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:
10/1/2012

Project Type: Partnership

Project ID:
MO_Cooper_2011

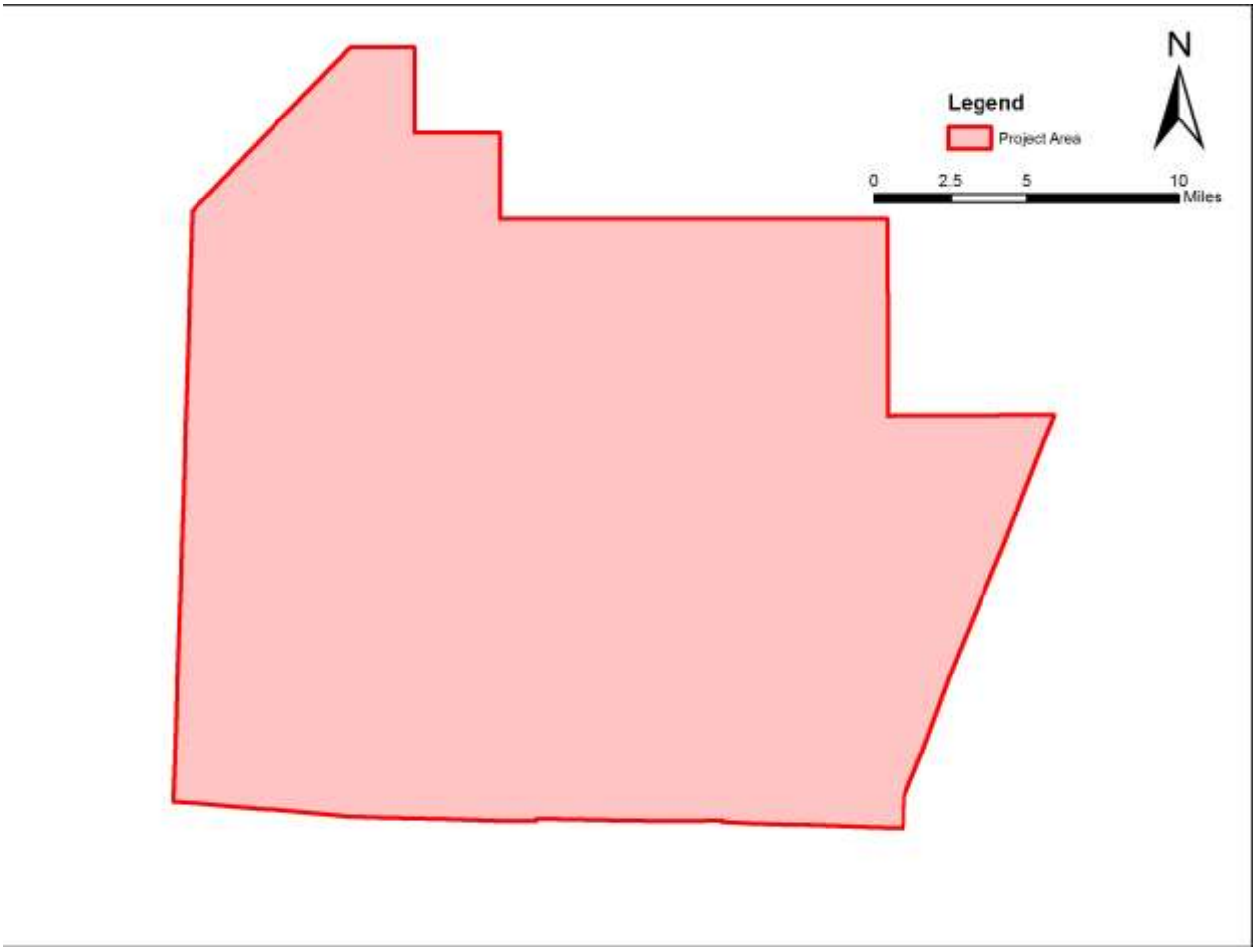
Project Description:
Portion of Cooper County, Missouri (Part of Delivery 4 of 4 for the MO Grand Project)

Project Alias(es):

Year of Collection: 2011

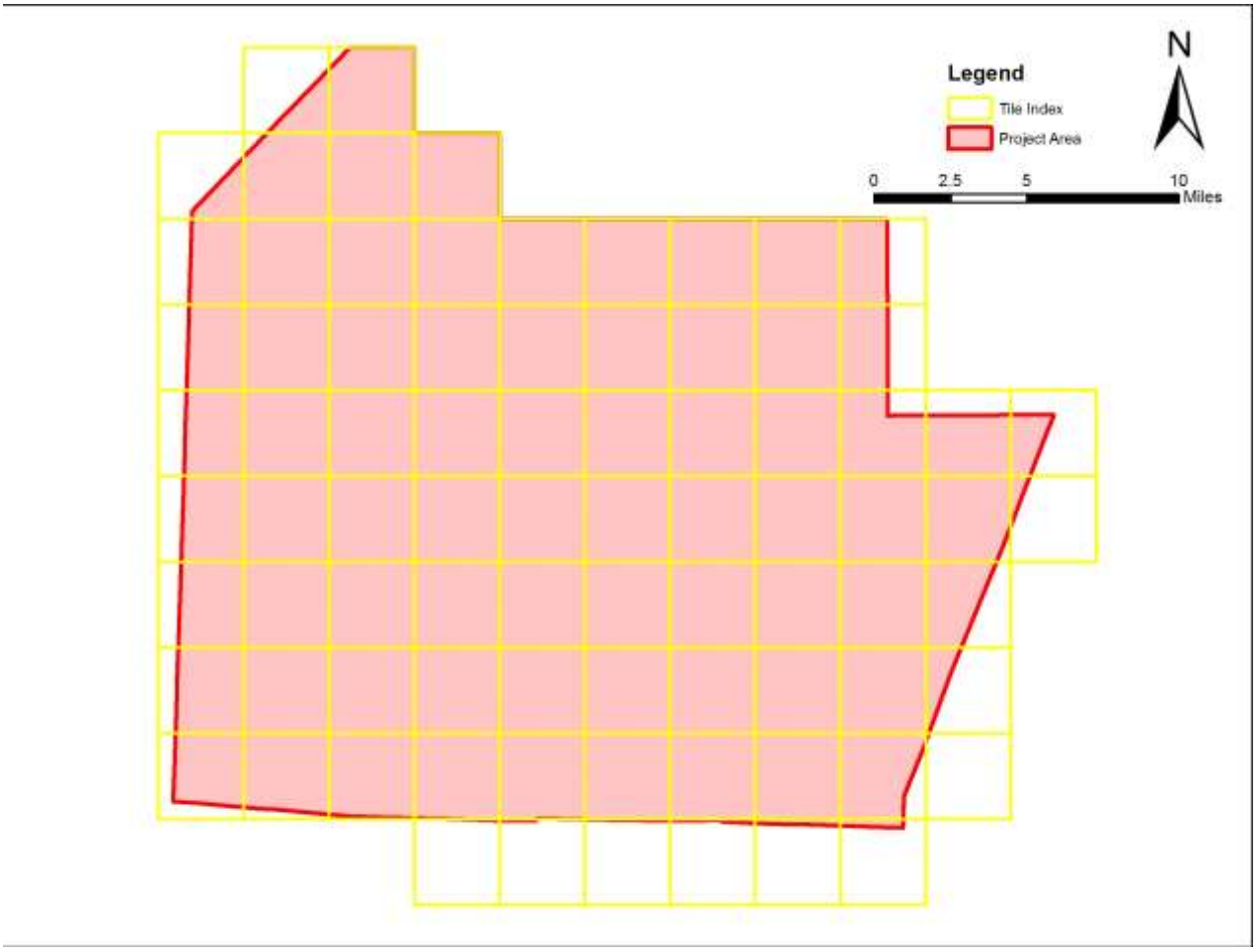
Lot 4 of 4 lots.

Project Extent:
☑ Project Extent image?



Project Tiling Scheme:

☑ Project Tiling Scheme image?



Contractor:

Surdex

Applicable Specification:

V13

Licensing Restrictions:

None.

☐ Third Party Performed QA?

Project Points of Contact:

POC Name	Type	Primary Phone	E-Mail
Ray Fox	NSDI Liaison	573-308-3744	rfox@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.

- [x] Collection Report
- [x] Survey Report
- [x] Processing Report
- [x] QA/QC Report
- [x] Control and Calibration Points
- [ ] Project Shapefile/Geodatabase
- [x] Project Tiling Scheme Shapefile/Gdb
- [x] Control Point Shapefile/Gdb
- [x] Breakline Shapefile/Gdb
- [ ] Project XML Metadata

Multi-File Deliverables

File Type		Quantity
[x] Swath LAS Files [x] Required? [ ] XML Metadata?		49
[ ] Intensity Image Files [ ] Required?		
[x] Tiled LAS Files [x] Required? [x] XML Metadata?		82
[x] Breakline Files [x] Required? [ ] XML Metadata?		84
[x] Bare-Earth DEM Files [x] Required? [x] XML Metadata?		82

Additional Deliverables

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

No Project XML Metadata will be provided.

Project Geographic Information

Areal Extent:

566.5

Sq Mi

Grid Size:

1

meters

Tile Size:

varies

Select...

Nominal Pulse Spacing:

.90

meters

Vertical Datum: NAVD88 meters

Horizontal Datum: NAD83 meters

Project Projection/Coordinate Reference System: NAD_1983_UTM_Zone_15N 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
- [ ] Project XML Metadata File
- [ ] Swath LAS XML Metadata File
- [x] Classified LAS XML Metadata File
- [ ] 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

Project XML Metadata CRS

None provided.

Swath LAS XML Metadata CRS

None provided.

Breakline XML Metadata 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:

A. Lowe

Review Start Date:

10/23/2012

Action to Contractor Date	Issue Description	Return Date
10/30/2012	Overlapping Classified LAS and Bare-Earth DEM tiles. Vertical Accuracy incorrectly reported. FVA of Swath LAS not within required threshold.	
4/15/2013	XML Metadata Update; Unknown Swath LAS Coordinate System	

Review Complete: 6/6/2013

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 with errors.

None provided.

The Classified LAS XML Metadata file parsed without errors.

The Bare-Earth DEM XML Metadata file parsed withouterrors.

Project QA/QC Report Review

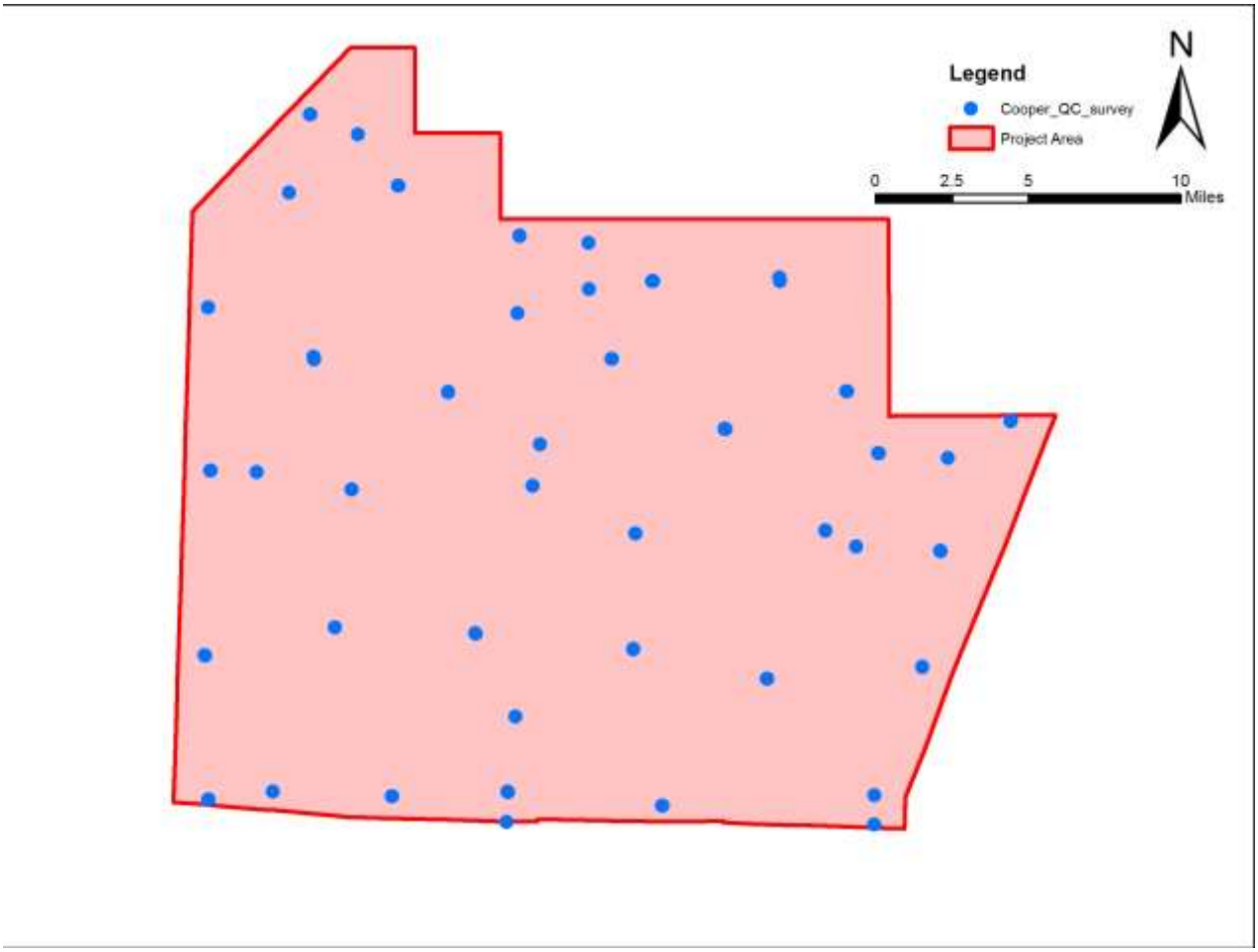
ASPRS recommends that checkpoint surveys be used to verify the vertical accuracy of LiDAR data sets. Checkpoints are to be collected by an independent survey firm licensed in the particular state(s) where the project is located. While subjective, checkpoints should be well distributed throughout the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

- [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 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

- [x] Image?

Stat	Hard Surface	Grass	Trees	Overall
Count	32	31	30	93
Average	-0.033	-0.083	-0.074	-0.063
RMSE	0.064	0.106	0.102	0.092
95% Confidence Level	0.126	0.208	0.200	0.181

The only accuracy values reported by Surdex Corporation describe the "LAS bare-earth surface developed from the LiDAR data". They are listed in the above table. The FVA (Hard Surface) value was calculated at the 95-percent confidence level as a function of vertical RMSE. The FVA and CVA values were calculated using the same method. This is not recommended according to the "NDEP Guidelines for Digital Elevation Data". A nonparametric testing method (95th Percentile) should be employed for supplemental and consolidated accuracy tests. No accuracies were reported for the DEM.

UPDATE: The accuracy values are now reported correctly.

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 0.140 meters.

The reported FVA of the Bare-Earth DEM data is 0.111 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	0.203	meters
Brush Lands and Low Trees		meters
Forested Areas Fully Covered by Trees	0.187	meters
Urban Areas with Dense Man-Made Structu...		meters

The reported CVA of this data set is: 0.173 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 0.140 meters.

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

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

- [ ] Image?

The FVA of the Swath LAS Data is 2.99 meters (NSSDA, 95% Confidence Interval). The swath data needs to be calibrated to meet the FVA requirement of .245 meters or less.

☑ Image?

UPDATE: The swath data was calibrated and the FVA is now 0.115 meters at the 95% Confidence Interval; however, one survey point had to be removed due to its location in a forested area. The removed point is "C7HS". The image above shows a TIN of the swath LAS points and the location of the removed point. This point had a Z Error of -8.785 meters, which indicates that the survey ground elevation is 8.785 meters less than the swath LAS TIN surface elevation. Swath LAS files have an Unknown Coordinate System.

☐ Image?

UPDATE 6/6/2013: Swath LAS files have been updated with coordinate reference system.

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:

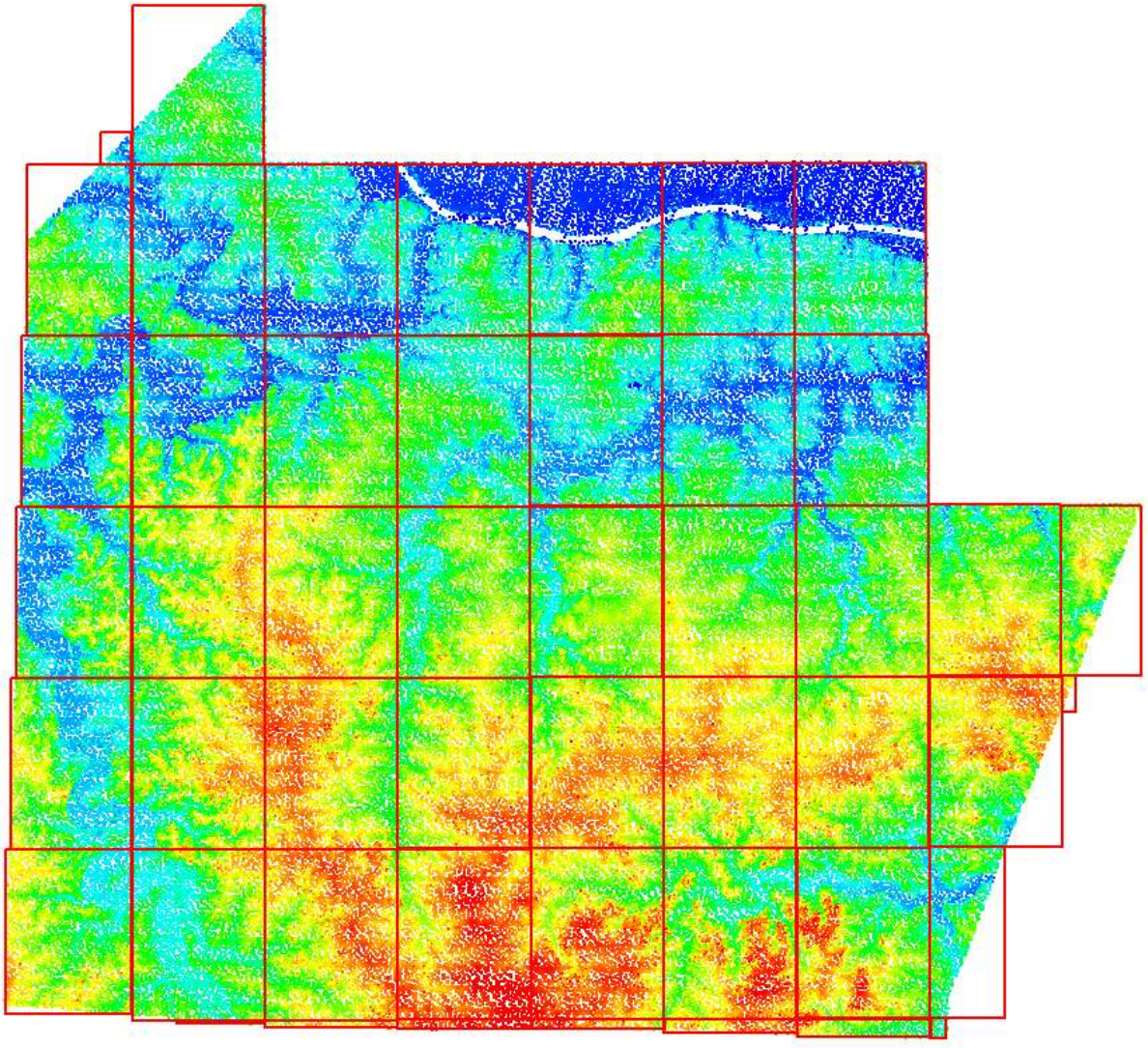
Code	Description
1	Processed, but unclassified
2	Bare-earth ground
7	Noise (low or high, manually identified, if needed)
9	Water
10	Ignored ground (breakline proximity)
11	Withheld (if the "Withheld" bit is not implemented in processing software)

☐ Buy up?

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

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

☑ Image?



Classified LAS tile files overlap.

☐ Image?

UPDATE: Classified LAS tiles no longer overlap.

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

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: ArcGrid

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	34	0.111		
Tall Weeds and Crops	34		0.203	
Brush Lands and Low Trees				
Forested Areas Fully Covered by Trees	30		0.187	
Urban Areas with Dense Man-Made Structures				
Consolidated	98			0.173

☑ 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	34	0.111		
Tall Weeds and Crops	34		0.203	
Brush Lands and Low Trees				
Forested Areas Fully Covered by Trees	30		0.187	
Urban Areas with Dense Man-Made Structures				
Consolidated	98			.173

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

None.

Internal Note:

4/15/2012 - UPDATE:

All previously identified issues have been corrected; however, the XML metadata is still incomplete. All vertical accuracy values need to be reported as they are in the document "LiDAR Accuracy Report St. Louis". Additionally in the review of the redelivery, it was noted that the Swath LAS files have an Unknown Coordinate System.

6/6/2013 - The Swath LAS files have been updated with the coordinate system information. None of the XML Metadata has been corrected, and will not be corrected. The project is therefore being accepted "as is".

This is the end of the report.

QA Form V1.4 12OCT11.xsn