



# 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.

Materials Received:

3/29/2013

Project Type:

Project ID:

AR\_Upper-White-Village\_2012

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 2.0 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 specification may be viewed at [http://lidar.cr.usgs.gov/USGS-NGP\\_Lidar\\_Guidelines\\_and\\_Base\\_Specification\\_v13\(ILMF\).pdf](http://lidar.cr.usgs.gov/USGS-NGP_Lidar_Guidelines_and_Base_Specification_v13(ILMF).pdf). These lidar specifications are required baseline specifications. In addition to the requirements listed below, variations from the specifications will be shown and noted below. For any item which is not specifically addressed, the referenced Version 13 specifications will be the required specification authority. This task is for lidar for a **high resolution data set of lidar of 185 square miles, to assist in floodplain mapping and for deaccreditation of the White River, Newport and Jacksonport Levees in northeastern Arkansas.**

Project Alias(es):

FEMA VI - Upper White Village Lidar

Year of Collection:

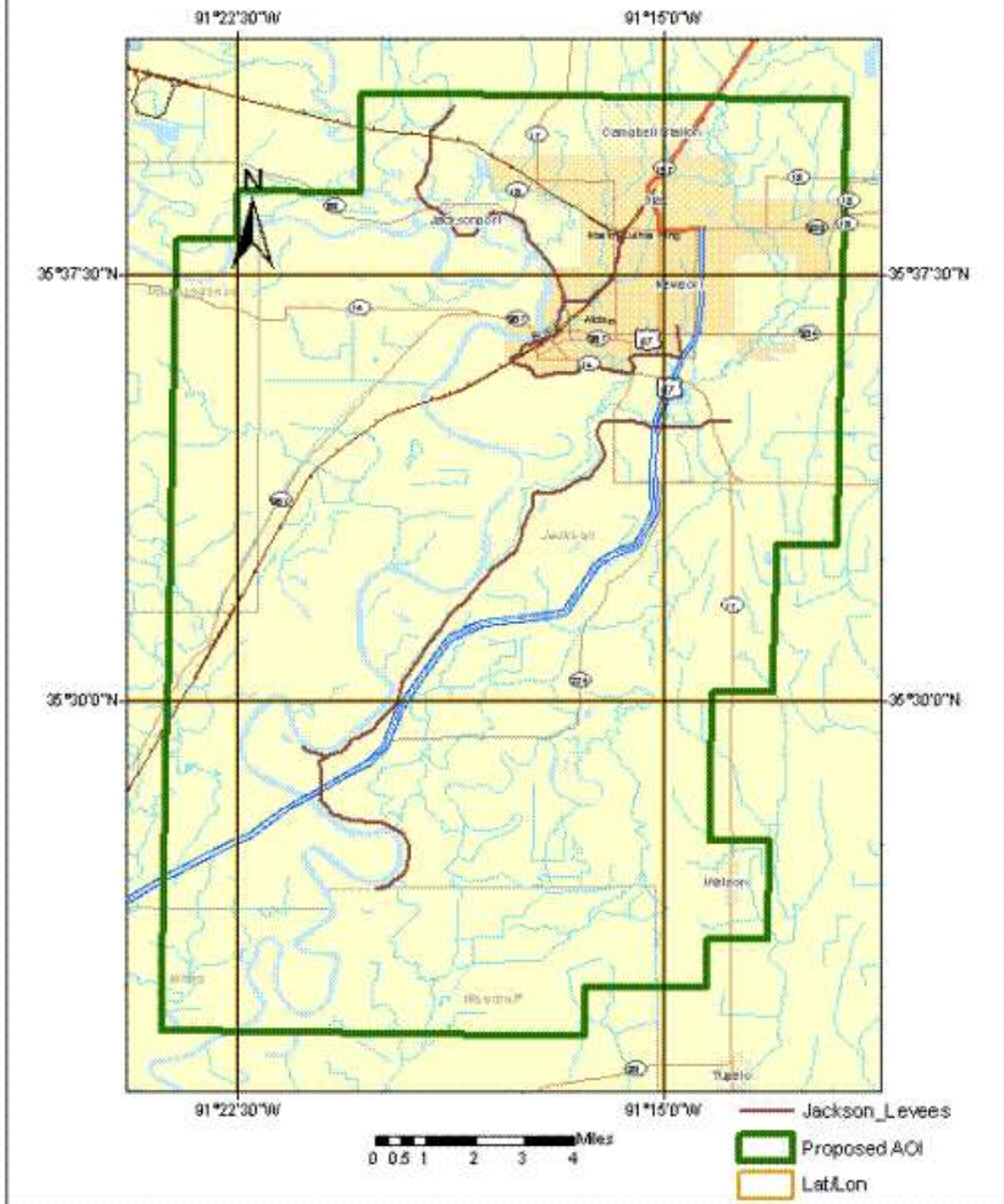
Lot  of  lots.

Project Extent:

Project Extent image?

# FY11 FEMA Region 6 & USGS LIDAR Acquisition Project

Proposed Area of Collection: Upper White Milage - 11010013



Project Tiling Scheme:

Project Tiling Scheme image?


Contractor:

3001, Inc.

Applicable Specification:

V13

Licensing Restrictions:

NONE

Third Party Performed QA?

Project Points of Contact:

POC Name	Type	Primary Phone	E-Mail
Robert Kelly	CPT	3612	ckelly@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
<input checked="" type="checkbox"/> Swath LAS Files <input checked="" type="checkbox"/> Required? <input checked="" type="checkbox"/> XML Metadata?	19
<input type="checkbox"/> Intensity Image Files <input type="checkbox"/> Required?	
<input checked="" type="checkbox"/> Tiled LAS Files <input checked="" type="checkbox"/> Required? <input checked="" type="checkbox"/> XML Metadata?	258
<input checked="" type="checkbox"/> Breakline Files <input checked="" type="checkbox"/> Required? <input checked="" type="checkbox"/> XML Metadata?	1
<input checked="" type="checkbox"/> Bare-Earth DEM Files <input checked="" type="checkbox"/> Required? <input checked="" type="checkbox"/> XML Metadata?	258

## Additional Deliverables

Errors, Anomalies, Other Issues to document?  Yes  No

None.

# Project Geographic Information

Areal Extent:

185

Sq Mi

Grid Size:

2

meters

Tile Size:

1500

meters

Nominal Pulse Spacing:

1

meters

Vertical Datum: North American Vertical Datum of 1988 meters

Horizontal Datum: North American Datum of 1983 Geodetic Reference System 80 meters

Project Projection/Coordinate Reference System: NAD\_1983\_UTM\_Zone\_15N meters.

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

- |   |  |
|---|--|
| <input checked="" type="checkbox"/> Project Shapefile/Geodatabase       | <input checked="" 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 checked="" 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 checked="" type="checkbox"/> Breaklines Files                 |
| <input checked="" type="checkbox"/> Classified LAS XML Metadata File    | <input checked="" type="checkbox"/> 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.

Reviewer:

K. Mantey

Review Start Date:

4/4/2013

Action to Contractor Date	Issue Description	Return Date
4/16/2013	Fixes to bare earth, hydro flattening.	4/25/2013

Review Complete: 4/25/2013

## 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

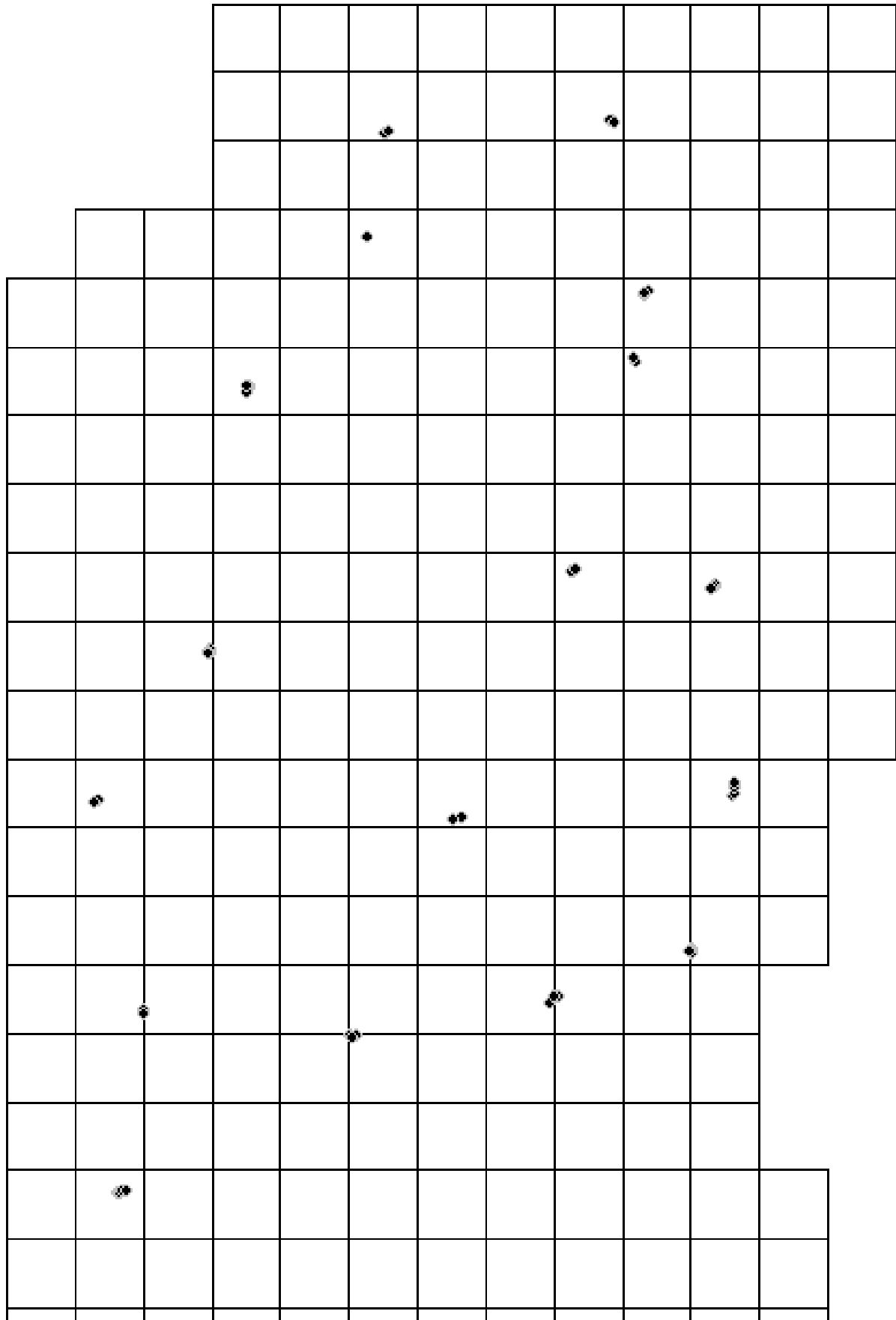
ASPRS recommends that checkpoint surveys be used to verify the vertical accuracy of LiDAR data sets. Checkpoints are to be collected by an independent survey firm licensed in the particular state(s) where the project is located. While subjective, checkpoints should be well distributed throughout the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

- 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?

There are points for Wetlands and Marsh. Since this report will not allow changing any of the categories, I have left Brush and Low trees checked to report the results for Wetlands and Marsh.

Image?

Metadata states 20 points were collected in each of the five predominate vegetation classes bare earth, tall weeds crops, Wetlands and Marsh. Needs to be corrected to reflect points were collected in only 3 overall categories.

04/25/2013: XML metadata files have been corrected. These files now only state that there are 3 overall categories in the project area.

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
Tall Weeds and Crops	<input type="text" value="0.35"/>	<input type="text" value="meters"/>
Brush Lands and Low Trees	<input type="text" value="0.35"/>	<input type="text" value="meters"/>
Forested Areas Fully Covered by Trees	<input type="text" value=""/>	<input type="text" value="N/A"/>
Urban Areas with Dense Man-Made Structu...	<input type="text" value=""/>	<input type="text" value="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.

Errors, Anomalies, Other Issues to document?  Yes  No

None.

## 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?

### 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

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

Errors, Anomalies, Other Issues to document?  Yes  No

Image?

There were no buy-up options specified in the task order. In two tiles (15SXV505645.las and 15SXV565480.las) there were some points in class 3 and class 5. In 15SXV565480.las there were also points in class 6. Since this additional classification does not diminish the quality of the dataset, the USGS will accept as is.

## Breakline File Review

Breaklines are vector feature classes that are used to hydro-flatten the bare earth Digital Elevation Models.

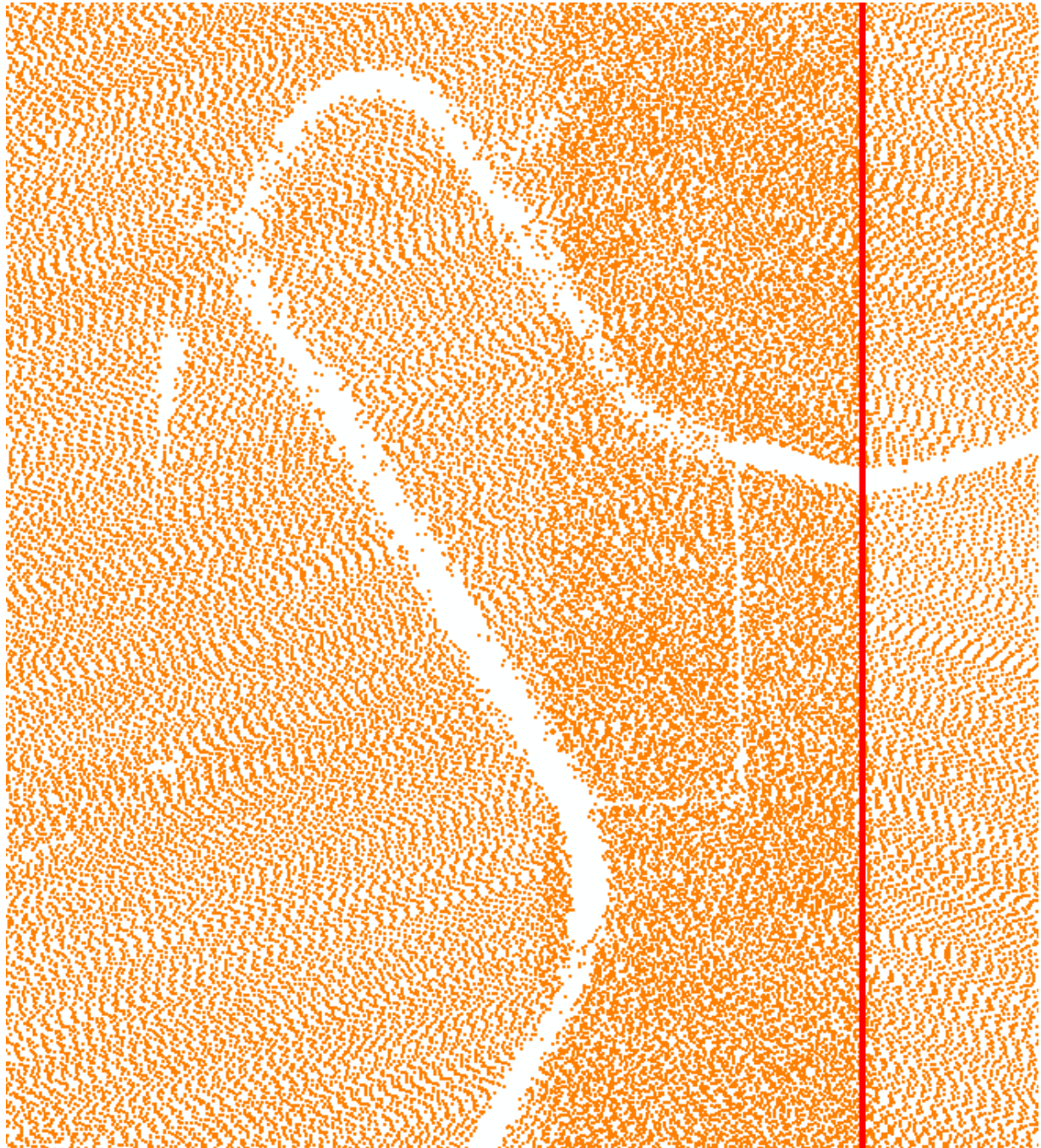
### Breakline File Characteristics

- Separate folder for breakline files
- All breaklines captured as PolylineZ or PolygonZ features
- No missing or misplaced breaklines

Based on this review, the USGS does not accept at this time the breakline files.

Errors, Anomalies, Other Issues to document?  Yes  No

Image for error?



This double line drain was not hydro-flattened. It appears to have a 100' nominal width. Please correct.

04/25/2013: Double line drain is hydro-flattened, and breakline was delivered. Breaklines and hydro-flattening are accepted.



## 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 <sub>z</sub> ) Required FVA = <span style="border: 1px solid black; padding: 2px;">0.245</span> or less.	Supplemental Vertical Accuracy @95th Percentile Error Target SVA = <span style="border: 1px solid black; padding: 2px;">0.363</span> or less.	Consolidated Vertical Accuracy @95th Percentile Error Required CVA = <span style="border: 1px solid black; padding: 2px;">0.363</span> or less.
Open Terrain	<span style="border: 1px solid black; padding: 2px;">20</span>	<span style="border: 1px solid black; padding: 2px;">0.19</span>		
Tall Weeds and Crops	<span style="border: 1px solid black; padding: 2px;">20</span>		<span style="border: 1px solid black; padding: 2px;">0.35</span>	
Brush Lands and Low Trees	<span style="border: 1px solid black; padding: 2px;">20</span>		<span style="border: 1px solid black; padding: 2px;">0.35</span>	
Forested Areas Fully Covered by Trees				
Urban Areas with Dense Man-Made Structures				
Consolidated	<span style="border: 1px solid black; padding: 2px;">60</span>			<span style="border: 1px solid black; padding: 2px;">0.35</span>

- QA performed Accuracy Calculations?

### Calculated Accuracies

		Fundamental Vertical Accuracy @95%	Supplemental Vertical Accuracy	Consolidated Vertical Accuracy

Land Cover Category	# of Points	Confidence Interval (Accuracy <sub>z</sub> ) Required FVA = <input type="text" value="0.245"/> or less.	@95th Percentile Error Target SVA = <input type="text" value="0.363"/> or less.	@95th Percentile Error Required CVA = <input type="text" value="0.363"/> or less.
Open Terrain	<input type="text" value="20"/>	<input type="text" value="0.17"/>		
Tall Weeds and Crops	<input type="text" value="20"/>		<input type="text" value="0.35"/>	
Wetlands and Marsh	<input type="text" value="20"/>		<input type="text" value="0.34"/>	
Forested Areas Fully Covered by Trees	<input type="text" value="1"/>		<input type="text" value="1"/>	
Urban Areas with Dense Man-Made Structures	<input type="text" value="1"/>		<input type="text" value="1"/>	
Consolidated	<input type="text" value="60"/>			<input type="text" value="0.34"/>

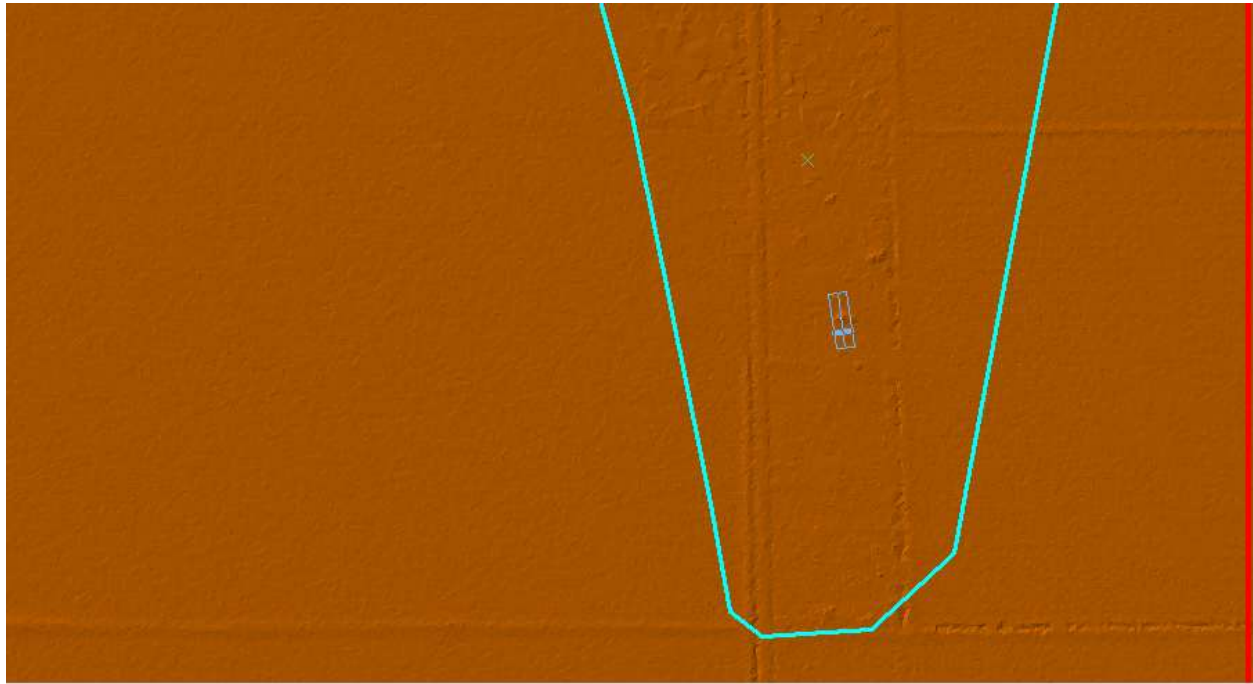
Based on this review, the USGS recommends the bare-earth DEM files for inclusion in the 1/3 Arc-Second National Elevation Dataset.

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?



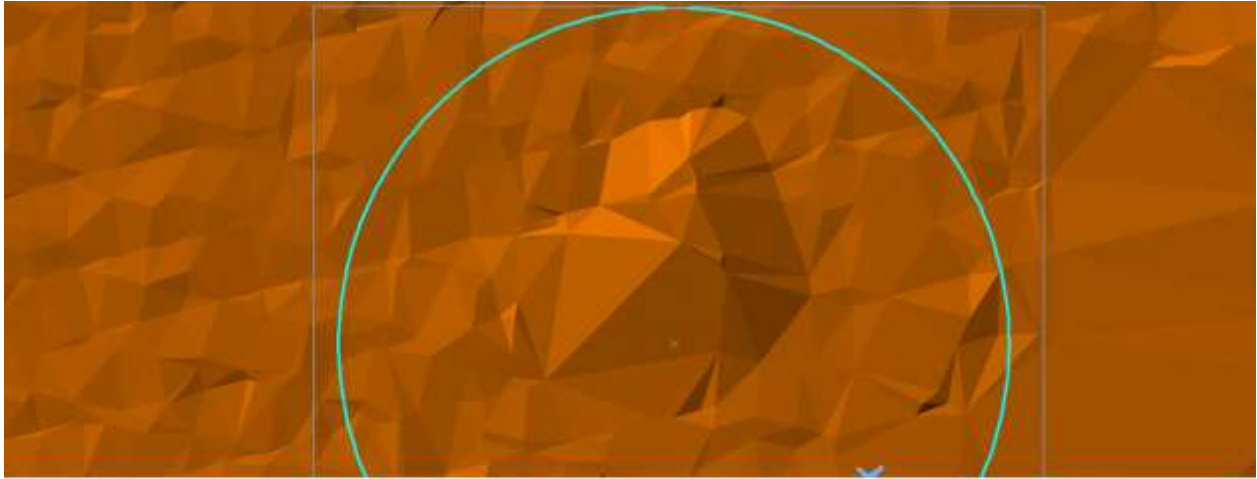
Destination Class:



This is one example of an error that was seen several times in this project. Some points that look to be vegetation are classified as ground. Please fix.

04/25/3013: Points were fixed, vegetation was removed from the DEM. All vegetation errors have been corrected.

Image?



This is an example of some sort of artifact that remained in the DEM. It appears that some of the points classified as ground are misclassified and need to be corrected.

04/25/2013: Point classifications have been corrected, and as a result, the artifacts found in the initial QA are no longer in the DEM data. All artifact errors noted have been corrected.

Image?

There are a couple areas in this project where it appears that bridges have not been appropriately classified and subsequently removed from the DEM. These are marked in the "errors to contractor" shapefile. These need to be addressed prior to project acceptance.

04/25/2013: Upon further review of the data by both the NGTOC and the contractor, the bridges appear to be culverts. Culverts are preserved in the DEM surface. These areas have been removed from the "errors to contractor" shapefile.

Image?

The following issues discussed above must be addressed prior to project acceptance:

1. Corrections to Metadata files
2. Hydro-flattening of double line drain
3. Reclassification of non-bare earth features

Errors found in the actual data have been identified by the "errors to contractor" shapefile that will be provided along with this report.

04/25/2013: All errors above have been corrected. This dataset is accepted.

Based on this review, the deliverables provided meet the Task Order requirements.

#### Internal Note:

Processing step for NED.

The img files were loaded into ArcMap. Using "mosaic to new raster" tool with the "blend" method the FINAL\_TO\_NED img was produced. Original projection, resolution, and file format were kept for this raster.

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

QA Form V1.4 12OCT11.xsn