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:
5/1/2012

Project ID:
KS_11County_2010

Project Alias(es):
KS_15County_2010

Project Type: Donated Data

Project Description:
The remaining 11 counties are Lot 3 of KS-15 County delivery project. The 11 counties are donated data and were delivered along with partnership data. Three reports will be delivered for the 15 counties - One for Harvey Co. (lot 1), 1 for Lyon, Morris and Chase Cos. (lot 2) and 1 for the remaining 11 counties plus Dodge City and USFWS (lot 3).

Year of Collection: 2010-11
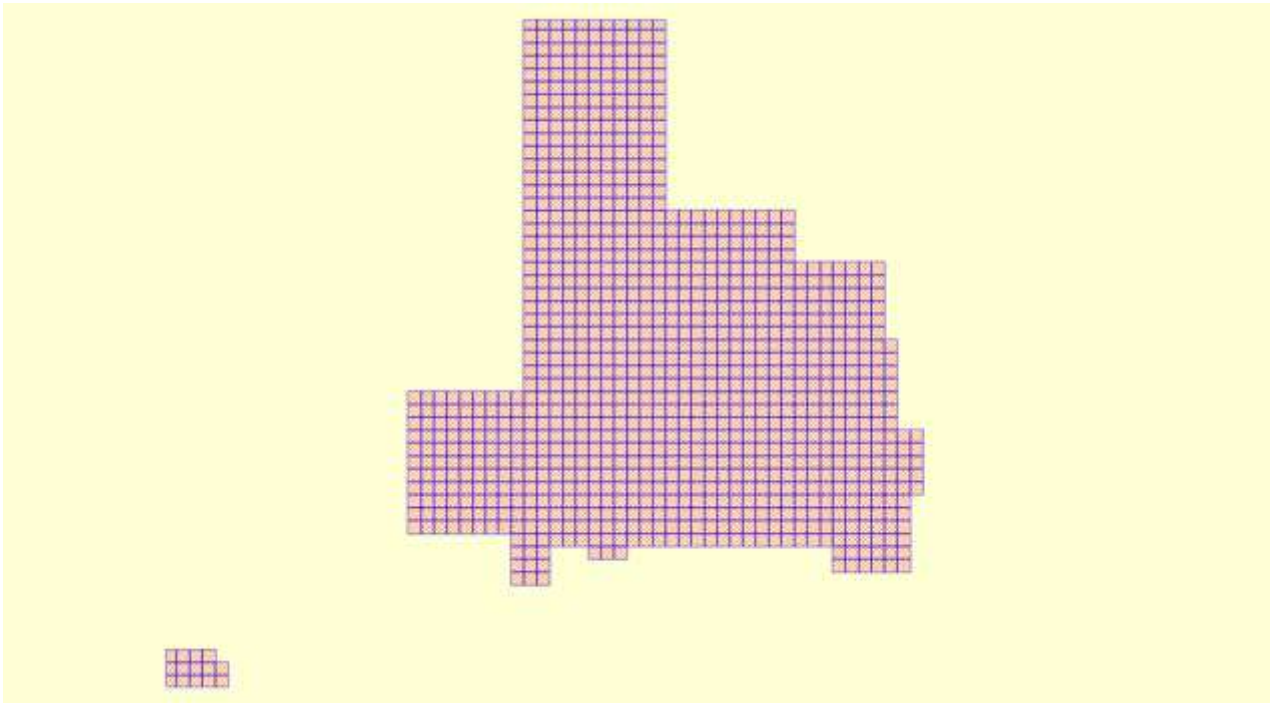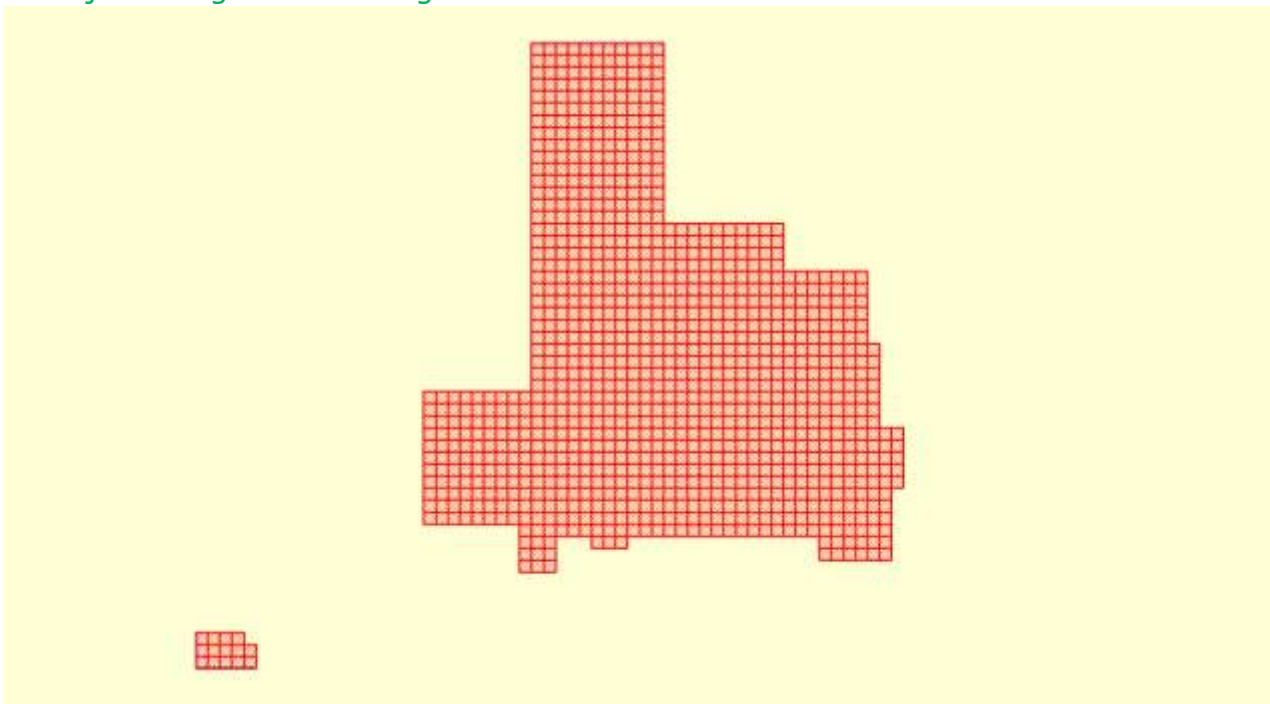
Lot 3 of 3 lots.

Project Extent:
☑ Project Extent image?

Project Tiling Scheme:
☑ Project Tiling Scheme image?

Contractor:	Applicable Specification:
Kucera	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?	520
☐ Intensity Image Files ☐ Required?	
☑ Tiled LAS Files ☑ Required? ☑ XML Metadata?	1183
☑ Breakline Files ☑ Required? ☑ XML Metadata?	13
☑ Bare-Earth DEM Files ☑ Required? ☑ XML Metadata?	1183

Additional Deliverables

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

The swath files were not separated by county. The 520 files are for all 15 counties and Dodge City, KS data.

Project Geographic Information

Areal Extent:

9975

Sq Mi

Grid Size:

1

meters

Tile Size:

5000 x 5000

meters

Nominal Pulse Spacing:

1.3 (reviewer measured, not given in metadata)

meters

Vertical Datum: NAVD88 meters

Horizontal Datum: NAD83 meters

Project Projection/Coordinate Reference System: Universal Transverse Mercator Zone 14 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

Check Point Shapefile/Geodatabase 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:
Select or type...

Review Start Date:
12/4/2012

Action to Contractor Date	Issue Description	Return Date
6/4/2012	Based on errors in previous lots, project sent back to contractor to check	9/5/2012
12/21/2012	Several errors relating to water, culvert removal, bridge removals and gaps in the data. Also, NPS needs to be reported.	4/18/2013
6/3/2013	Errors in Jewell County not corrected	6/12/2013
11/20/2013	No more corrections will be received for the project. Sending what I have to EROS.	12/6/2013

Review Complete: 12/6/2013

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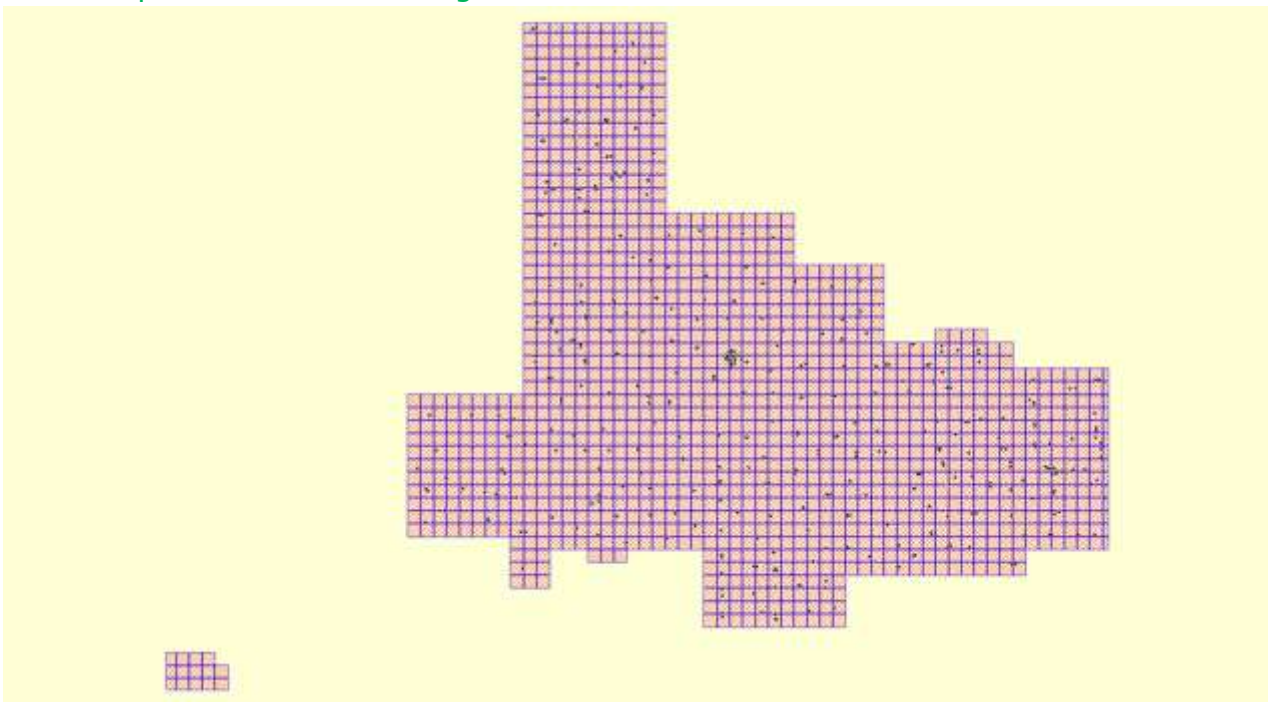
The following land cover classes are represented in this dataset (uncheck any that do not apply):

☑ 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 able to locate independent checkpoints for this analysis. USGS accepts the quality of the checkpoint data for these LiDAR datasets.

◉ Yes ○ No

☐ Image?

From the Kucera Survey Report (page 8): For the land cover accuracy checkpoint survey the project area was divided into 12 contiguous area "blocks" (FEMA01 – FEMA12), each covering approximately 1000 square miles. For each significant land cover type within each block, at least 20 ground checkpoints spread through the cover type were surveyed. The land covers surveyed in each block were brushlands/low trees (BR), high grass/weeds/crops (HG), and bare earth/low grass/pavement (BE).
In FEMA Block 6 (Saline County/City of Salina) urban (UR) land cover points were also surveyed.

**Vertical Accuracy was calculated on the entire project and the overall results will be listed in all three lot reports. A total of 814 checkpoints were included for the entire project.

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: centimeters

Required FVA Value is 24.5 centimeters or less.
Target SVA Value is 36.3 centimeters or less.
Required CVA Value is 36.3 centimeters or less.

The reported FVA of the LAS Swath data is 24.5 centimeters.

The reported FVA of the Bare-Earth DEM data is 19.2 centimeters.
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	30.5	centimeters
Brush Lands and Low Trees	27.7	centimeters
Forested Areas Fully Covered by Trees		N/A
Urban Areas with Dense Man-Made Structu...	05.9	centimeters

The reported CVA of this data set is: 27.9 centimeters.

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 24.5 centimeters.

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

Metadata states LAS version 1.0, need FVA stated for swath in metadata	◉ Yes ○ No

☐ Image?

Vertical Accuracy testing done at NGTOC: FVA of the swath data is 14.8 cm

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.

◉ Yes ○ No

☐ Image?

Other classes include: Class 17: overlap unclassified, Class 18: overlap bare-earth ground, Class 23: overlap noise, Class 24: overlap water per the metadata.

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?

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 centimeters .

Reported Accuracies

Land Cover Category	# of Points	Fundamental Vertical Accuracy @95% Confidence Interval (Accuracy$_z$) Required FVA = 24.5 or less.	Supplemental Vertical Accuracy @95th Percentile Error Target SVA = 36.3 or less.	Consolidated Vertical Accuracy @95th Percentile Error Required CVA = 36.3 or less.
Open Terrain	20	19.2		
Tall Weeds and Crops			30.5	
Brush Lands and Low Trees			27.7	
Forested Areas Fully Covered by Trees				
Urban Areas with Dense Man-Made Structures	20		05.9	
Consolidated	40			27.9

☑ QA performed Accuracy Calculations?

Calculated Accuracies

		Fundamental Vertical Accuracy	Supplemental	Consolidated

Land Cover Category	# of Points	@95% Confidence Interval (Accuracy$_z$) Required FVA = 24.5 or less.	Vertical Accuracy @95th Percentile Error Target SVA = 36.3 or less.	Vertical Accuracy @95th Percentile Error Required CVA = 36.3 or less.
Open Terrain	272	14.0		
Tall Weeds and Crops	266		30.775	
Brush Lands and Low Trees	256		26.725	
Forested Areas Fully Covered by Trees				
Urban Areas with Dense Man-Made Structures	20		05.185	
Consolidated	814			26.7

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
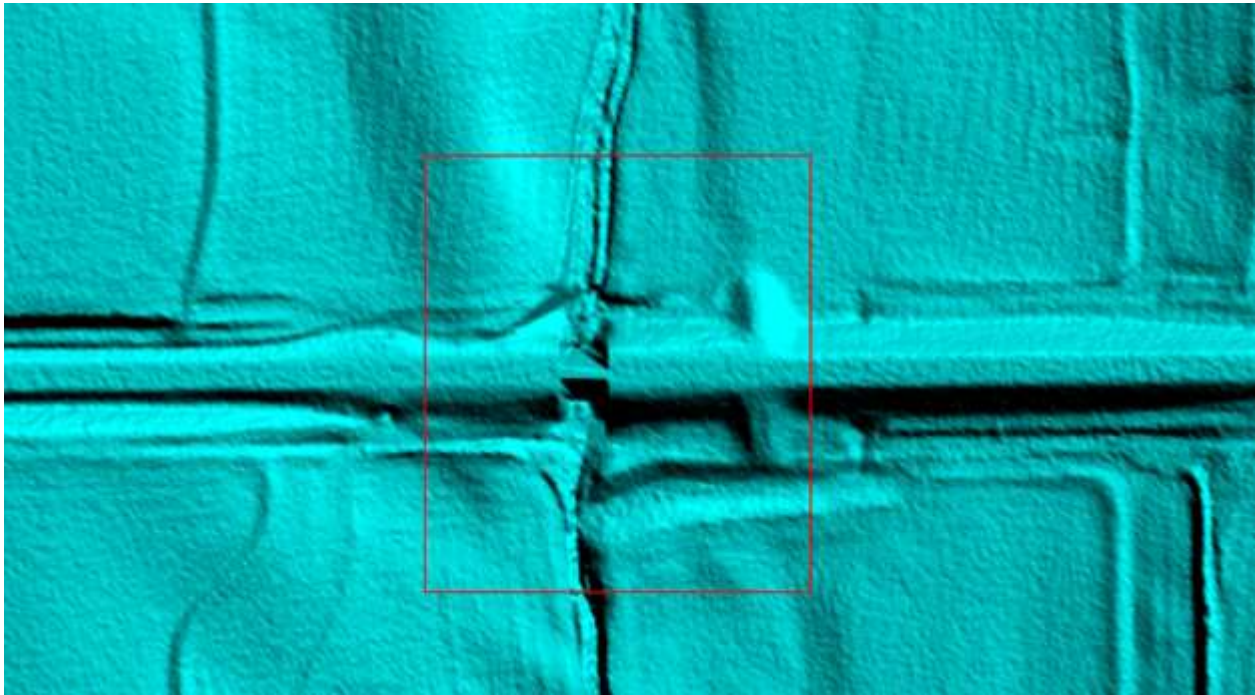
☑ Image?

Bridge not completely removed. This is a representative image, there are 3 of these types of errors.

**Vendor corrected errors
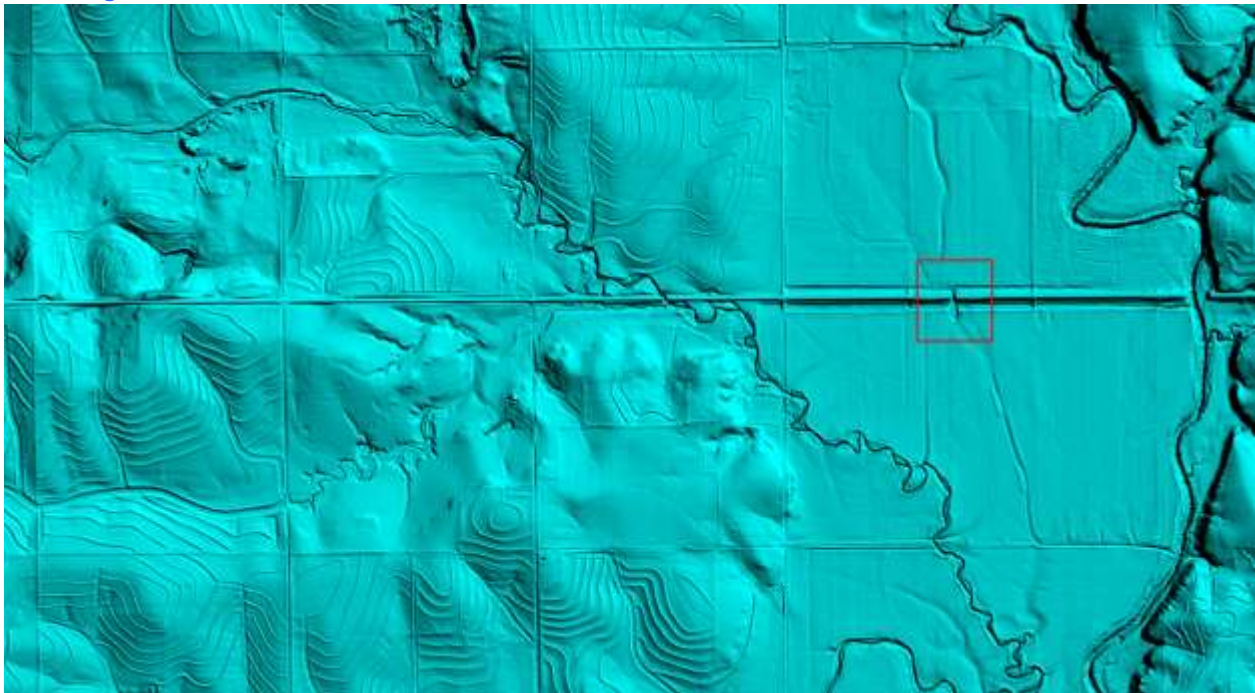
☑ Image?

Area where a culvert has been removed. There are 17 errors. This is only a representative image.
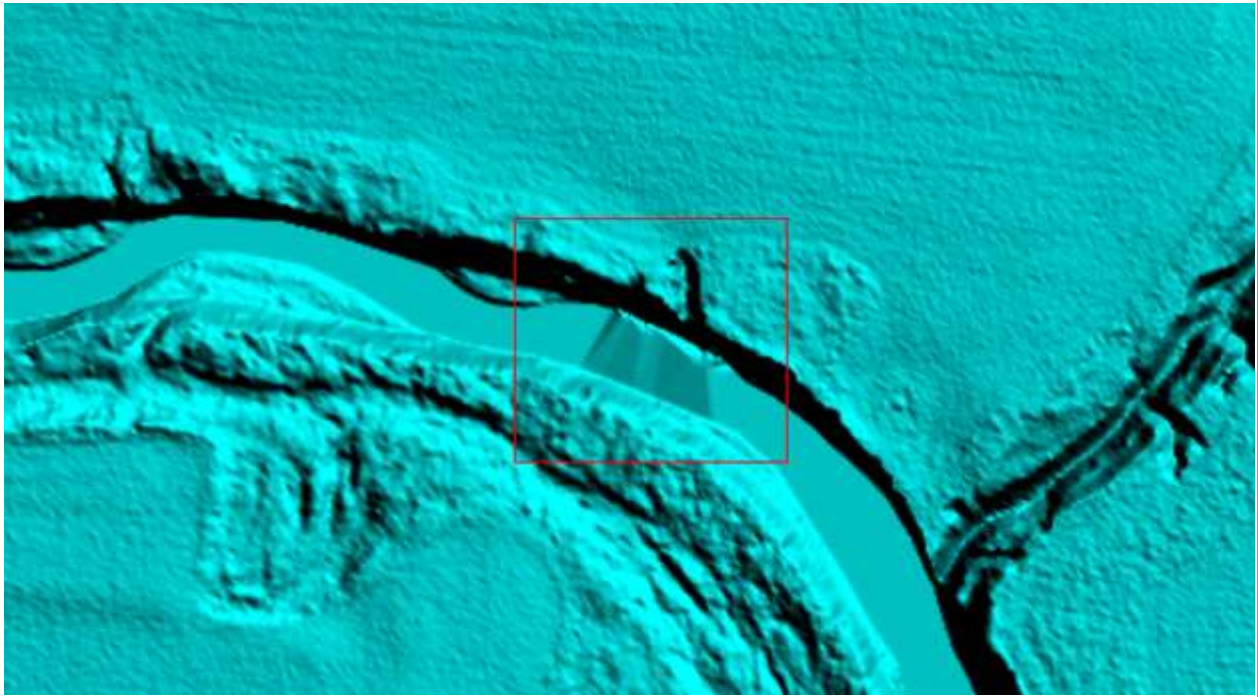
**Vendor corrected errors

☑ Image?

The shoreline along most of the reservoir above is elevated above the surrounding land. Location at 38° 23' 53.2916" N, 97° 07' 1.1953" W
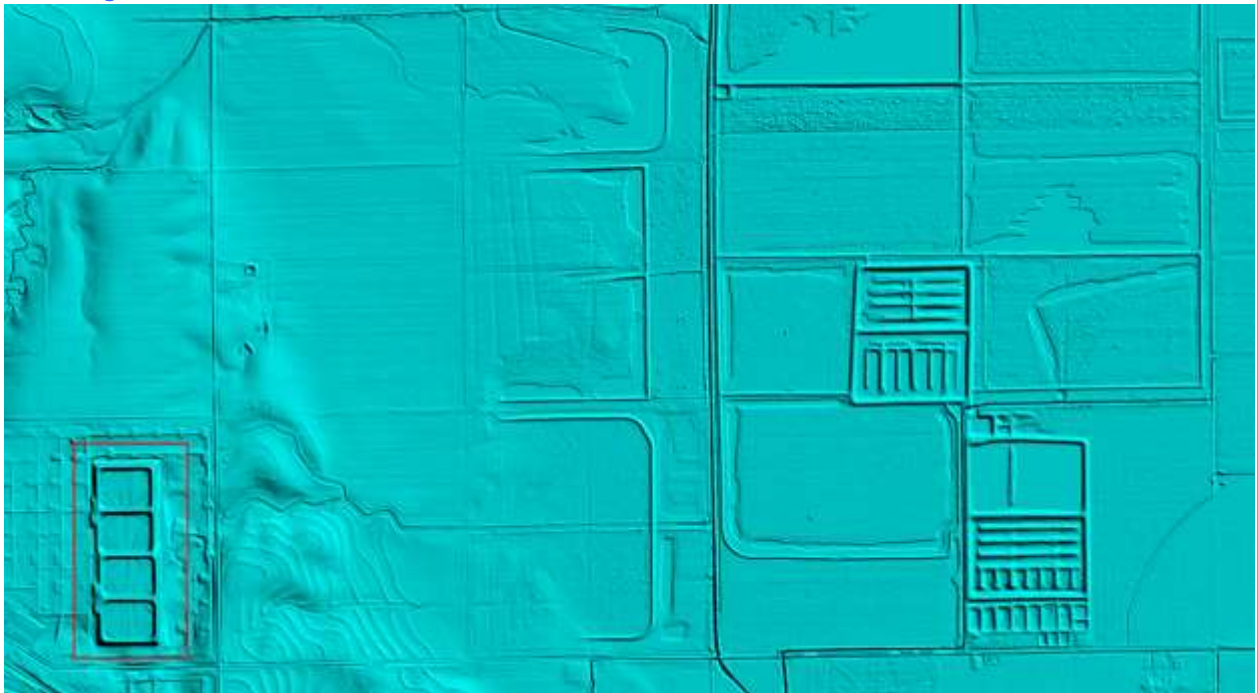
**Vendor corrected errors

☑ Image?

Water elevated above land. There are 4 errors of this type. This is only a representative image.
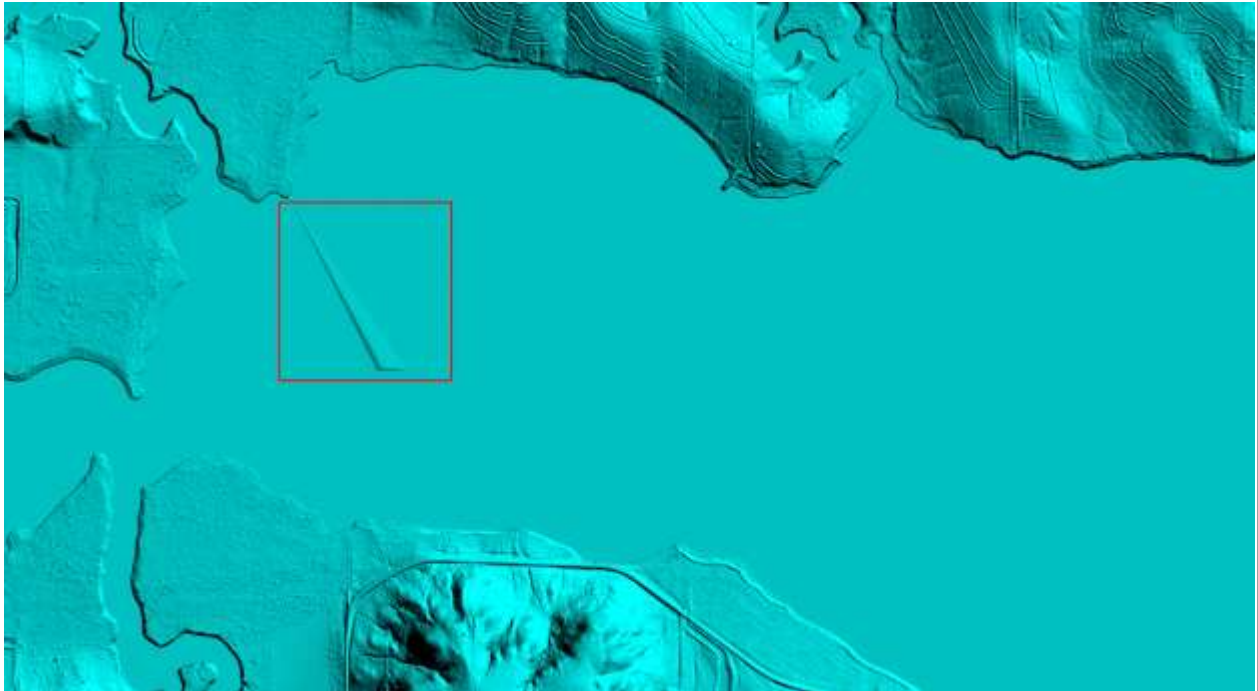
**Vendor corrected the errors.

☑ Image?

These need to be hydroflattened. The area is greater than 2 acres for each. Location at 38° 22' 24.3823" N, 97° 46' 52.0240" W
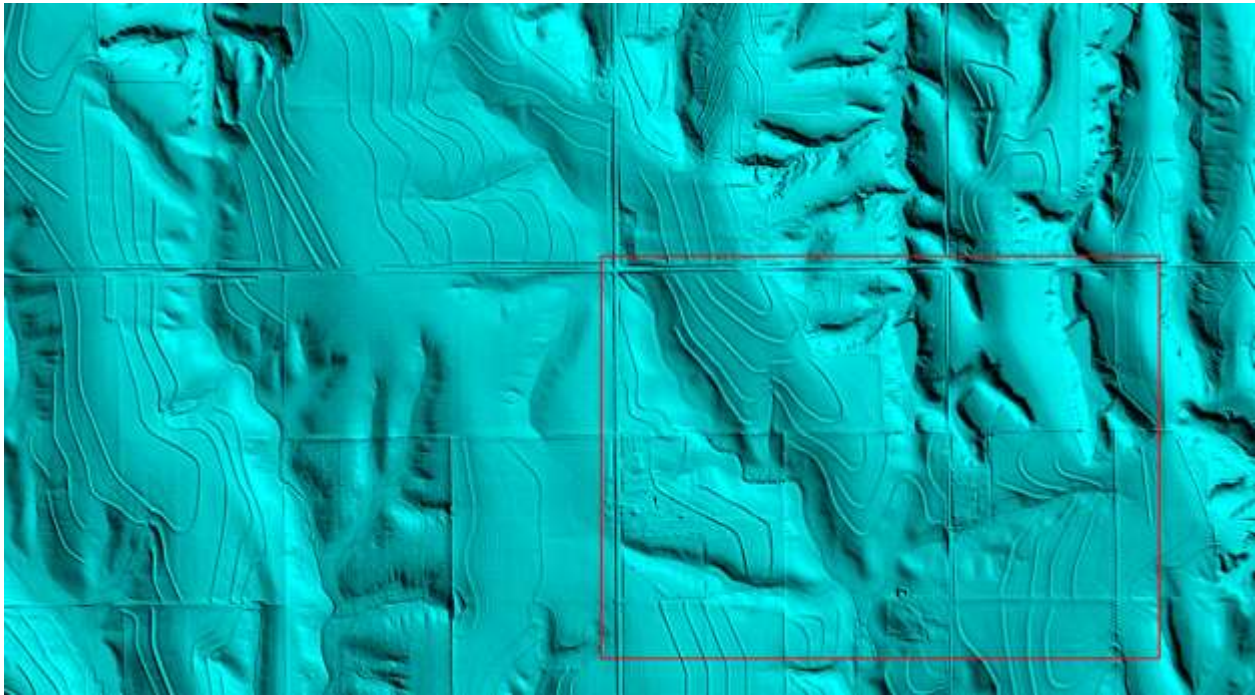
**Vendor corrected error

☑ Image?

Tinning in the waterbodies. There are 3 errors of this type. This is only a representative image.

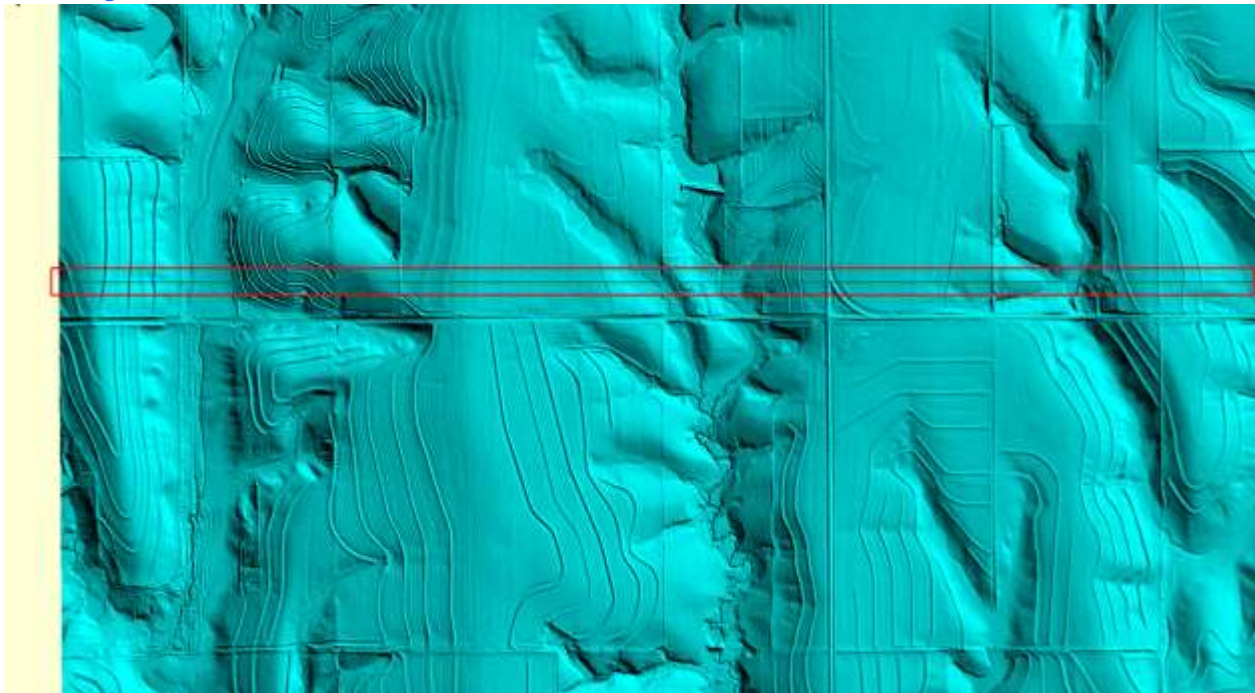**Above error not corrected (Jewell County). Vendor fixed other 2 errors

☑ Image?

Anomalous error in which the DEM has lines and gouges in the DEM. Location at
39° 59' 0.3406" N, 98° 21' 50.1239" W

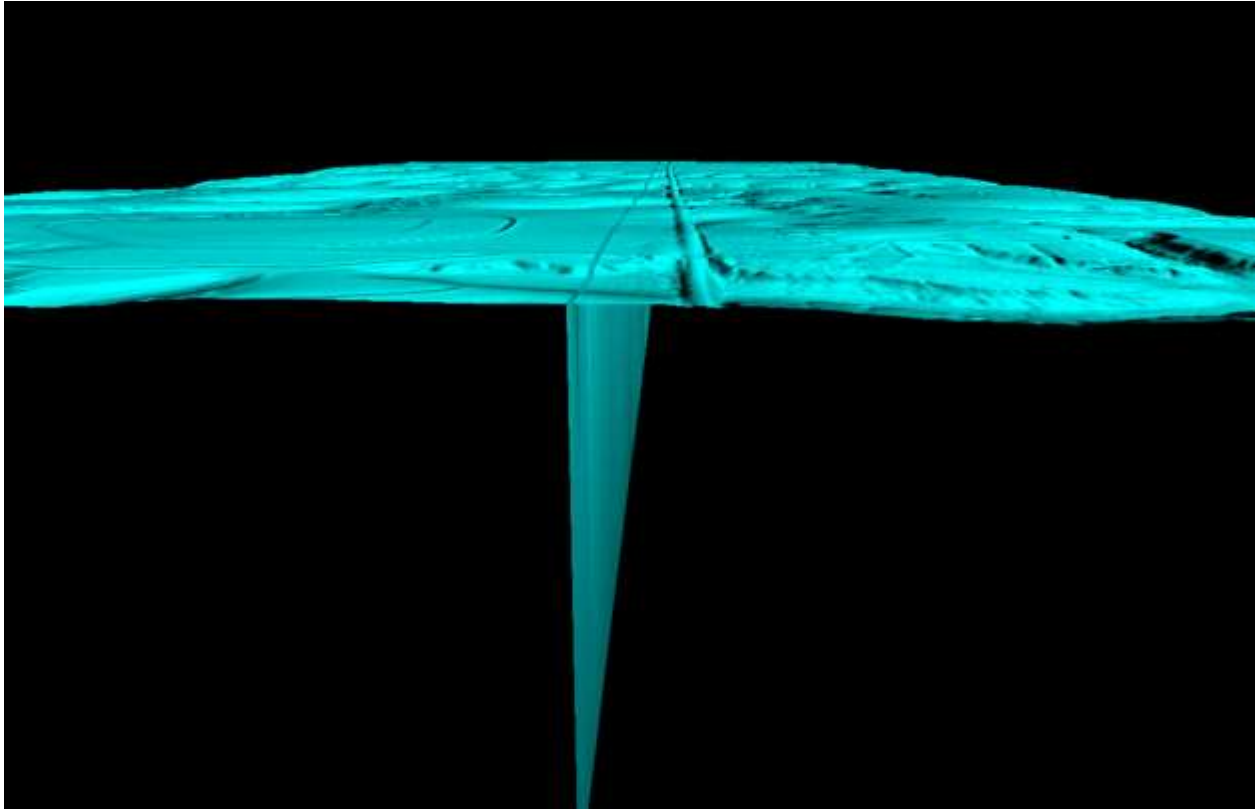**Vendor did not correct error (Jewell County)

☑ Image?

Anomalous error #2. There is a gap in the data that results in a 300+ meter drop on either side of the DEM. This error box is only a small section of the entire error which stretches across the length of the data. Location at 39° 58' 26.5944" N, 98° 29' 59.9340" W
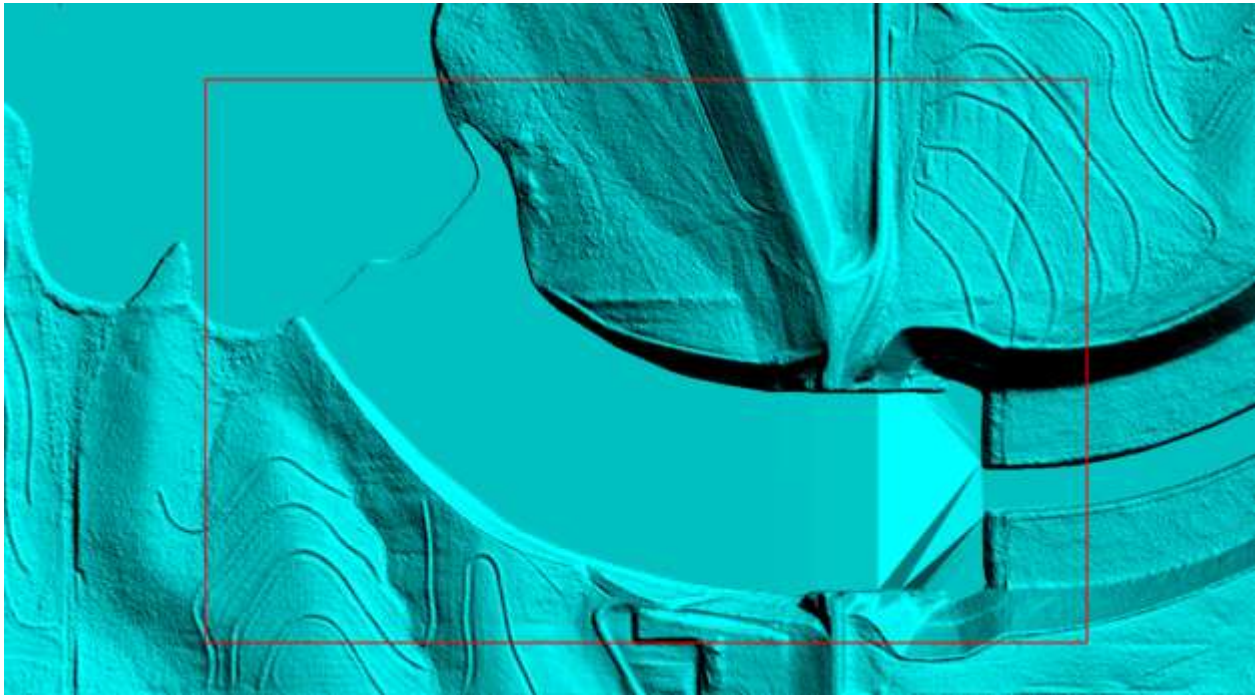
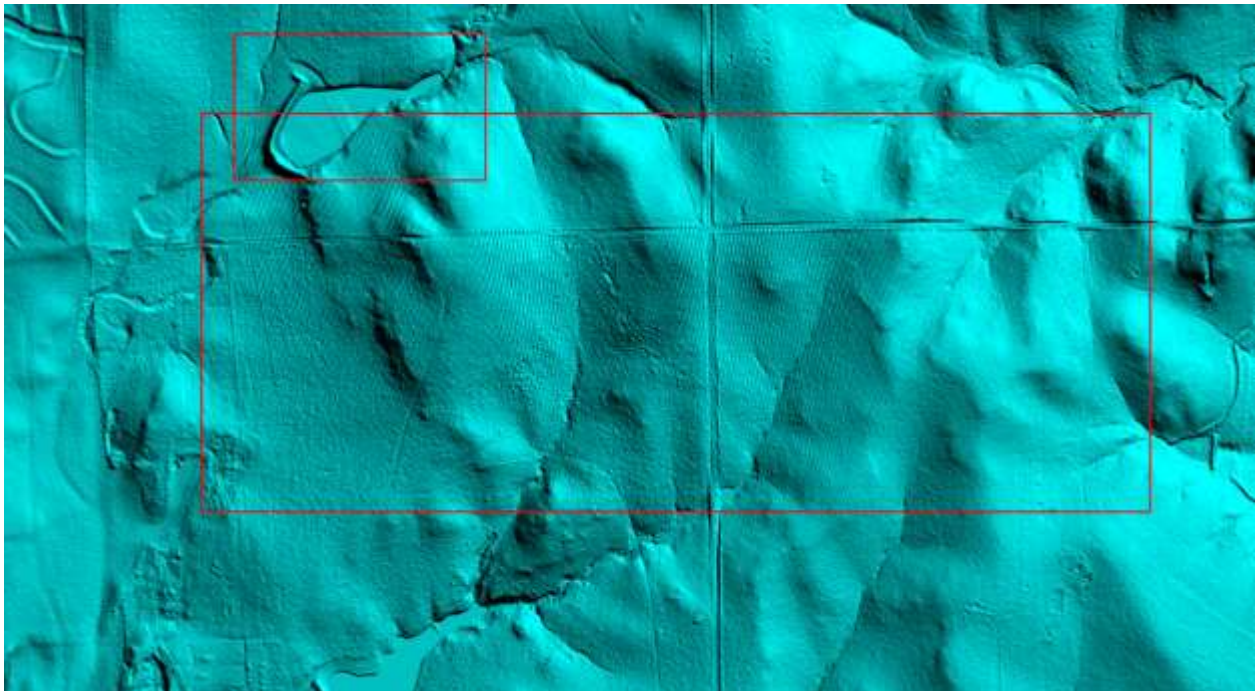**Vendor did not fix correct error (Jewell County)

☑ Image?

3D view of the above error.
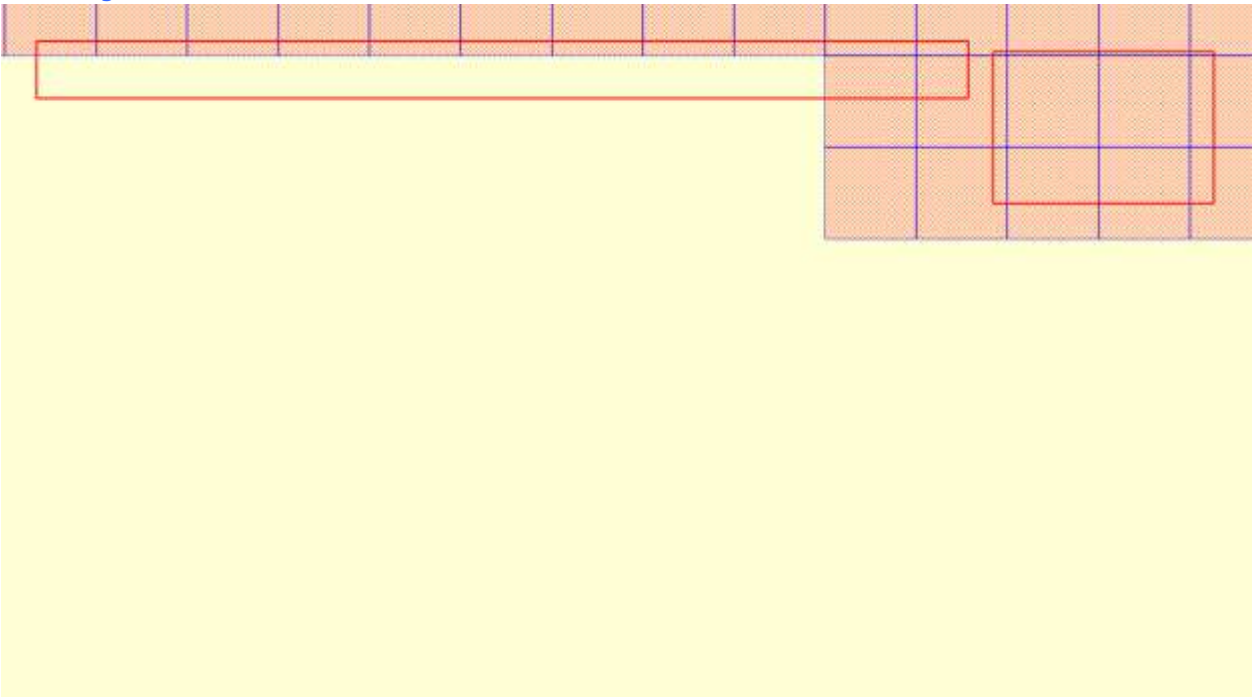
☑ Image?

**Vendor corrected error

☑ Image?

Anomalous error in which there are lines in a rectangular pattern in the DEM.
Location at 39° 11' 20.7963" N, 97° 55' 50.4278" W

**Vendor corrected error

☑ Image?

Two areas in which there are rectangular features that are raised above the land. Location at 38° 08' 36.4732" N, 97° 08' 11.0977" W

**Vendor corrected error

☑ Image?

Gap in the data between tiles 14SPH8015 and 14SPH8515 in Marion County.

Internal Note:

11 County, KS along with parts of Dodge City and USFWS are part of a larger project called KS_15County_2010 and represents Lot 3 of 3. Lots 1 and 2 are partnership data. The other 11 counties and two areas are donated data and will be Lot 3 (KS_11Counties_2010). Swath data is not broken up by county and will be provided in Lot 3. The classified .las files were broken up by county, but not the metadata, therefore classified .las will be provided in Lot 3 along with the metadata files. A best-use metadata file is provided in Lots 1 and 2 for the bare earth DEM files and las. A project level breaklines metadata file is also provided for all the lots, however, a separate breakline file is provided for each county.

The checkpoints were separated by FEMA blocks, each covering about 1000 square miles, and not by county. Due to this, vertical accuracy was ran on the entire project at once and the results are reported in each lot. The FVA was checked on the swath data with a result of 14.8 cm.

Point Cloud Statistics was ran for all 15 counties individually for the classified .las. and as one file for the entire project for swath .las.

Jewell County and Marion County still need corrections. For Jewell County, the original DEM data will be provided in the NED folder under be_rasters called Jewell. The corrected DEM file will also be provided in be_rasters in a folder called Jewell_Corrected_DEMs. The corrections provided for Jewell county were good, however, other errors were introduced into the corrected DEMs (floating waterbodies). Marion County has a gap in the data between two tiles and noted in the error image above. A Read Me file is provided in the data delivery that explains the issues with the dataset as well.

This is the end of the report.

QA Form V1.4 12OCT11.xsn