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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 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:
1/4/2013

Project ID:
MS_Madison-Yazoo_2012

Project Alias(es):

Project Type: Donated Data

Project Description:
Lidar data was collected for an approximate 1,268 square mile area of Madison County and a portion of Yazoo County, Mississippi. This project was contracted by the Mississippi Department of Environmental Quality in support of FEMA's RiskMAP program. All elements of the project were to follow specifications of FEMA's Appendix A and Procedure Memorandum No. 61. An accuracy assessment was performed by Waggoner Engineering, Inc.
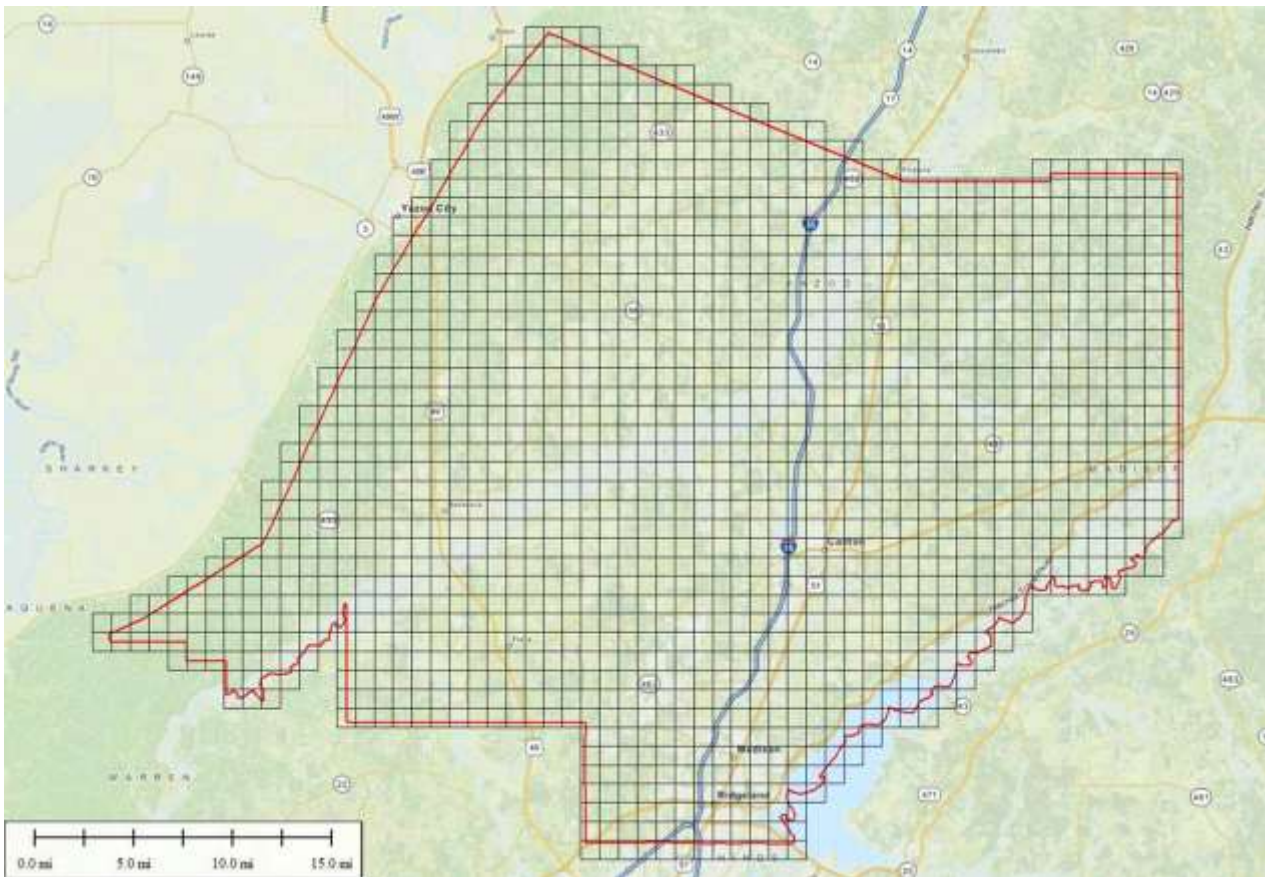
Year of Collection: 2012

Lot 1 of 1 lots.

Project Extent:
☑ Project Extent image?

Project Tiling Scheme:
☑ Project Tiling Scheme image?

Contractor:

The Atlantic Group

Applicable Specification:

V13

Licensing Restrictions:

☑ Third Party Performed QA?

Third Party QA Performed By:

Waggoner Engineering, Inc.

Project Points of Contact:

POC Name	Type	Primary Phone	E-Mail
George Heleine	NSDI Liaison	601-933-2950	gheleine@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
- ☐ Survey Report
- ☐ Processing Report
- ☑ QA/QC Report
- ☐ Control and Calibration Points

- ☑ Project Shapefile/Geodatabase
- ☑ Project Tiling Scheme Shapefile/Gdb
- ☐ Control Point Shapefile/Gdb
- ☑ Breakline Shapefile/Gdb
- ☐ Project XML Metadata

Multi-File Deliverables

File Type		Quantity
☐ Swath LAS Files ☐ Required? ☐ XML Metadata?		
☑ Intensity Image Files ☐ Required?		1,527
☑ Tiled LAS Files ☑ Required? ☑ XML Metadata?		1,527
☑ Breakline Files ☑ Required? ☑ XML Metadata?		1
☑ Bare-Earth DEM Files ☑ Required? ☑ XML Metadata?		1,527

Additional Deliverables

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

Project Geographic Information

Areal Extent:

1268

Sq Mi
Grid Size:

3

U.S. Feet

Tile Size:

5000

U.S. feet

Nominal Pulse Spacing:

Select...

Vertical Datum: NAVD88 Select...

Horizontal Datum: NAD83 Select...

Project Projection/Coordinate Reference System: Mississippi State Plane Zone 2302 U.S. feet.

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

☑ Project Shapefile/Geodatabase   ☑ Breaklines XML Metadata File
☑ Project Tiling Scheme Shapefile/Gdb   ☑ Bare-Earth DEM XML Metadata File
☐ Checkpoints Shapefile/Geodatabase   ☐ Swath LAS Files
☐ Project XML Metadata File   ☑ Classified LAS Files
☑ Swath LAS XML Metadata File   ☑ Breaklines Files
☐ Classified LAS XML Metadata File   ☑ Bare-Earth DEM Files

Check Point Shapefile/Geodatabase CRS

Project XML Metadata CRS

Classified LAS XML Metadata CRS

Swath LAS Files CRS

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:

T. Jerris

Review Start Date:

1/31/2013

Action to Contractor Date	Issue Description	Return Date
3/6/2013	Errors for this project include: Incomplete Metadata for those that were submitted (breakline, DEM, and LAS); DEM errors consisting of data gaps (1), unremoved bridges (4), roadways removed above culverts (17), TINd areas (2), and unflattened waterbodies (>2 acres, 216). Also, LAS Metadata was not provided.	

Review Complete:

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.

5 errors: 1 misplaced, 3 missing, 1 bad_value

Type	Description or line numbers
Severity 5: Misplaced elements	
Error	Time of Day (9.1.2) is not permitted in Process Step (2.5.2)
Severity 3: Missing elements	
Error	Horizontal Positional Accuracy Report (2.4.1.1) is required in Horizontal Positional Acc
Error	Process Date (2.5.2.3) is required in Process Step (2.5.2)
Error	Vertical Positional Accuracy Report (2.4.2.1) is required in Vertical Positional Accuracy
Severity 0: Informative warnings and upgrade notes	

The Classified LAS XML Metadata file parsed witherrors.

LAS XML Metadata not provided

The Breakline XML Metadata file parsed witherrors.

5 errors: 1 misplaced, 3 missing, 1 bad_value

Type	Description or line numbers
Severity 5: Misplaced elements	
Error	Time_of_Day (9.1.2) is not permitted in Process_Step (2.5.2)
Severity 3: Missing elements	
Error	Horizontal_Positional_Accuracy_Report (2.4.1.1) is required in Horizontal_Positional_Ac
Error	Process_Date (2.5.2.3) is required in Process_Step (2.5.2)
Error	Vertical_Positional_Accuracy_Report (2.4.2.1) is required in Vertical_Positional_Accurac
Severity 0: Informative warnings and upgrade notes	

The Bare-Earth DEM XML Metadata file parsed witherrors.

5 errors: 1 misplaced, 3 missing, 1 bad_value

Type	Description or line numbers
Severity 5: Misplaced elements	
Error	Time_of_Day (9.1.2) is not permitted in Process_Step (2.5.2)
Severity 3: Missing elements	
Error	Horizontal_Positional_Accuracy_Report (2.4.1.1) is required in Horizontal_Positional_Ac
Error	Process_Date (2.5.2.3) is required in Process_Step (2.5.2)
Error	Vertical_Positional_Accuracy_Report (2.4.2.1) is required in Vertical_Positional_Accurac
Severity 0: Informative warnings and upgrade notes	

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 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?

Third Party QA does not include the following classes in their assessment:
1) Brush Lands and Low Trees
2) Forested Areas Fully Covered by Trees

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 0.8038 U.S. feet or less.
Target SVA Value is 1.1909 U.S. feet or less.
Required CVA Value is 1.1909 U.S. feet or less.

The reported FVA of the LAS Swath data is 0.639 U.S. feet.

The reported FVA of the Bare-Earth DEM data is 0.502 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		0.425		U.S. feet
Brush Lands and Low Trees				N/A
Forested Areas Fully Covered by Trees				N/A
Urban Areas with Dense Man-Made Structu…		0.385		U.S. feet

The reported CVA of this data set is: 0.427 U.S. feet.

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

None.

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

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: GeoTIFF

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 = 0.8038 or less.	Supplemental Vertical Accuracy @95th Percentile Error Target SVA = 1.1909 or less.	Consolidated Vertical Accuracy @95th Percentile Error Required CVA = 1.1909 or less.
Open Terrain	20	0.502		
Tall Weeds and Crops			0.425	
Brush Lands and Low Trees				
Forested Areas Fully Covered by Trees				

Urban Areas with Dense Man-Made Structures			0.385
Consolidated	20		0.427

☐ QA performed Accuracy Calculations?

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

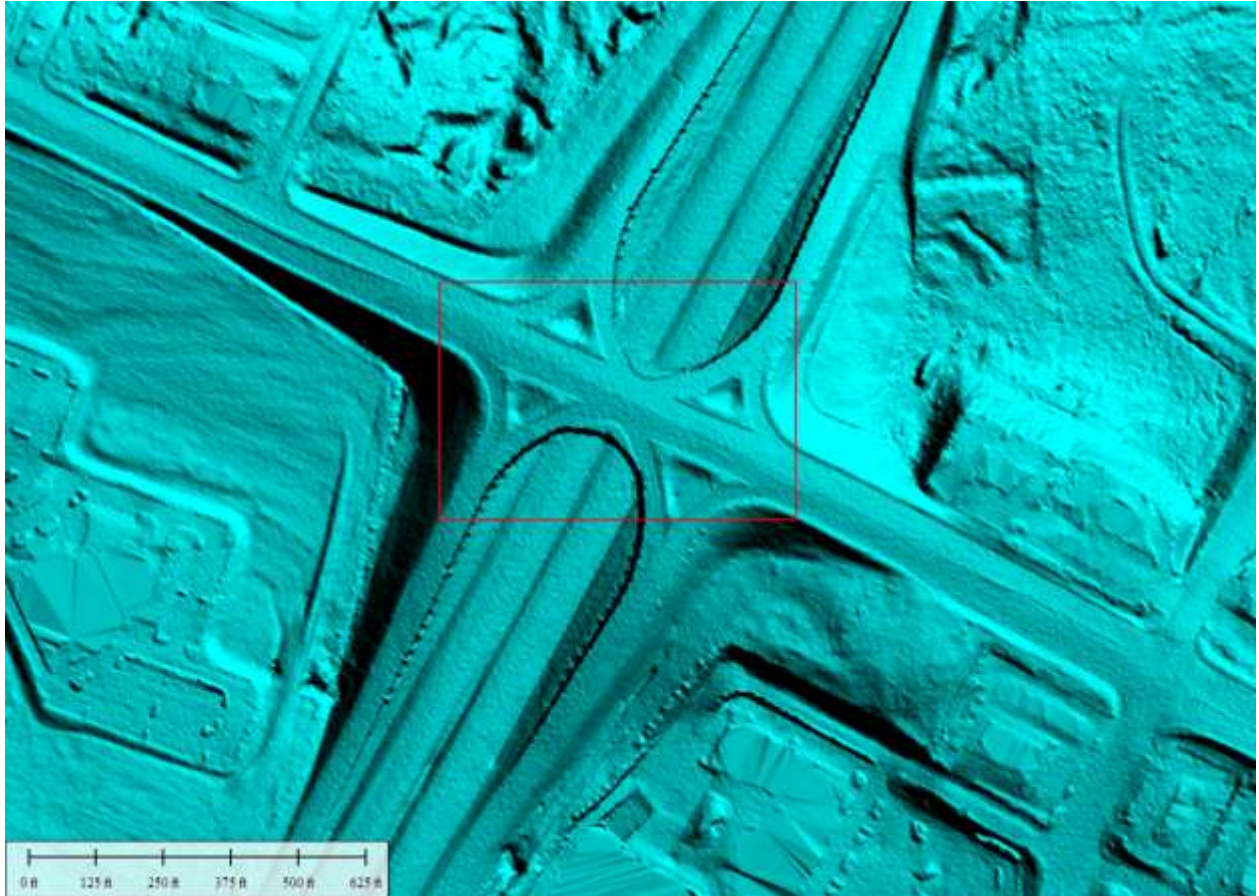Based on this review, the USGS <u>does not accept at this time</u> the bare-earth DEM files.

Bare-Earth DEM Anomalies, Errors, Other Issues

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

☑ Image?

data_gap: This image shows a gap between three tiles...43_37, 43_38, and 44_38.
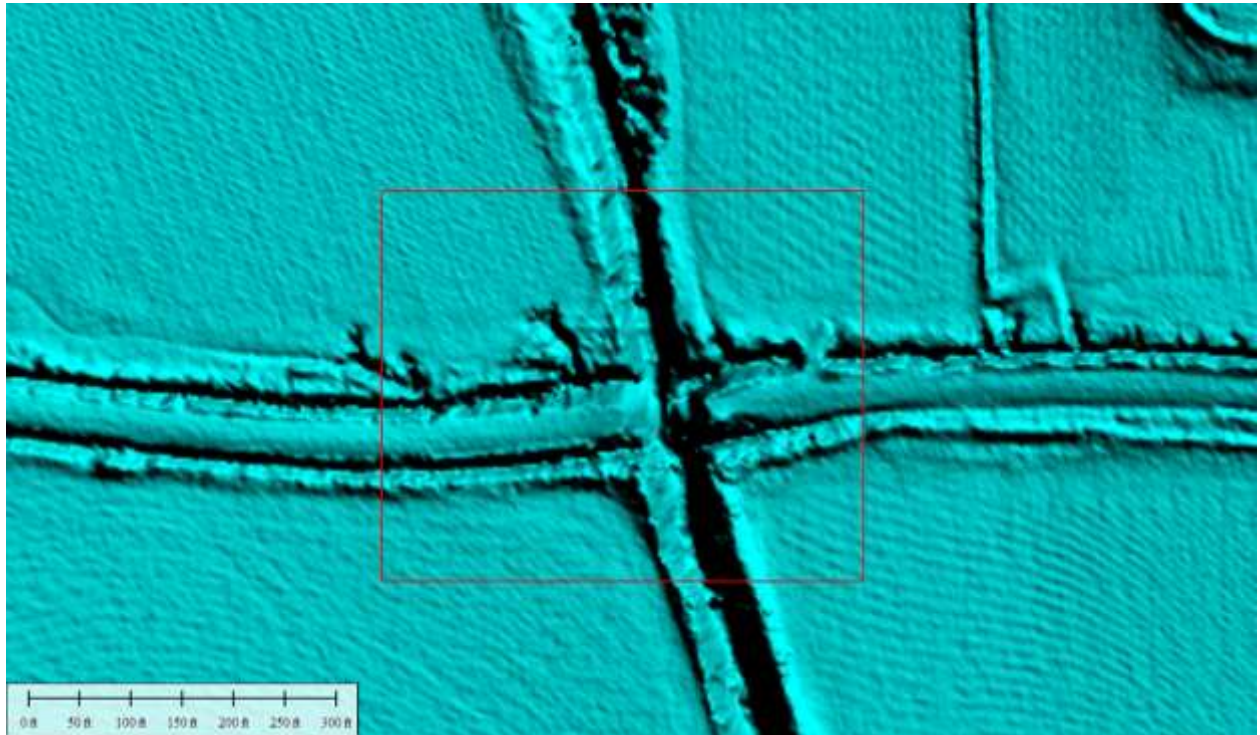
☑ Image?

bridge_9: Bridge-structure not removed from DEM/LAS. There are four of these error-types.
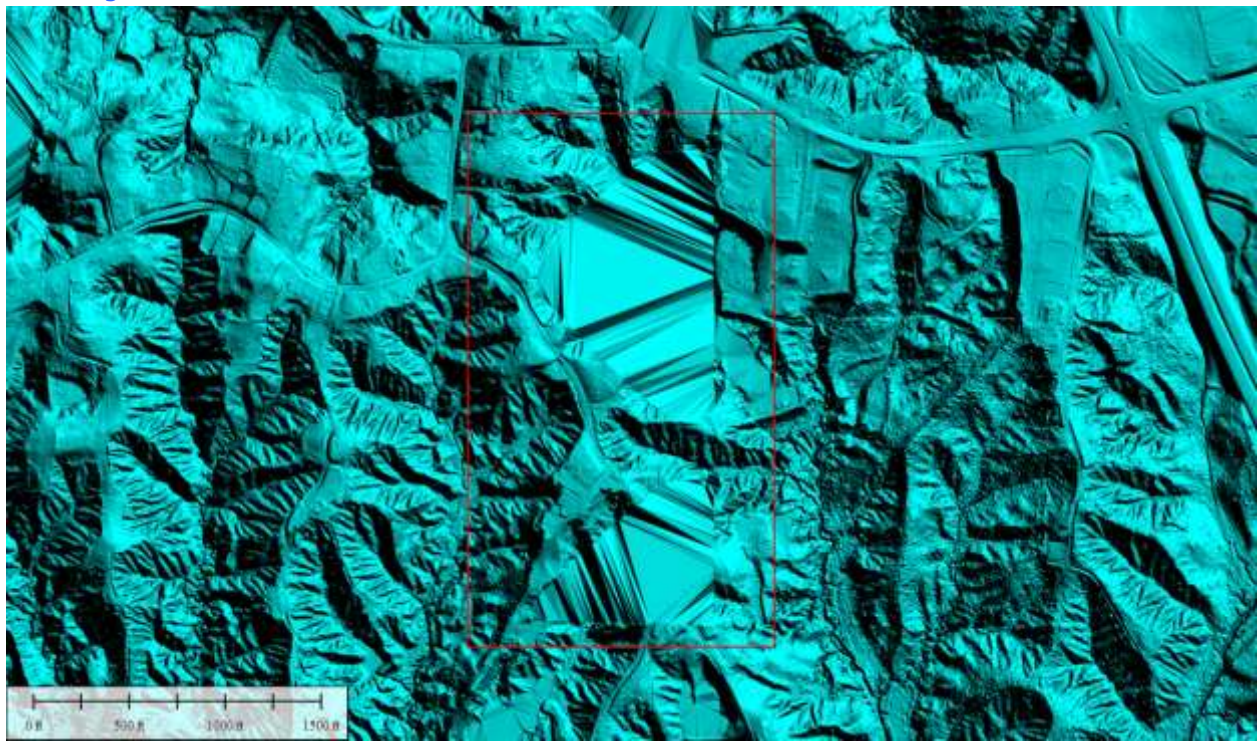
☑ Image?

bridge_or_culvert: These structures are technically culverts and, thus, are not to be
                     removed from the DEM. However, culverts spanning a distance
                     greater than 20 ft. are often considered bridges. These
culverts

                     are greater than 50 ft. and should be removed from the DEM.
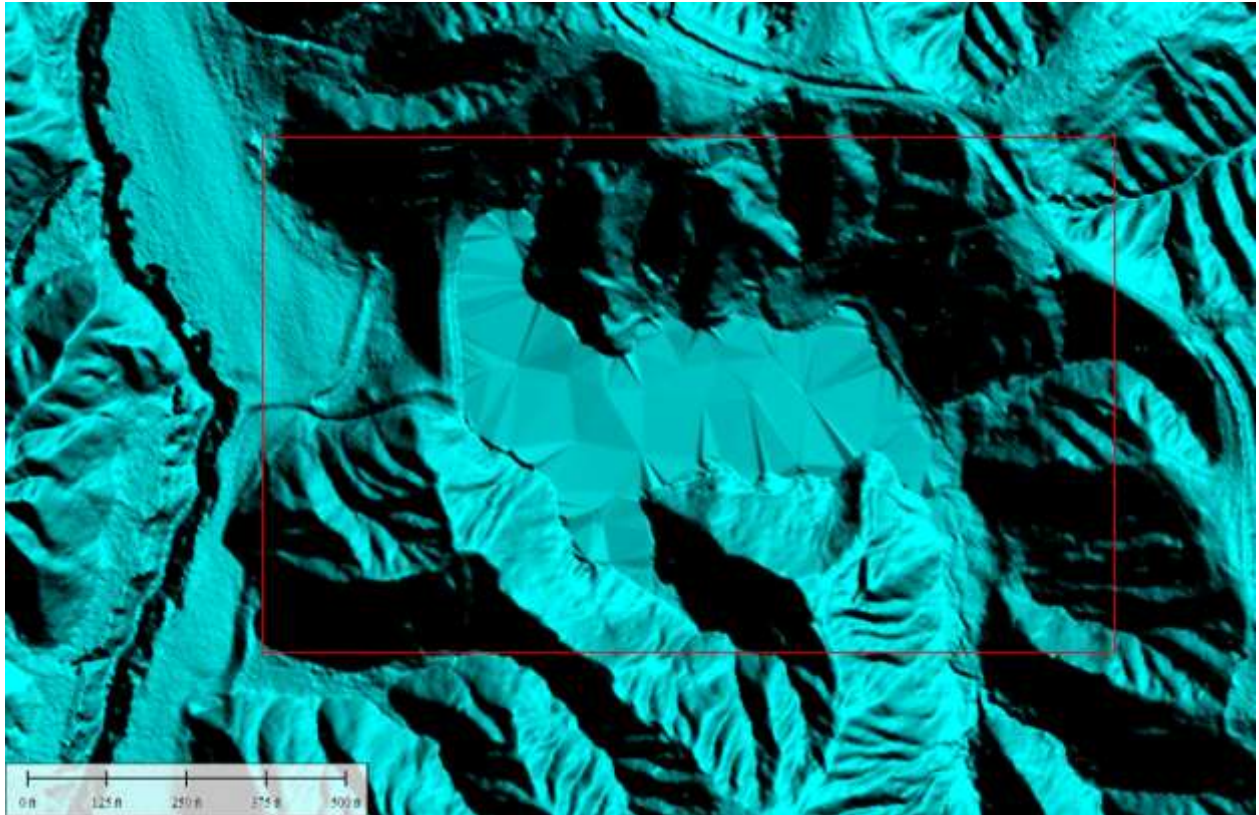
☑ Image?

culvert_1: Roadway should not be removed over culverts. There are 17 of these error-types.

☑ Image?

TIN_24: This image shows two areas of TINing. NAIP imagery shows a land-surface and not a waterbody under those areas.   There are two of these error-types. The name of this error, TIN_24, suggests there are many of this error type; the others were either outside of the project boundary or are areas of swamp lands, which tend to TIN upon creation of the DEM… and are being pointed-out for reference only.

☑ Image?

unflattened_waterbody_2: This image shows a waterbody behind a dam…greater than 2 acres. 216 unflattened waterbodies, greater than 2 acres have been identified within this dataset. The majority of these waterbodies are located within the northwestern portion of the dataset…to the north of the major waterway transecting the DEM.

Internal Note:

This dataset has the following errors:
- 1 @ gap in DEM/LAS
- 4 @ bridges not removed from DEM
- 17 @ roadway removed above culverts
- 216 @ unflattened waterbodies (>2 acres)
- Provided metadata contains errors; received metadata for Project, DEM, and
  breaklines; metadata for LAS not provided.

This is the end of the report.