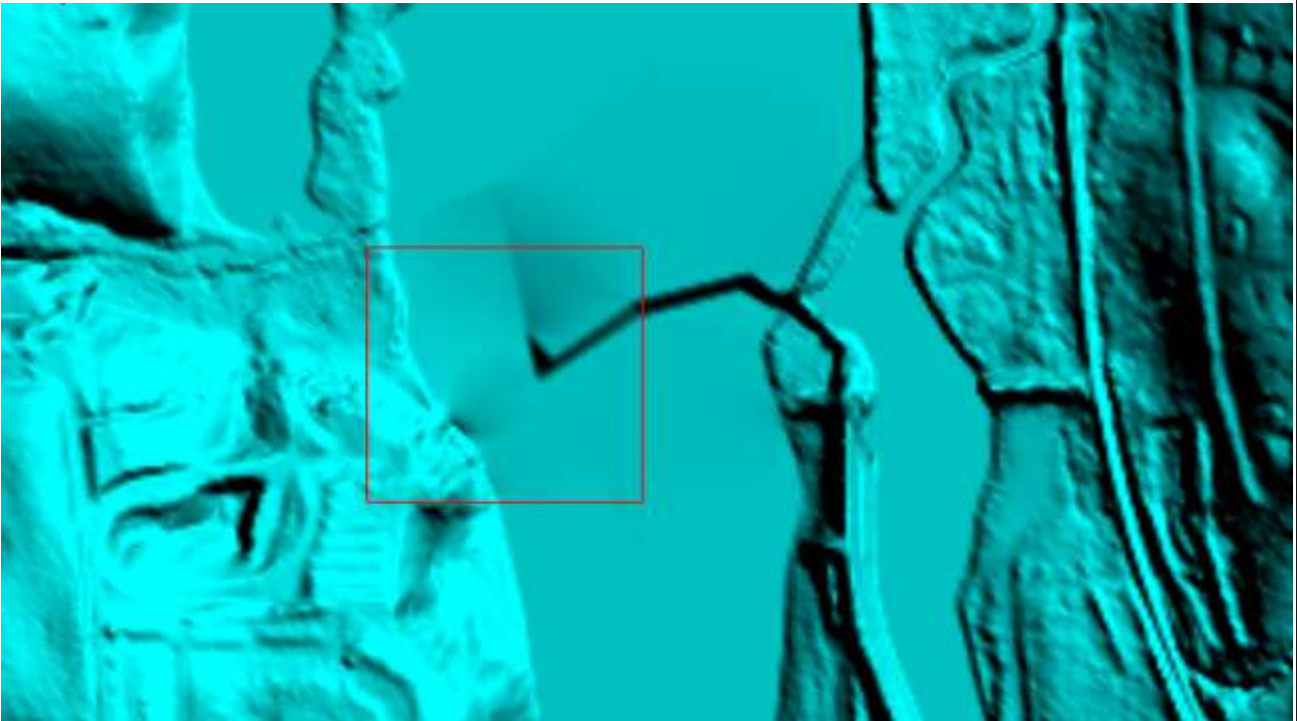

☑ Image?
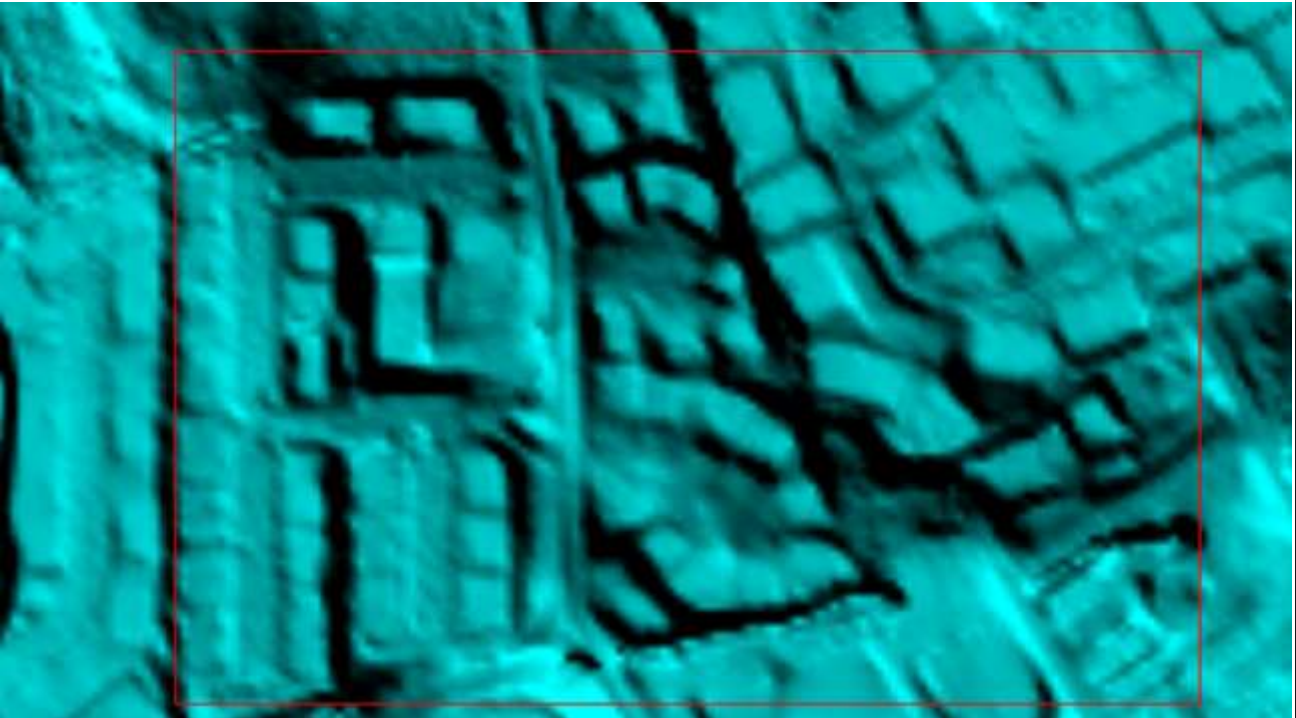
There are at least 9 areas where buildings were insufficiently removed from the Bare-Earth DEM. (Building_Removal_01)
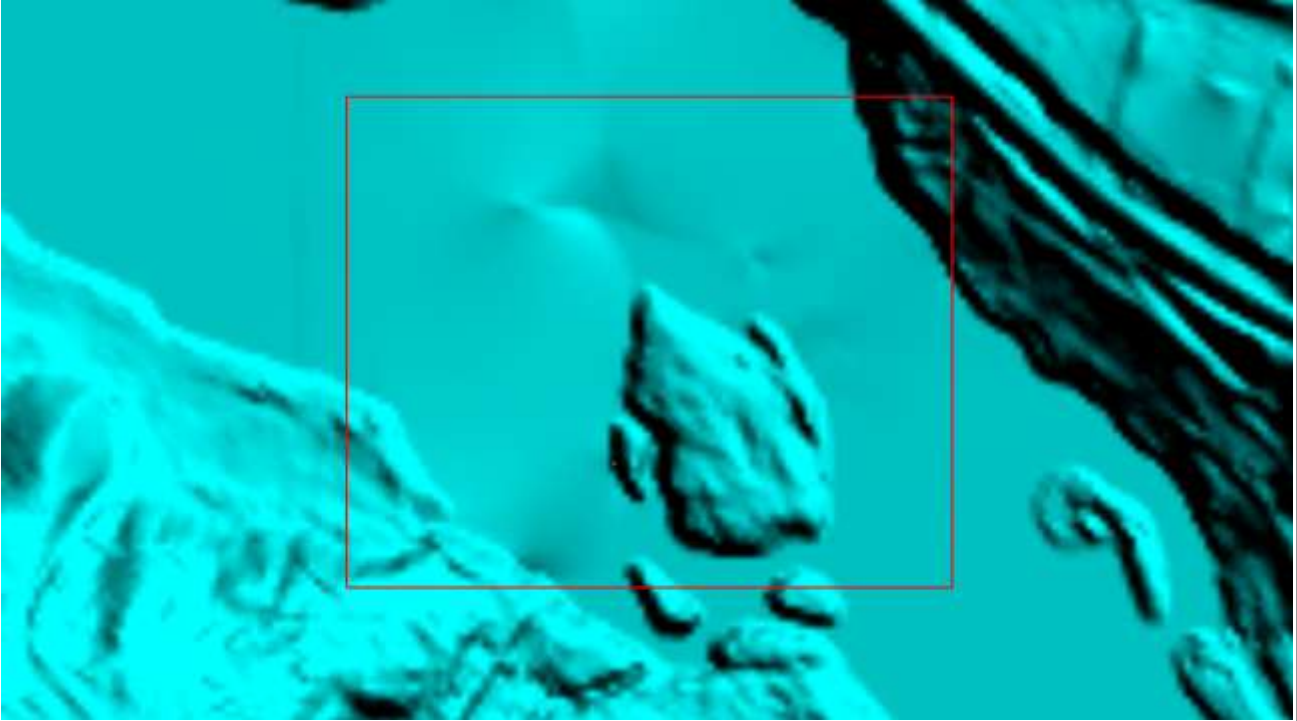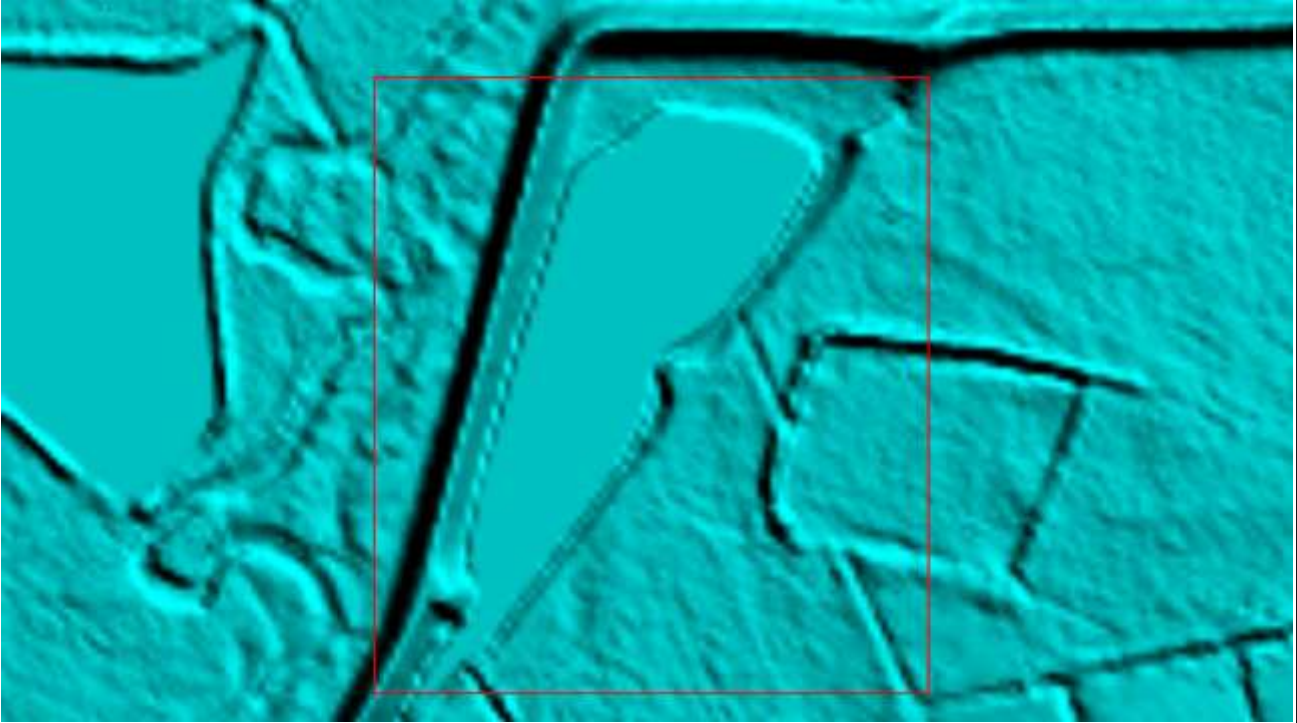
☑ Image?
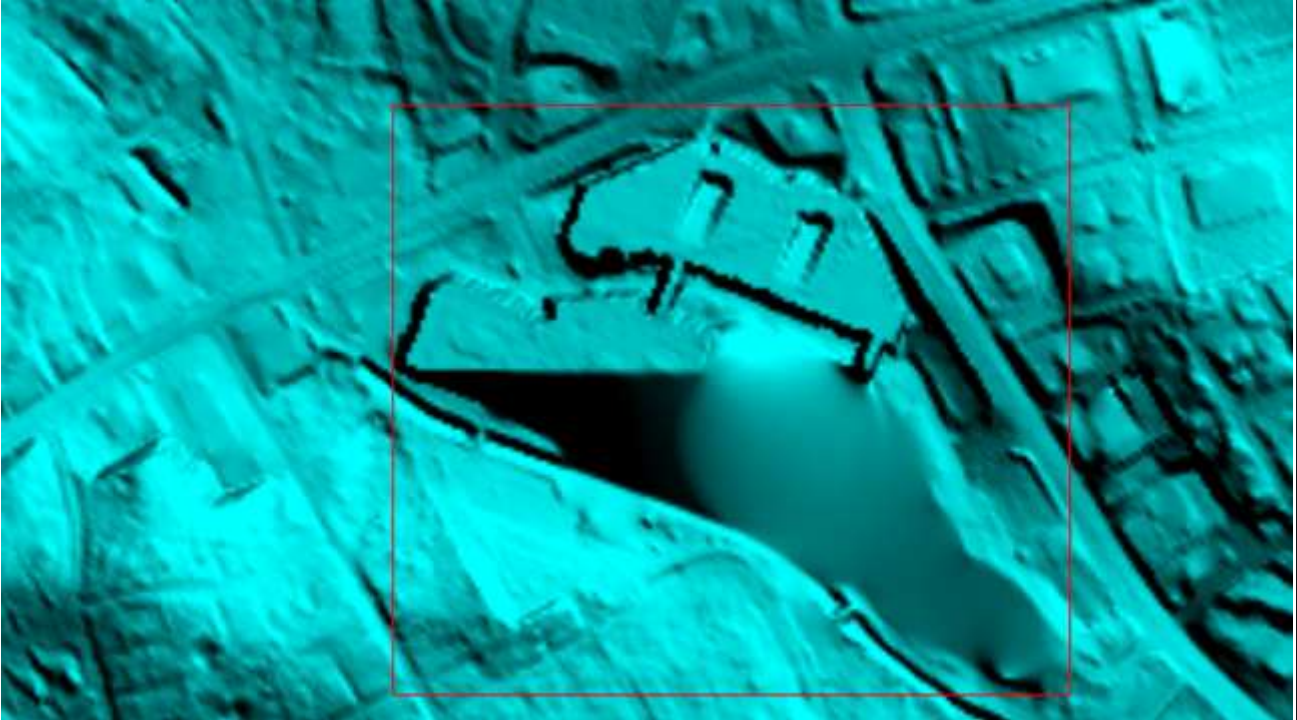
(Building_Removal_06)

☑ Image?

Part of a dam was removed improperly when the river was hydro-flattened. There is no indication that the dam was removed in reality. (Dam_Removal_01)

☑ Image?

Hydro-flattening of the river is not flat in some areas, mostly surrounding large boulders or islands in the stream. (Lumpy_Water_01)
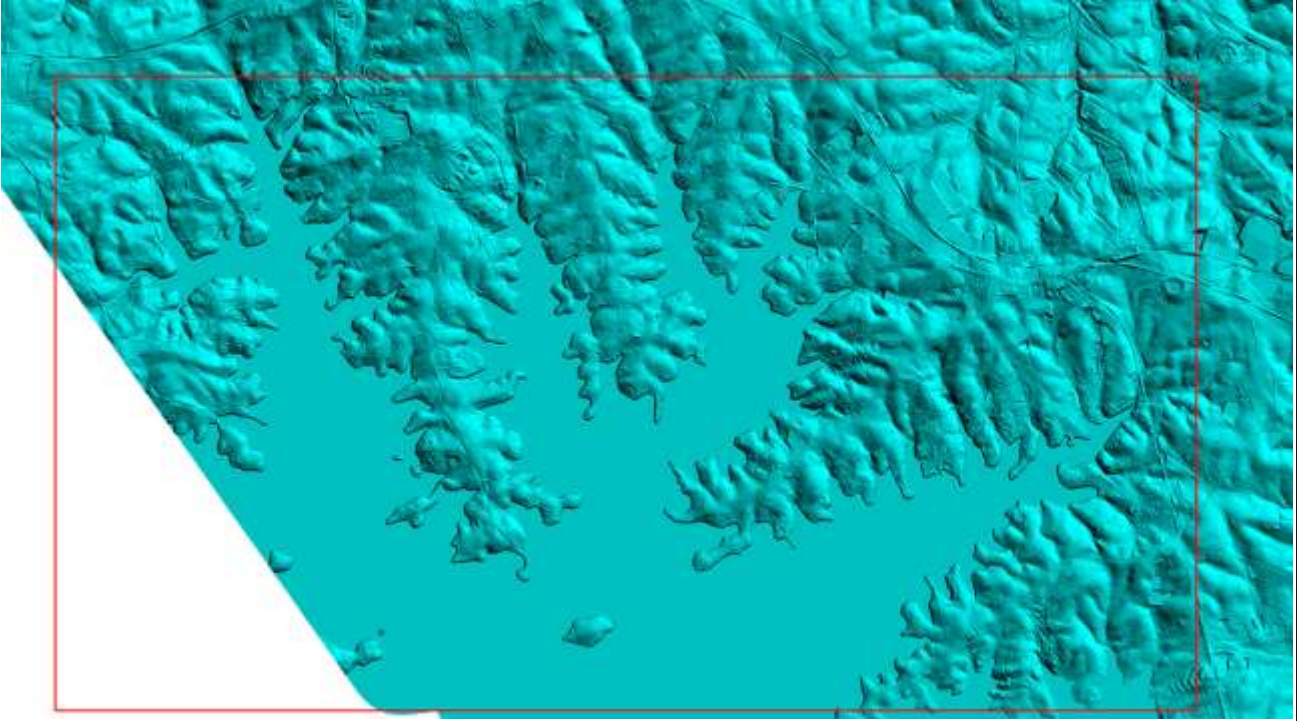
There was one area where the assigned water elevation is higher than the surrounding topography, giving the impression of floating water. (Floating_Water_01)
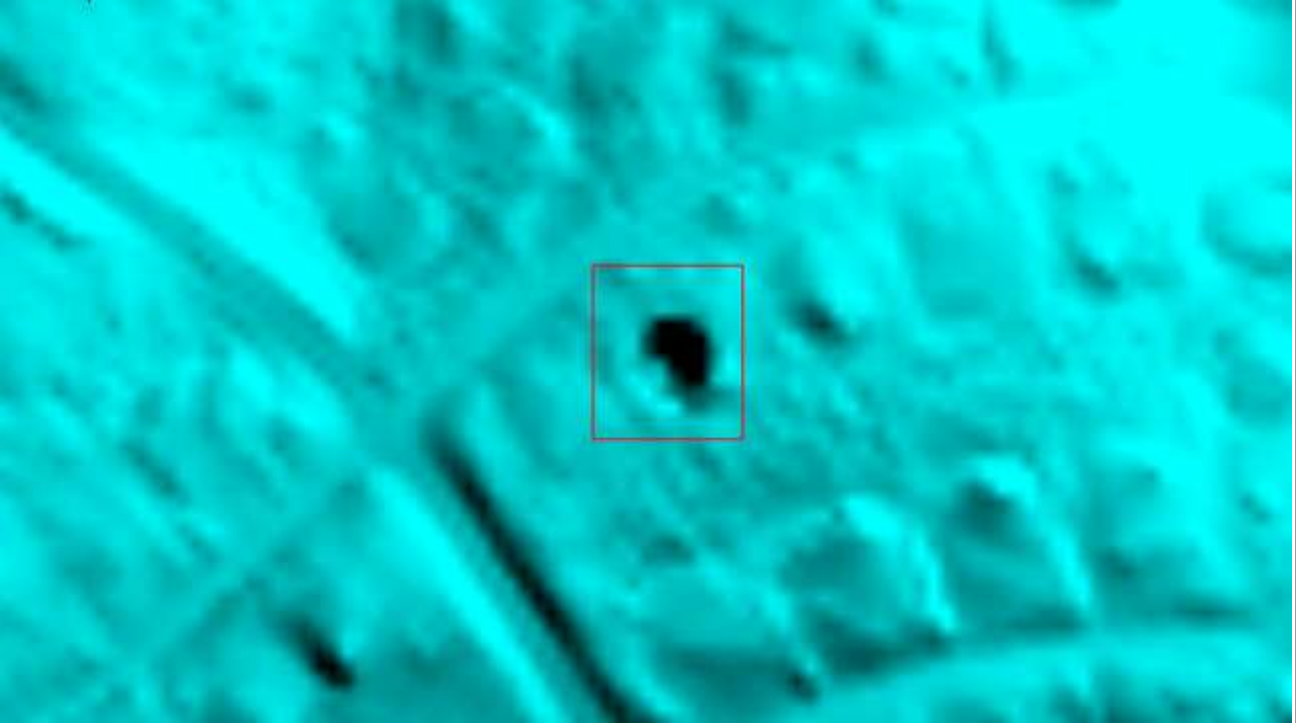
There are three areas where the assigned water elevation is substantially lower than the surrounding topography, giving the impression of steep drop-offs between the land and water surfaces. (Low_Water_02)

☑ Image?

There are two small areas where there appears to be deep pits in places where buildings are indicated in multi-year satellite imagery. LAS also indicates buildings in these locations (Pits_01)
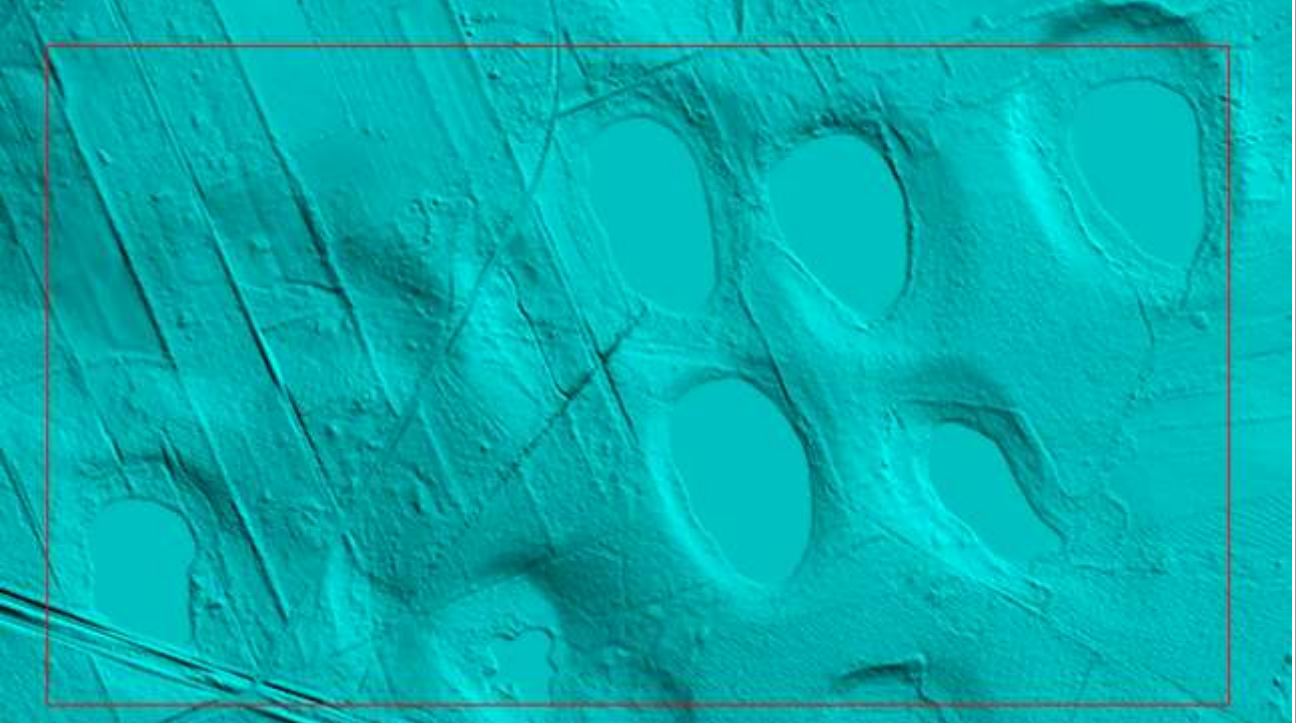
☑ Image?
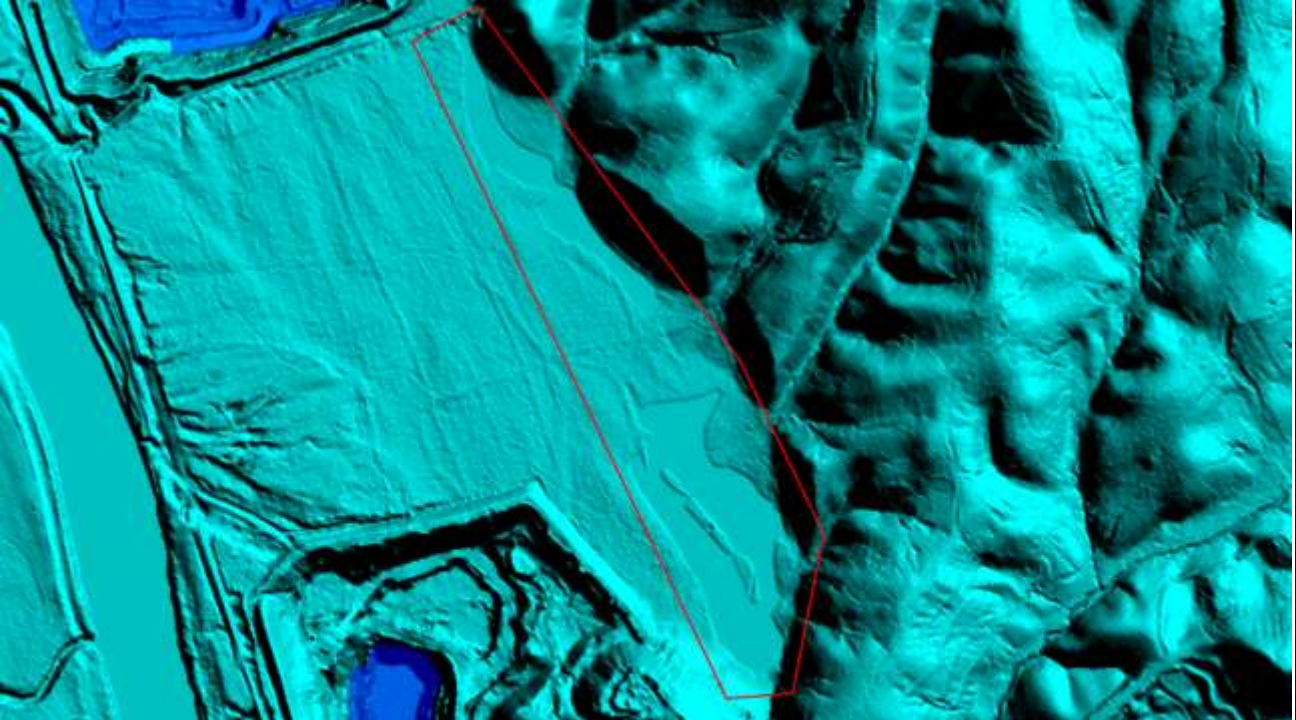
There are at least three areas where forested areas have been hydro-flattened. These are most likely intermittently inundated areas, and while not necessarily an error, they are being identified in this report for clarification. (Hydoflattened_Forest_01)

☑ Image?

NAIP Image of the area pictured above. (Hydroflattened_Forest_01_NAIP)

☑ Image?

(Hydroflattened_Forest_02)

☑ Image?

(Hydroflattened_Forest_02_NAIP)

Internal Note:

The Bare-Earth DEM contains several errors, all of which are inconsistent with standards set forth in the USGS specification v13. These include errors related to building removal, bridge removal and hydro-flattening. QA was not able to be performed by NGTOC since there were no checkpoints provided. Third party QA performed by Dewberry indicates that FVA, SVA and CVA values are within v13 specifications.

This is the end of the report.

QA Form V1.4 12OCT11.xsn