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:
3/15/2013

Project ID:
KS_Area3-NortheastB_2012

Project Alias(es):
KS_25 COUNTIES LIDAR#1

Project Type: Partnership

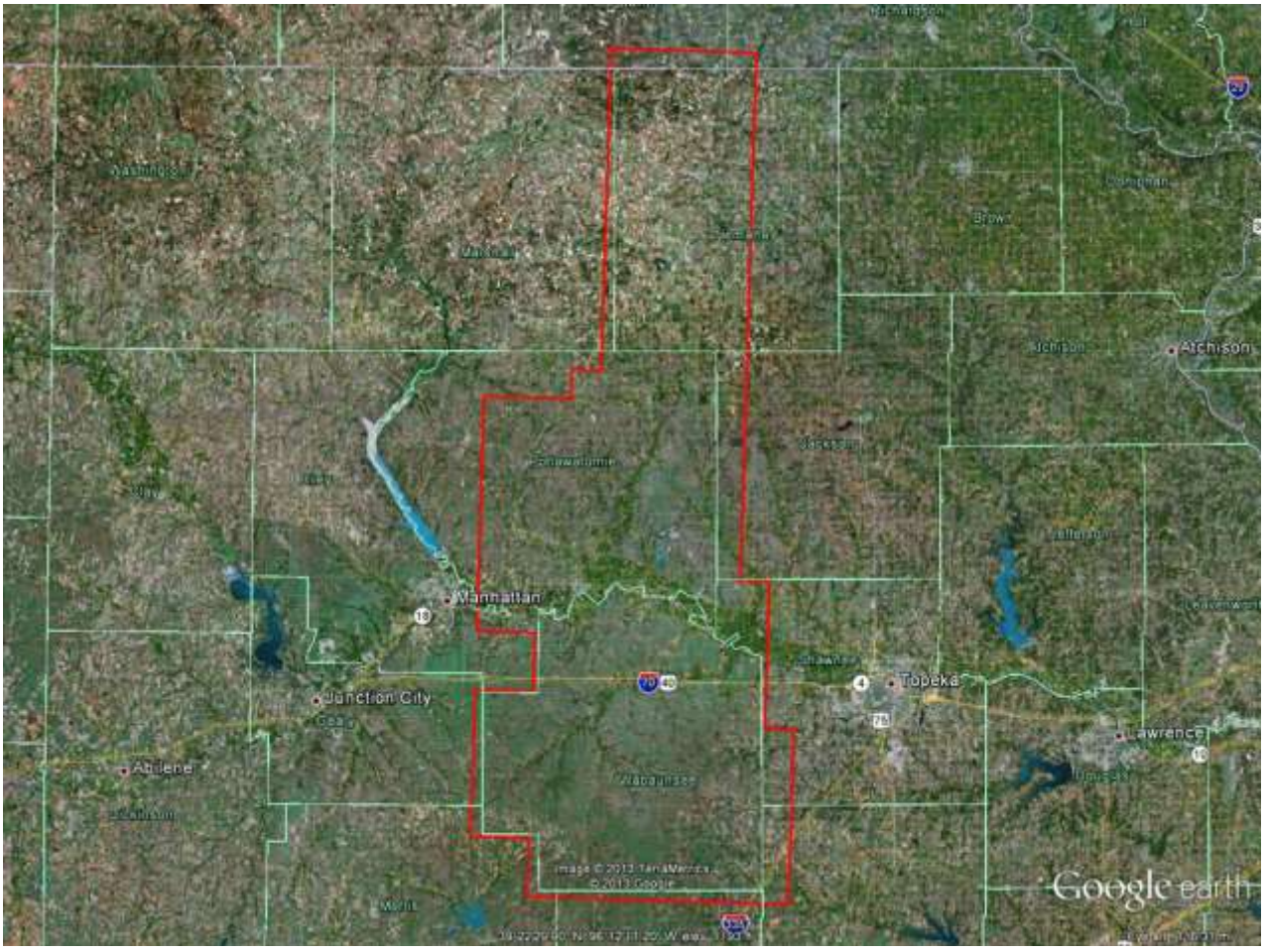
Project Description:
The project consists of 3 areas: Area 1 as one lot, Area 2 as one lot and Area 3 as four lots. Area 3 Kansas will consist of the Northeast area (in two lots) including Brown, Doniphan, Jackson, Leavenworth, Nemaha, Pottawatomie, Webaunsee, and Wyandotte counties; the Southeast including Cherokee, Crawford, Linn and Bourbon counties; and Butler County. Areas were defined and supplied by Kansas Department of Administration and includes approximately 9700 square miles for analysis.

Year of Collection: 1/13/2012 to 4/17/12

Lot 6 of 6 lots.

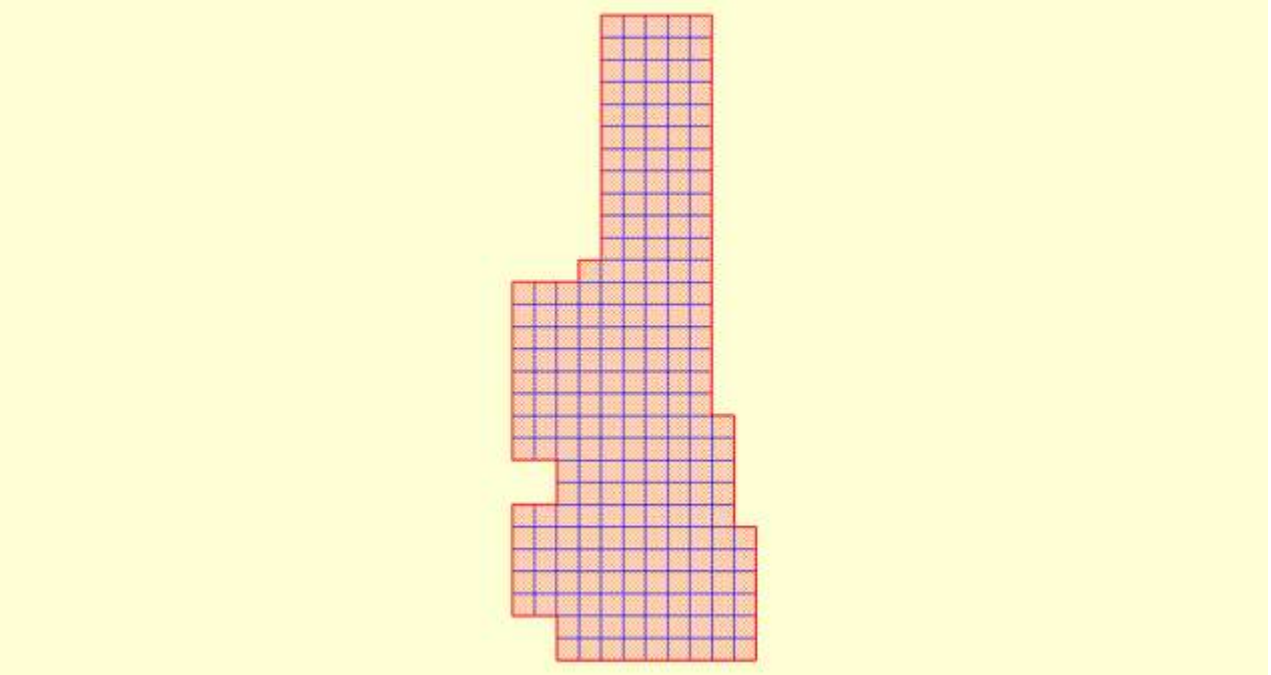
Project Extent:

☑ Project Extent image?



Project Tiling Scheme:

☑ Project Tiling Scheme image?



Contractor:

Aerometric, Inc.

Applicable Specification:

V13

Licensing Restrictions:

☐ Third Party Performed QA?

Project Points of Contact:

POC Name	Type	Primary Phone	E-Mail
Ingrid Landgraf	NSDI Liaison	785-832-3566	imlandgraf@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?	525
☑ Intensity Image Files ☑ Required?	409
☑ Tiled LAS Files ☑ Required? ☑ XML Metadata?	223
☑ Breakline Files ☑ Required? ☑ XML Metadata?	2
☑ Bare-Earth DEM Files ☑ Required? ☑ XML Metadata?	223

First Return DEM - 223 .img files

Swath files refer to entire Northeast section of Area 3 ◉ Yes ○ No

UTM14 Hydro Area 3 Blocks 5&6 20121217.gdb cannot be opened. Item description shows 25 files are contained in gdb. Needs to be re-delivered.

**Update: Breaklines files re-delivered and are good. Two files were delivered - Breaklines.shp and Hydro Breaklines.shp which were exported by NGTOC reviewer.

Project Geographic Information

Areal Extent:
2152.5
Sq Mi
Grid Size:
1
meters
Tile Size:
5000 x 5000
meters
Nominal Pulse Spacing: 1.4 meters
Vertical Datum: NAVD88 meters
Horizontal Datum: NAD83_HARN meters

Project Projection/Coordinate Reference System: NAD83_HARN_UTM_zone_14N meters.

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

- [x] Project Shapefile/Geodatabase
- [x] Project Tiling Scheme Shapefile/Gdb
- [x] Checkpoints Shapefile/Geodatabase
- [x] Project XML Metadata File
- [x] Swath LAS XML Metadata File
- [x] Classified LAS XML Metadata File
- [x] Breaklines XML Metadata File
- [x] Bare-Earth DEM XML Metadata File
- [x] Swath LAS Files
- [x] Classified LAS Files
- [x] Breaklines Files
- [x] 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: 5/7/2013

Action to Contractor Date	Issue Description	Return Date
5/22/2013	Several errors relating to the DEM including floating water, culverts being removed and bad tiles. The breakline geodatabase will need to be redelivered with the corrections. Some scan angles are excessive in raw .las data.	8/14/2013
8/27/2013	Metadata issues reporting vertical accuracy, swath scan angles need clarified.	9/10/2013
9/10/2013	Issues still with Vertical accuracy and metadata. Incomplete swath file not addressed.	11/15/2013

Review Complete: 12/23/2013

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 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

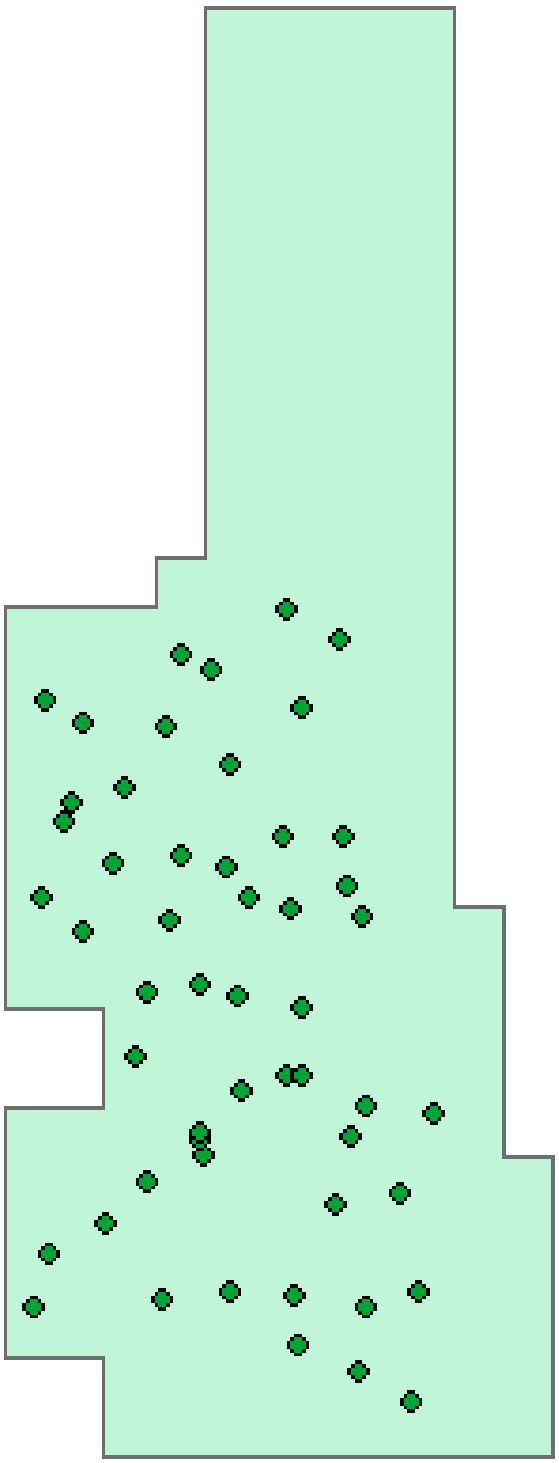
ASPRS recommends that checkpoint surveys be used to verify the vertical accuracy of LiDAR data sets. Checkpoints are to be collected by an independent survey firm licensed in the particular state(s) where the project is located. While subjective, checkpoints should be well distributed throughout the 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
- [x] 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?

Contractor reports Short Grass SVA in all of the metadata. However, there is no land cover class for the checkpoints for short grass. The only land cover classes are Bare Earth/Low Grass for FVA, High Grass/weeds/crops for SVA, Forested for SVA, Urban/Hard Surface for SVA. The metadata does not state an SVA value for Urban. Please clarify/amend all metadata.

Discrepancies exist between reported vertical accuracy categories in the metadata and checkpoint shapefile provided.

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 0.149 meters.

The reported FVA of the Bare-Earth DEM data is 0.150 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	0.156	meters
Brush Lands and Low Trees		N/A
Forested Areas Fully Covered by Trees	0.153	meters
Urban Areas with Dense Man-Made Structu...	0.128	meters

The reported CVA of this data set is: 0.153 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 0.149 meters.

Based on this review, the USGS does not accept at this time the LAS swath file data.

Please review the scan angles for the Swath data for Area 3 Northeast (see below) (•) Yes ( ) No

- [ ] Image?

There was an error with the swath file that falls within Nemaha county. The swath data was delivered for the entire Northeast section for Area 3 and assessed at that time. The error is reported in another QA report (Lot 3 - KS_Area3-NortheastA_2012). Once it is corrected, the raw .las will be accepted in both reports. Please look over and clarify why some of the scan angles listed in the raw data are excessive (-128, 124 - FL_221_E; -53, 45 - FL_621; -47, 42 - FL_591_A).

**Swath file error not addressed by the vendor.

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

- [x] Separate folder for Classified LAS tile files
- [x] Classified LAS tile files conform to Project Tiling Scheme
- [x] Quantity of Classified LAS tile files conforms to Project Tiling Scheme
- [x] Classified LAS tile files do not overlap
- [x] Classified LAS tile files are uniform in size
- [x] 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?

Additional classifications in this data set.

☐ 3 - Tall weeds and crops (low vegetation)
☐ 4 - Brush lands and low trees (medium vegetation)
☐ 5 - Forested areas fully covered by trees
☐ 6 - Urban area with dense man-made structures

☑ 17	-	Overlap - Unclassified
☑ 18	-	Overlap - Bare Earth
☑ 24	-	Overlap - Water
☑ 25	-	Overlap - Ignored Ground

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.

◉ Yes ○ No

☐ Image for error?

Breakline .gdb re-delivered and breaklines are good. The breakline shapefiles are for the entire Northeast section of the Area 3. Since this report is for the western portion of the Northeast section, the reviewer clipped the breaklines to the footprint. The original breakline shapefiles are located in the NED folder under breaklines and the clipped breaklines will be in the Metadata folder under NGTOC Created Metadata.

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

- [x] Separate folder for bare-earth DEM files
- [x] DEM files conform to Project Tiling Scheme
- [x] Quantity of DEM files conforms to Project Tiling Scheme
- [x] DEM files do not overlap
- [x] DEM files are uniform in size
- [x] DEM files properly edge match
- [x] 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	52	0.150		

Tall Weeds and Crops	52		0.156	
Brush Lands and Low Trees				
Forested Areas Fully Covered by Trees	52		0.153	
Urban Areas with Dense Man-Made Structures	52		0.128	
Consolidated	208			0.153

☑ 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	12	0.162		
Tall Weeds and Crops	15		.195	
Brush Lands and Low Trees				
Forested Areas Fully Covered by Trees	15		0.080	
Urban Areas with Dense Man-Made Structures	10		0.136	
Consolidated	52			0.167

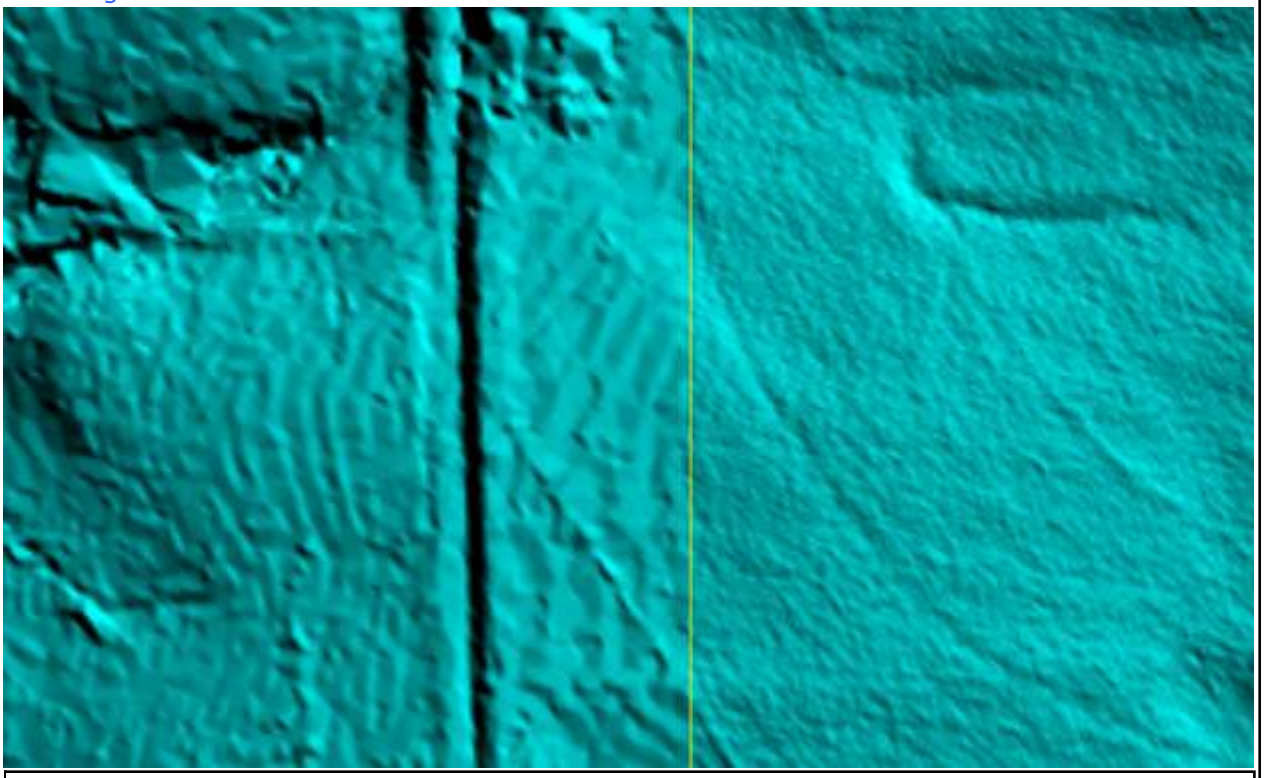
Based on this review, the USGS recommends the bare-earth DEM files for inclusion in the 1/3 Arc-Second National Elevation Dataset.

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

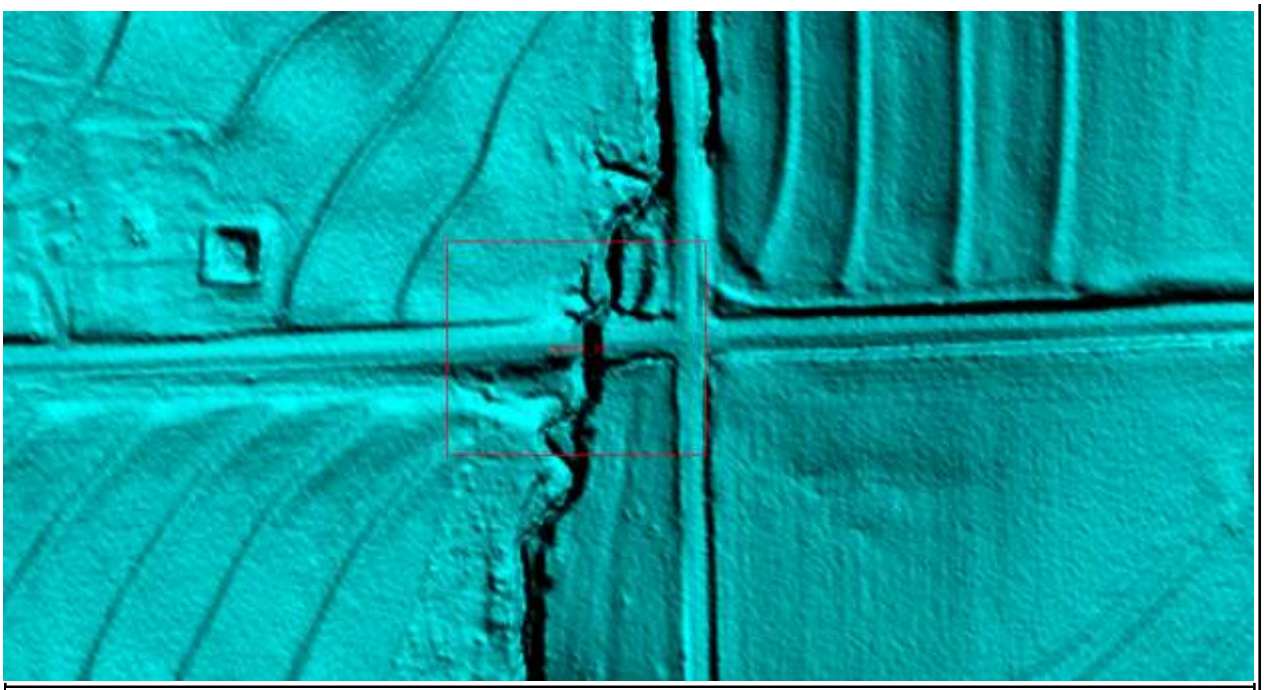
☑ Image?



There are several bad tiles that need to be corrected. This is a representative image of this error type. The yellow line delineates tile boundaries. The tile on the left (BE_R055C101) is the bad tile. There are 16 tiles of this error type. They are: BE_R047C102, BE_R047C104, BE_R047C105, BE_R047C106, BE_R048C101, BE_R048C104, BE_R049C108, BE_R050C102, BE_R050C105, BE_R051C103, BE_R054C101, BE_R054C105, BE_R055C101, BE_R055C104, BE_R056C101, BE_R057C101.

Contractor corrected the tiles

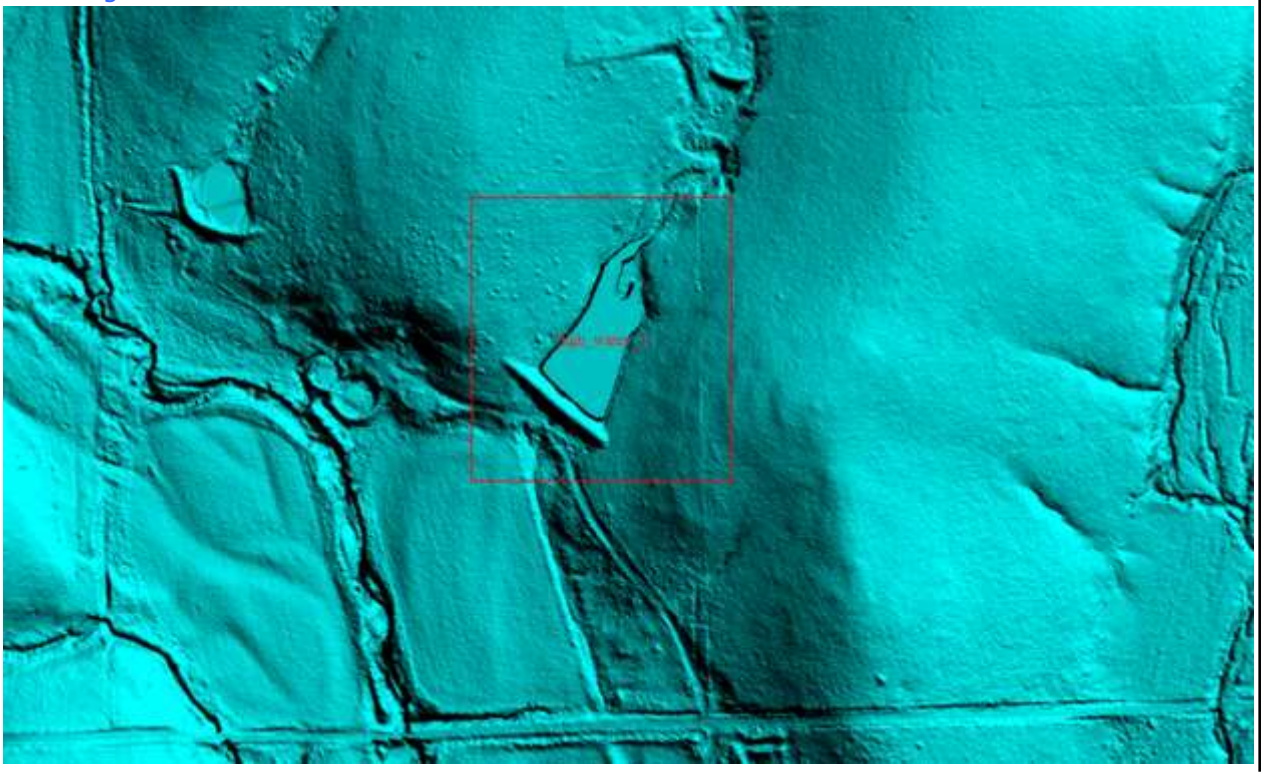
☑ Image?



There are several errors in which culverts were removed from the DEM. Roadways over culverts are to be retained in the DEM. There are 104 of this error type.

All except for one culvert error were corrected

☑ Image?



This is a representative image of water elevated above surrounding terrain. There are four of this error type.

Contractor corrected errors

This is the end of the report.