



## 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 [NGTOCooperations@usgs.gov](mailto:NGTOCooperations@usgs.gov).

Materials Received:

8/6/2012

Project Type: Donated Data

Project ID:

UT\_Ogden-FEMA

Project Description:

LiDAR generated point cloud acquired in October 2011 for a 116-square mile area encompassing Ogden UT.

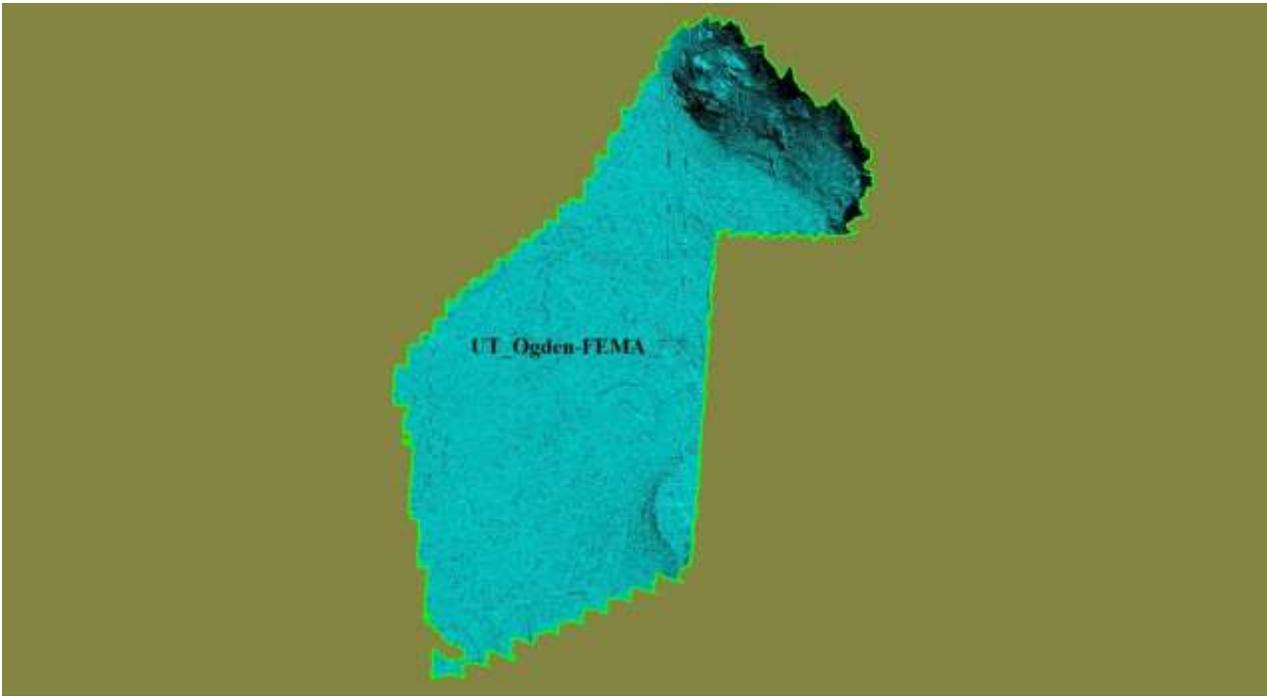
Project Alias(es):

Year of Collection: 10/2011

Lot 1 of 1 lots.

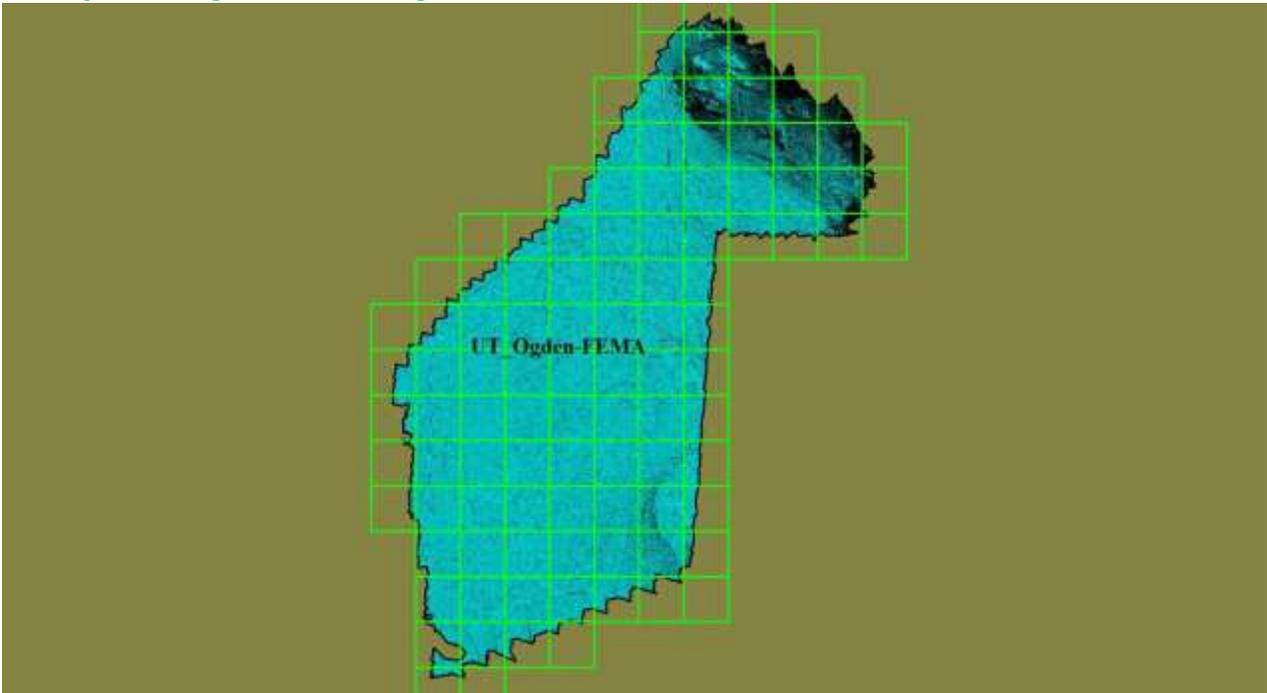
Project Extent:

Project Extent image?



Project Tiling Scheme:

Project Tiling Scheme image?



Contractor:

(Utah AGRC) and (USU)

Applicable Specification:

V13

Licensing Restrictions:

Third Party Performed QA?

Project Points of Contact:

| POC Name     | Type         | Primary Phone  | E-Mail             |
|--------------|--------------|----------------|--------------------|
| Dave Vincent | NSDI Liaison | (801) 975-3435 | dmvincent@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.

- |   |   |
|---|---|
| <input checked="" type="checkbox"/> Collection Report             | <input checked="" type="checkbox"/> Project Tiling Scheme Shapefile/Gdb |
| <input checked="" type="checkbox"/> Survey Report                 | <input type="checkbox"/> Breakline Shapefile/Gdb                        |
| <input checked="" type="checkbox"/> Processing Report             | <input checked="" type="checkbox"/> Project XML Metadata                |
| <input type="checkbox"/> QA/QC Report                             | <input checked="" type="checkbox"/> Swath LAS XML Metadata              |
| <input type="checkbox"/> Control and Calibration Points           | <input checked="" type="checkbox"/> Classified LAS XML Metadata         |
| <input checked="" type="checkbox"/> Project Shapefile/Geodatabase | <input type="checkbox"/> Breakline XML Metadata                         |
| <input type="checkbox"/> Control Point Shapefile/Gdb              | <input checked="" type="checkbox"/> Bare-Earth DEM XML Metadata         |

## Multi-File Deliverables

| File Type  | Quantity |
|--|----------|
| <input checked="" type="checkbox"/> Swath LAS Files      | 41       |
| <input type="checkbox"/> Intensity Image Files           |          |
| <input checked="" type="checkbox"/> Tiled LAS Files      | 105      |
| <input type="checkbox"/> Breakline Files                 |          |
| <input checked="" type="checkbox"/> Bare-Earth DEM Files | 104      |

## Additional Deliverables

| Item   |
|--|
| <input checked="" type="checkbox"/> DSM .img files = 104 |

Errors, Anomalies, Other Issues to document?  Yes  No

None.

# Project Geographic Information

Areal Extent:

116

Sq Mi

Grid Size:

1

meters

Tile Size:

2000x2000

meters

Nominal Pulse Spacing:

0.85

meters

Vertical Datum: NAVD88 using GEOID09 meters

Horizontal Datum: NAD83(CORS96) meters

Project Projection/Coordinate Reference System: UTM Zone 12N NAD 83 meters.

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

- |   |  |
|---|--|
| <input checked="" type="checkbox"/> Project Shapefile/Geodatabase       | <input type="checkbox"/> Breaklines XML Metadata File                |
| <input checked="" type="checkbox"/> Project Tiling Scheme Shapefile/Gdb | <input checked="" type="checkbox"/> Bare-Earth DEM XML Metadata File |
| <input type="checkbox"/> Checkpoints Shapefile/Geodatabase              | <input checked="" type="checkbox"/> Swath LAS Files                  |
| <input checked="" type="checkbox"/> Project XML Metadata File           | <input checked="" type="checkbox"/> Classified LAS Files             |
| <input checked="" type="checkbox"/> Swath LAS XML Metadata File         | <input type="checkbox"/> Breaklines Files                            |
| <input checked="" type="checkbox"/> Classified LAS XML Metadata File    | <input checked="" type="checkbox"/> Bare-Earth DEM Files             |

Check Point Shapefile/Geodatabase CRS

None delivered

Breakline XML Metadata CRS

None delivered

Breakline Files CRS

None delivered

# 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:

E. Jaramillo

Review Start Date:

8/23/2012

| Action to Contractor Date | Issue Description               | Return Date |
|---------------------------|---------------------------------|-------------|
| 9/17/2012                 | Water areas not hydro flattened | 10/4/2012   |

Review Complete: 10/9/2012

## 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 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):

- 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 notable to locate independent checkpoints for this analysis. USGS does not accept at this time the quality of the checkpoint data for these LiDAR datasets.

Errors, Anomalies, Other Issues to document?  Yes  No

Image?

Check points were collected for a whole group of counties only 3 are located in Ogden. Fundamental vertical accuracy was not reported as directed by the NDEP guidelines.

In addition to not having 20 checkpoints for FVA within Ogden itself (as mentioned above, checkpoints are across multiple counties), FVA appears to have only been checked against the DEM raster, not against the swath LAS. SVA and CVA are not assessed in this project. The project standards state that the minimum requirement for SVA is 18.5 cm RMSE(z). There is no way to assess this as SVA cannot be measured with RMSE(z) due to the non-normal distribution of error in the SVA category. Therefore, no SVA standard will be recorded below. No SVA was tested by the contractor. Also, there were no CVA standards listed in the project requirements provided to the USGS.

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:

Required FVA Value is   or less.

Target SVA Value is   or less.

Required CVA Value is   or less.

The reported FVA of the LAS Swath data is  .

The reported FVA of the Bare-Earth DEM data is  .

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 |
|-----------------------------|-----------|-------|
| <i>Tall Weeds and Crops</i> |           | N/A   |

|  |  |     |
|--|--|-----|
| <i>Brush Lands and Low Trees</i>                   |  | N/A |
| <i>Forested Areas Fully Covered by Trees</i>       |  | N/A |
| <i>Urban Areas with Dense Man-Made Structur...</i> |  | N/A |

The reported CVA of this data set is: .

## 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  .

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

Yes  No

Image?

## 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

Image for error?

Polylines that serve as breaklines for hydro-flattening were created in the LAS files as Breakline points not lines . So breaklines were not sent with this data.

## 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:

### 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 .

### Reported Accuracies

| Land Cover Category                   | # of Points                    | <u>Fundamental Vertical Accuracy @95% Confidence Interval (Accuracy<sub>2</sub>)</u><br>Required FVA = 24.5 or less. | <u>Supplemental Vertical Accuracy @95th Percentile Error</u><br>Target SVA = or less. | <u>Consolidated Vertical Accuracy @95th Percentile Error</u><br>Required CVA = or less. |
|---------------------------------------|--------------------------------|--|---|---|
| Open Terrain                          | <input type="text" value="3"/> | <input type="text" value="6.86"/>  |   |   |
| Tall Weeds and Crops                  | <input type="text" value=""/>  |  | <input type="text" value=""/>   |   |
| Brush Lands and Low Trees             | <input type="text" value=""/>  |  | <input type="text" value=""/>   |   |
| Forested Areas Fully Covered by Trees | <input type="text" value=""/>  |  | <input type="text" value=""/>   |   |
| Urban Areas with Dense                | <input type="text" value=""/>  |  |   |   |

|                     |   |  |  |  |
|---------------------|---|--|--|--|
| Man-Made Structures |   |  |  |  |
| Consolidated        | 3 |  |  |  |

QA performed Accuracy Calculations?

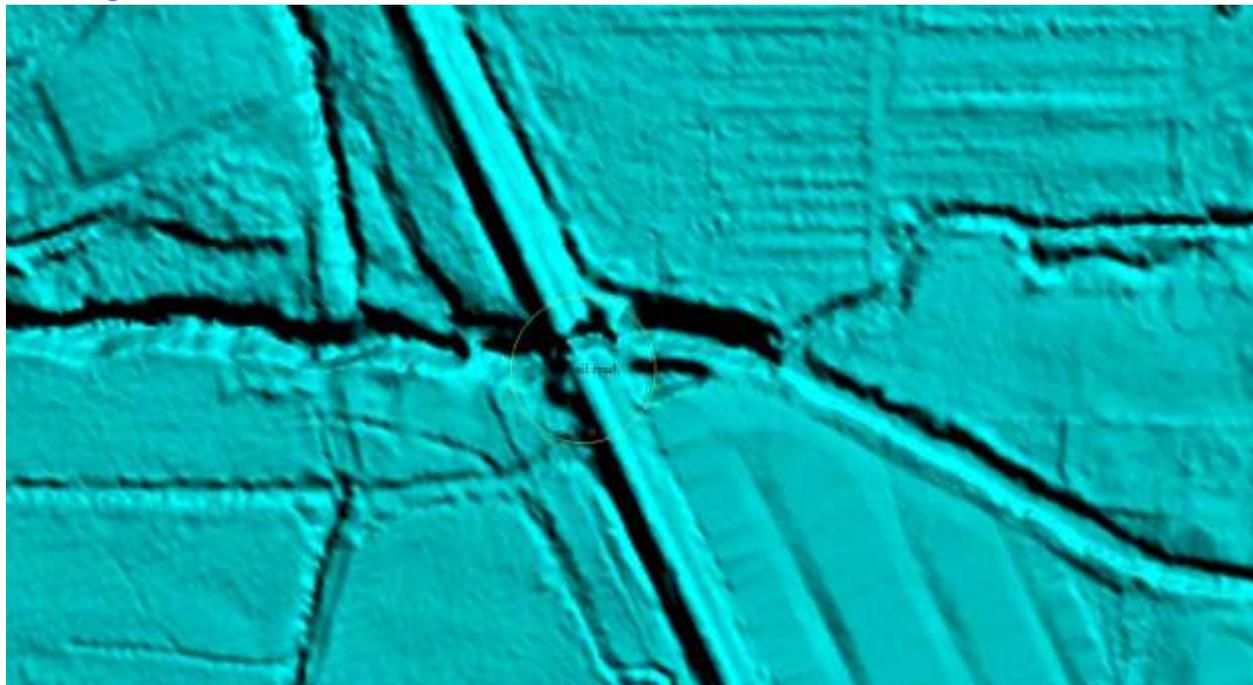
Based on this review, the USGS recommends the bare-earth DEM files for inclusion in the 1/3 Arc-Second National Elevation Dataset.

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

#### Bare-Earth DEM Anomalies, Errors, Other Issues

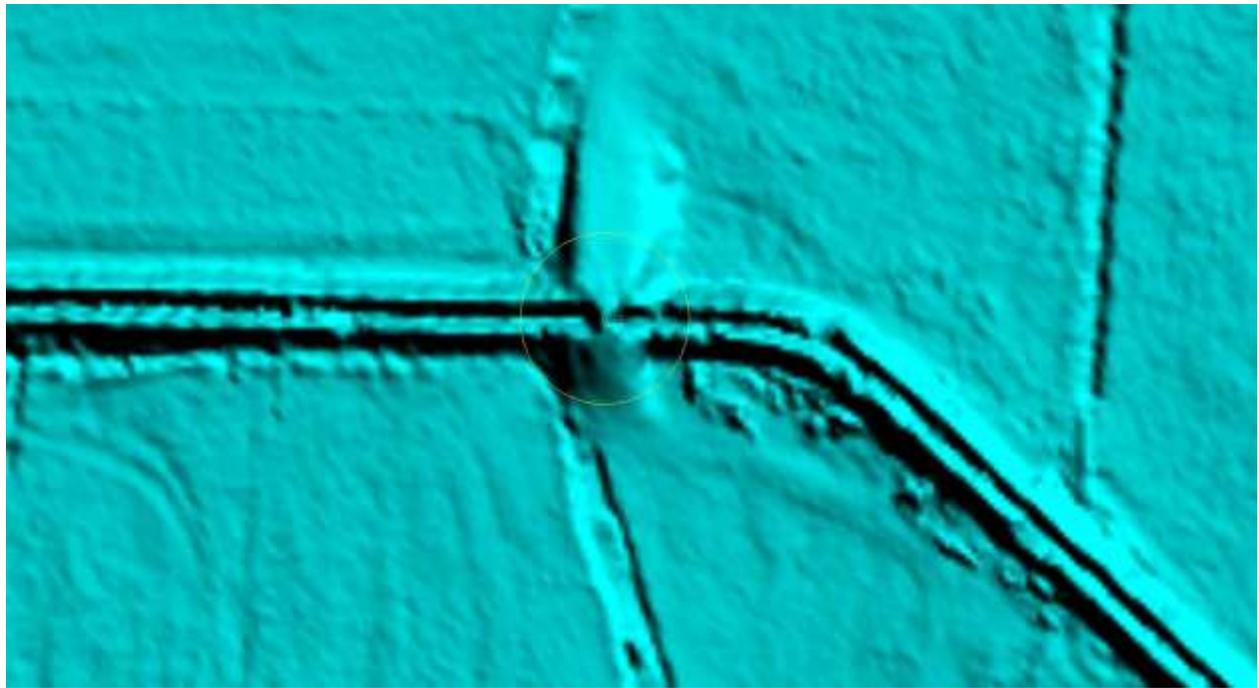
Errors, Anomalies, Other Issues to document?  Yes  No

Image?



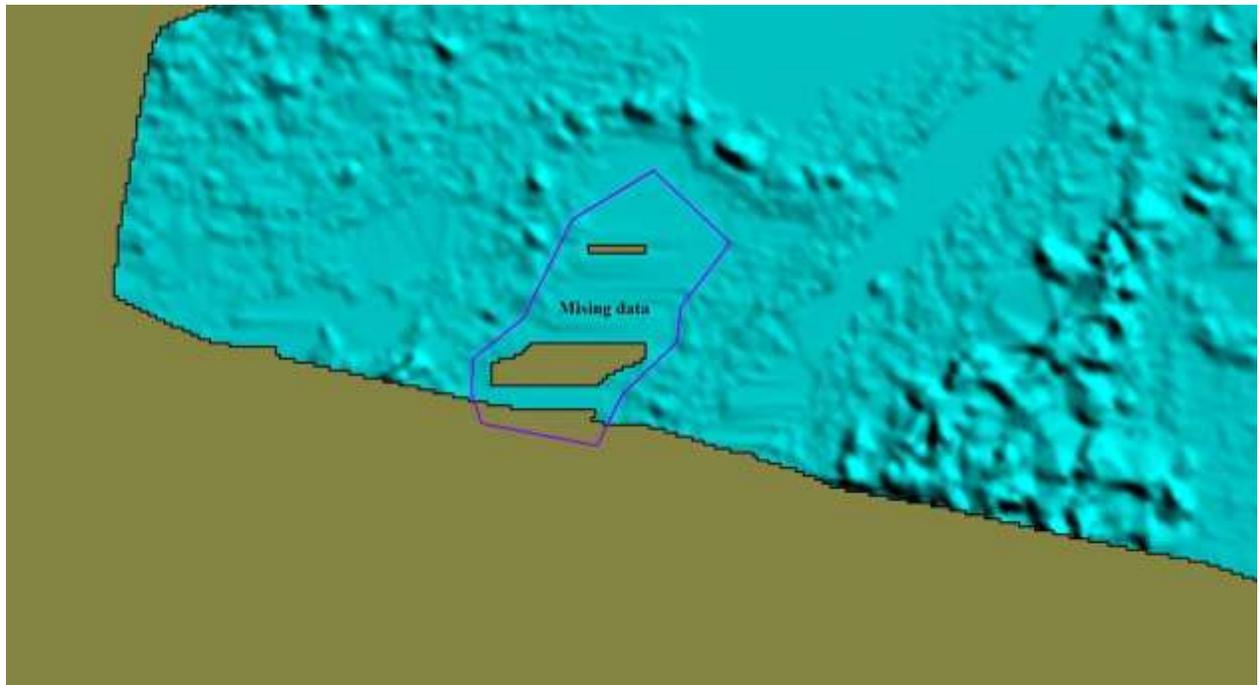
Rail road not fixed by the contractor

Image?



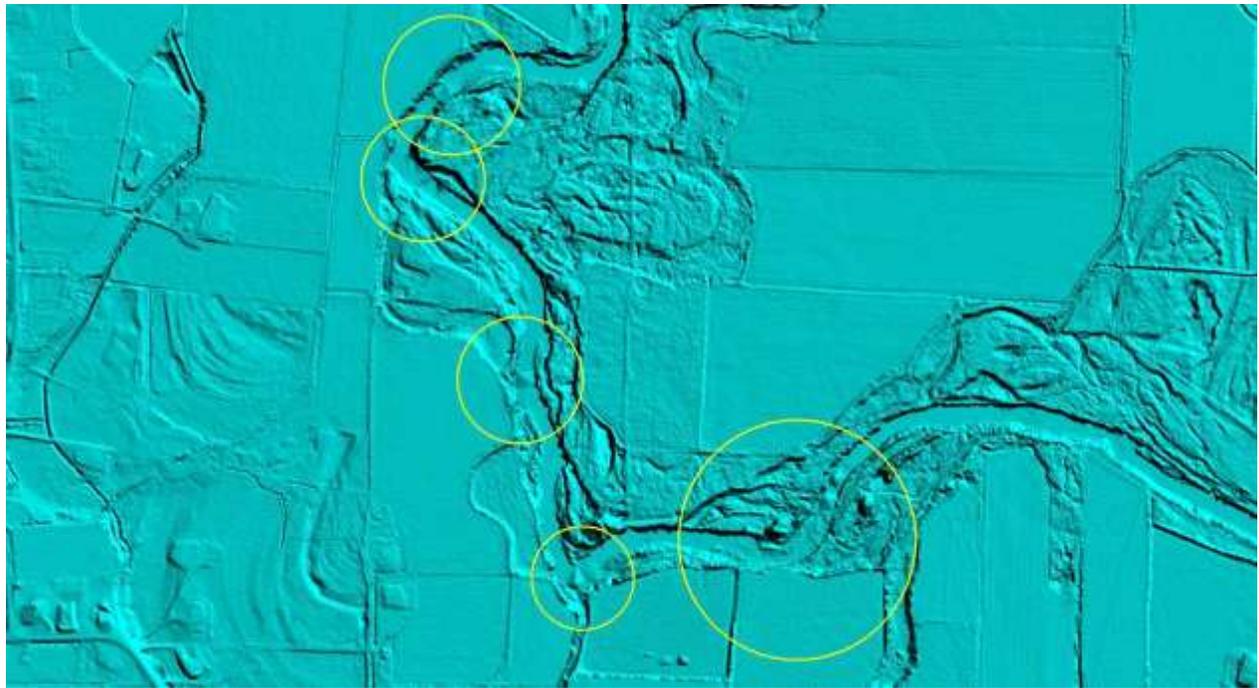
Road not fixed by the contractor

Image?



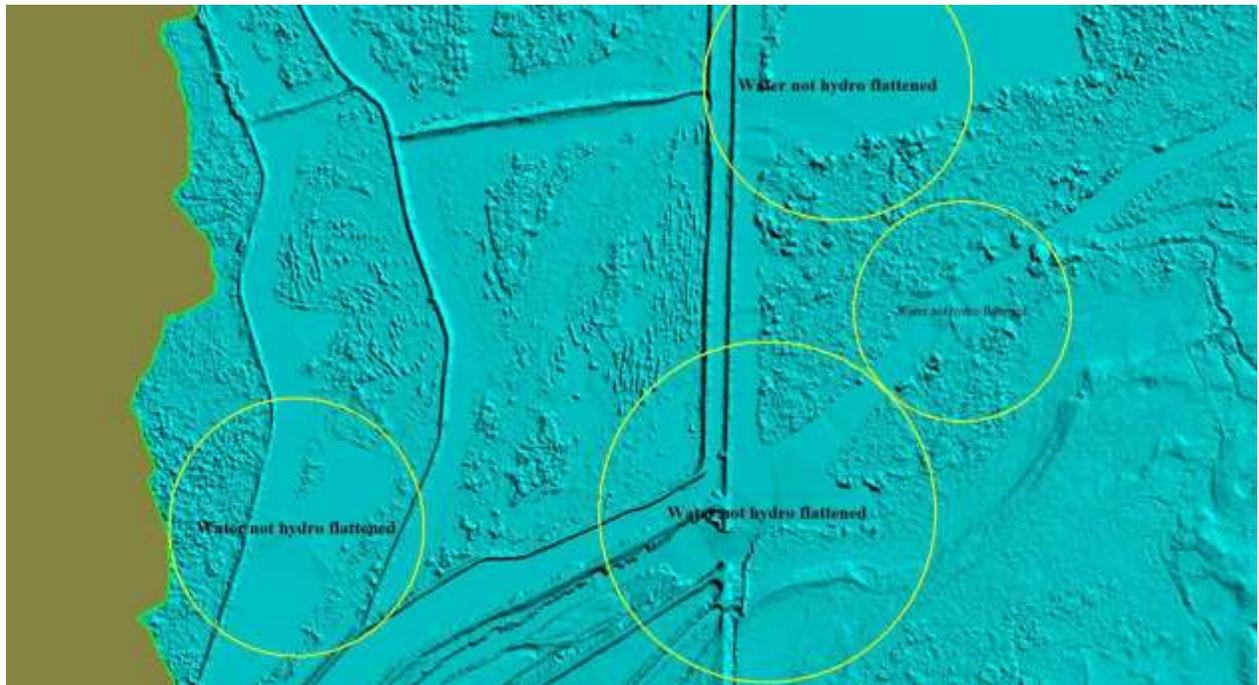
Missing data not fixed by the contractor

Image?



River errors fixed by the contractor

Image?



River errors fixed by the contractor

Internal Note:

Images above reflect examples of errors found throughout this dataset, most fixed by the contractor, we thank them for that.

**This is the end of the report.**

QA Form V1.4 12OCT11.xsn