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:
11/7/2012

Project ID:
CA_PlacerCo_2012

Project Alias(es):
FEMA IX - Placer County CA LiDAR

Project Type: GPSC

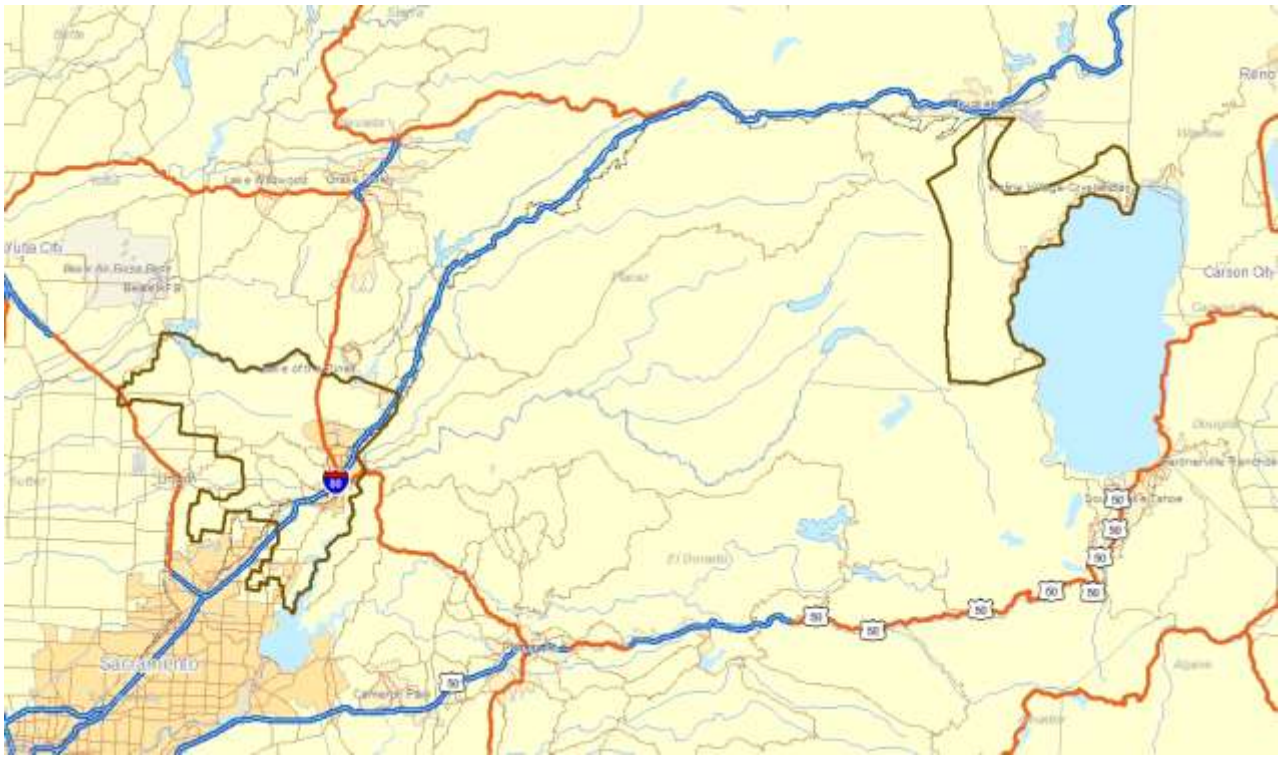
Project Description:
This task order is for planning, acquisition, processing and derivative products of lidar data to be collected at a nominal pulse spacing (NPS) of 1.0 meters. Specifications listed below are based on the ***"U.S. Geological Survey National Geospatial Program Base Lidar Specification, Version 13 (ILMF)",*** of which sections I through IV are incorporated by reference to this task order. This task is for lidar for a high resolution data set of lidar to support the FEMA Risk MAP program covering approximately 303 square miles of Placer County in California.

Year of Collection: 2012

Lot 1 of 1 lots.

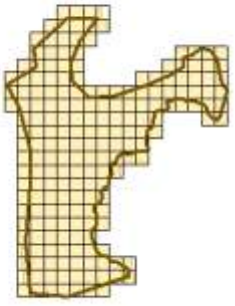
Project Extent:

☑ Project Extent image?



Project Tiling Scheme:

☑ Project Tiling Scheme image?



Contractor:

Applicable Specification:

Dewberry	V13

Licensing Restrictions:

☐ Third Party Performed QA?

Project Points of Contact:

POC Name	Type	Primary Phone	E-Mail
Gail Dunn	CPT	573-308-3756	gdunn@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?	190
☑ Intensity Image Files ☑ Required?	464
☑ Tiled LAS Files ☑ Required? ☑ XML Metadata?	464
☑ Breakline Files ☑ Required? ☑ XML Metadata?	4
☑ Bare-Earth DEM Files ☑ Required? ☑ XML Metadata?	464

Additional Deliverables

	Item
☑	There is one project report and 2 AOIs for which each has the content listed above. T...
☑	Breaklines available in both shapefile and geodatabase for each AOI.

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

Task order calls for the eastern extent to be UTM Zone 11. This is a mistake which I will have to try to work out with the contractor. Most of the AOI except a very small sliver lies in UTM Zone 10 along with the western AOI. The contractor split the data out by Zones as stated in the task order. *A delivery of the data was provided for the Eastern Extent in UTM zone 10. All the final data submitted for the NED and CLICK will be in UTM Zone 10.
See "Placer_County_Easter_Extent_UTM10_memo_20121212.pdf" for more information.

Project Geographic Information

Areal Extent:

303.18

Sq Mi

Grid Size:

1

meters

Tile Size:

1500

meters

Nominal Pulse Spacing: 0.69 meters

Vertical Datum: NAVD88 (GEOID 09) meters

Horizontal Datum: NAD83_HARN meters

Project Projection/Coordinate Reference System: UTM Zones 10N & 11N* meters.

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

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: 11/9/2012

Action to Contractor Date	Issue Description	Return Date
11/19/2012	Waiting on delivery of Eastern Extent Deliverables in UTM zone 10 N.	12/20/2012

Review Complete: 11/19/2012

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 without errors.

The Swath LAS XML Metadata file parsed without errors.

The Classified LAS XML Metadata file parsed without errors.

The Breakline XML Metadata file parsed without errors.

The Bare-Earth DEM XML Metadata file parsed without 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):

- [x] Bare Earth
- [x] Tall Weeds and Crops
- [ ] Brush Lands and Low Trees
- [x] 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 wasable to locate independent checkpoints for this analysis. USGS acceptsthe quality of the checkpoint data for these LiDAR datasets.

Errors, Anomalies, Other Issues to document? (•) Yes ( ) No

- [ ] Image?

Reported Accuracies for Combined AOIs:
-Swath FVA: 0.20
-Point Cloud FVA: 0.19M
-Point Cloud Tall Weeds and Crops: 0.16M
-Point Cloud Forested Areas Fully Covered by Trees: 0.21M
-Point Cloud CVA: 0.18M
-DEM FVA: 0.13M
-DEM Tall Weeds and Crops: 0.17
-DEM Forested Areas Fully Covered by Trees: 0.21
-DEM CVA: 0.17

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: meters

Required FVA Value is 0.245 meters or less.

Target SVA Value is 0.363 meters or less.
Required CVA Value is 0.363 meters or less.

The reported FVA of the LAS Swath data is 0.20 meters.

The reported FVA of the Bare-Earth DEM data is 0.13 meters.
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	0.17	meters
Brush Lands and Low Trees		N/A
Forested Areas Fully Covered by Trees	0.21	meters
Urban Areas with Dense Man-Made Structur...		N/A

The reported CVA of this data set is: 0.17 meters.

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

The reported FVA of the LAS swath data is 0.20 meters.

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

Errors, Anomalies, Other Issues to document? ( ) Yes ( ) No

[ ] Image?

There is no Spatial Reference System Defined in the Header for both the Eastern and Western Swath LAS files.

☐ Image?

The Swath points for Eastern and Western LAS files reside on class 1 as opposed to class 0.

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?

Withheld points (class 11) are those with scan angles over +or- 19 degrees.

Breakline File Review

Breakline 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

None.

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: Erdas Imagine *.img

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 meters.

Reported Accuracies

Land Cover Category	# of Points	Fundamental Vertical Accuracy @95% Confidence Interval ($Accuracy_z$) Required FVA = 0.245 or less.	Supplemental Vertical Accuracy @95th Percentile Error Target SVA = 0.363 or less.	Consolidated Vertical Accuracy @95th Percentile Error Required CVA = 0.363 or less.
Open Terrain	23	0.13		
Tall Weeds and Crops	20		0.17	
Brush Lands and Low Trees				
Forested Areas Fully Covered by Trees	21		0.21	
Urban Areas with Dense Man-Made Structures				
Consolidated	64			0.17

☑ QA performed Accuracy Calculations?

Calculated Accuracies

Land Cover Category	# of Points	Fundamental Vertical Accuracy @95% Confidence Interval ($Accuracy_z$) Required FVA = 0.245 or less.	Supplemental Vertical Accuracy @95th Percentile Error Target SVA = 0.363 or less.	Consolidated Vertical Accuracy @95th Percentile Error Required CVA = 0.363 or less.
Open Terrain	23	0.194		
Tall Weeds and Crops	20		0.159	
Brush Lands and Low Trees				
Forested Areas Fully Covered by Trees	21		0.236	
Urban Areas with Dense Man-Made Structures				
Consolidated	64			0.197

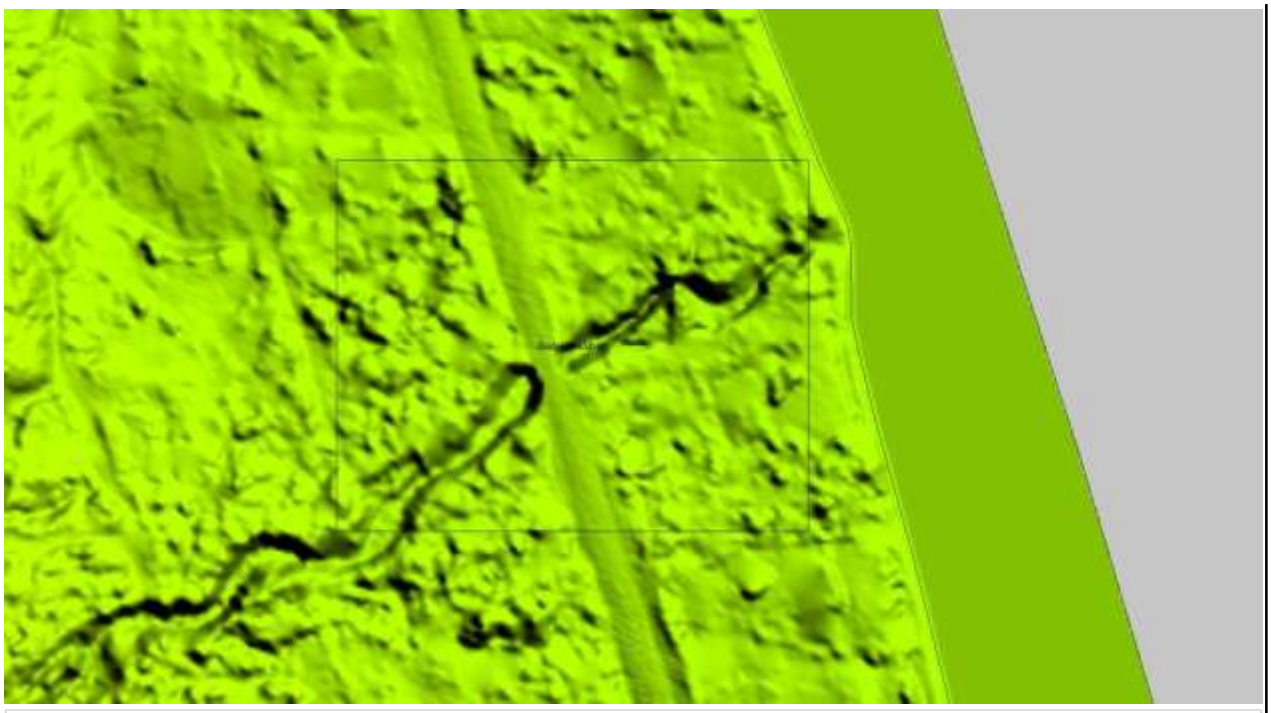
Based on this review, the USGS recommends the bare-earth DEM files for inclusion in the 1/3 Arc-Second National Elevation Dataset.

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

Bare-Earth DEM Anomalies, Errors, Other Issues

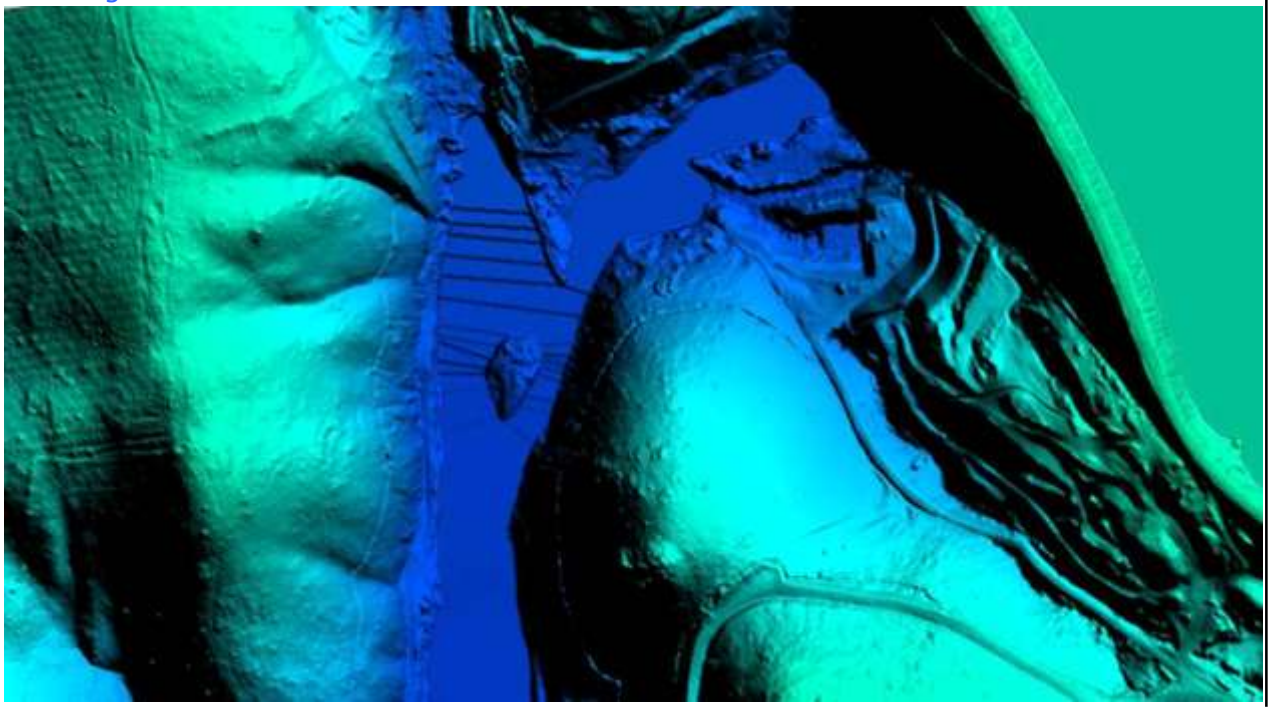
Errors, Anomalies, Other Issues to document? (•) Yes ( ) No

☑ Image?



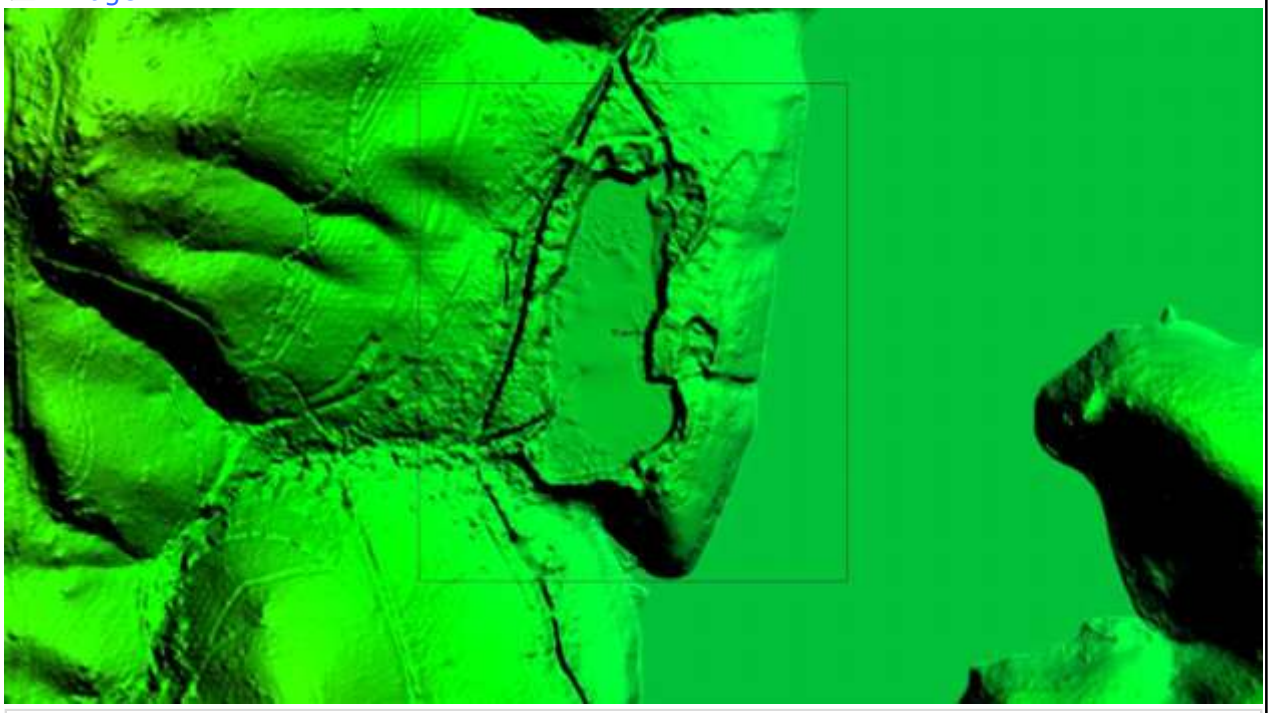
A few Areas where it was difficult to determine if a feature was a Culvert or Bridge. Dewberry states in their delivery report: "Culverts and Bridges: Bridges have been removed from the bare earth surface while culverts remain in the bare earth surface. In instances where it is difficult to determine if the feature is a culvert or bridge, such as with some small bridges, Dewberry erred on assuming they would be culverts especially if they are on secondary or tertiary roads".

☑ Image?



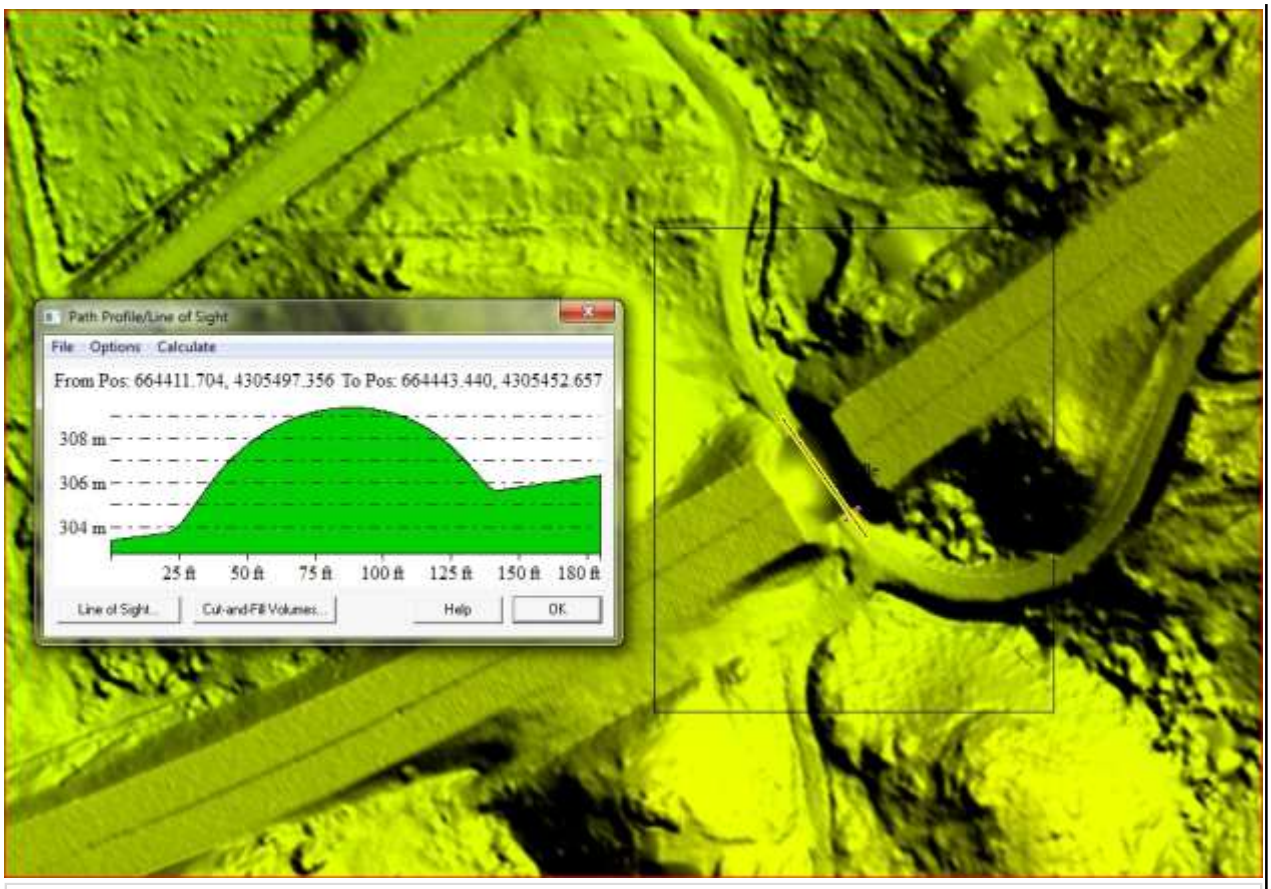
In the Western DEMs river elevation is flattened in a stair step manner, water flows downhill correctly. This is noted in the delivery report.

☑ Image?



A couple waterbody flattening calls, the majority of 2 Acre or greater water is well flattened.

☑ Image?



When viewed and profiled in a hillshade several bridge removal areas exhibit a "saddle" artifact. Dewberry states that "
Because a continuous surface is being created, the TIN or Terrain will use interpolation to triangulate across a bridge opening from legitimate ground points on either side of the actual bridge. This can cause visual artifacts or "saddles." These "artifacts" are only visual and do not exist in the LiDAR points or breaklines". (see page 26 of the Dewberry Project Report for more information). While the point cloud classification is correct, the use of breaklines or raster techniques could have been used to create a more level area under the bridge.

This is the end of the report.