LiDAR Quality Assessment Report

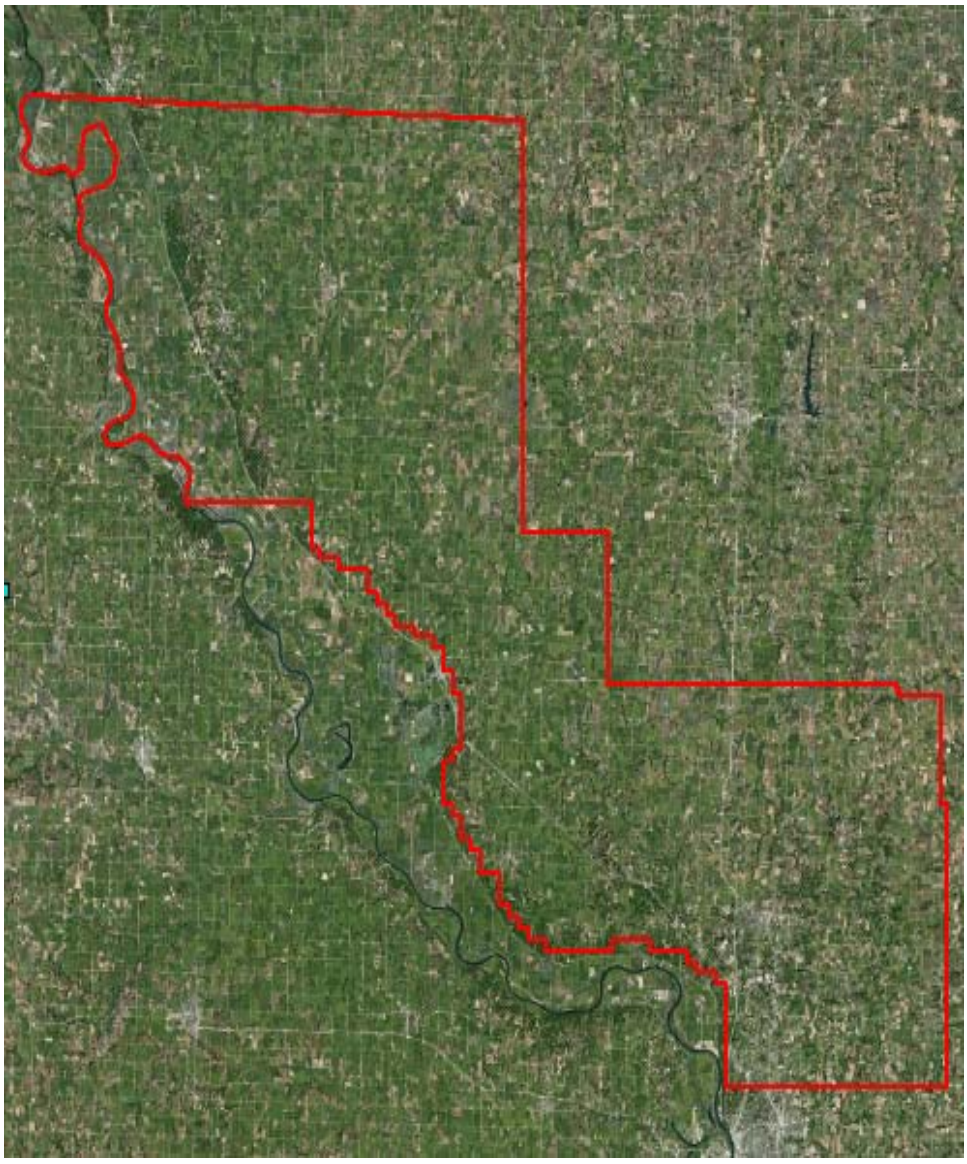
The USGS National Geospatial Technical Operations Center, Data Operations Branch is responsible for conducting reviews of all Light Detection and Ranging (LiDAR) point-cloud data and derived products delivered by a data supplier before it is approved for inclusion in the National Elevation Dataset. The 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.

MO_Atchison-Holt-Andrew_2013

NGTOC

2016-02-16

Stephanie Fulk



Project Information

Project: MO_Atchison-Holt-Andrew_2013

Contractor: Surdex

Project Type:
Contributed

Applicable Specification:
NGP LiDAR Base Specification V 1.0

Project Points of Contact:

Name:	Type:	Email:
Shelley Silch	NGP Liaison	ssilch@usgs.gov

REPORT QUALIFICATION SUMMARY:

Metadata:
1 of 1 Reviews Accepted
0 Reviews Not Accepted

Vertical Accuracy:
1 of 1 Reviews Accepted
0 Reviews Not Accepted

Swath/Raw LAS:
1 of 1 Reviews Accepted
0 Reviews Not Accepted

Tiled/Classified LAS:
1 of 1 Reviews Accepted
0 Reviews Not Accepted

Breakline:
1 of 1 Reviews Accepted
0 Reviews Not Accepted

DEM(s):
1 of 1 Reviews Accepted
0 Reviews Not Accepted

NED Review:
1 of 1 DEM tile reviews recommended for NED 1/3rd
0 of 1 DEM tile reviews recommended for NED 1/9th

Project Delivery Lots: Select...

Dates Collected Range:
Collection Start: *11/27/2013*
Collection End: *12/15/2013*

Project Aliases:

Licensing:
Public Domain

Project Description:

The St. Louis District of the United States Army Corps of Engineers (USACE) contracted with Surdex Corporation in the fall of 2013 to collect high resolution LiDAR elevation data over multiple counties as part of the Missouri & Arkansas Counties Lidar Project. The project combines the varied interests of the NRCS, DNR, USGS & USACE totaling over 20,200 square miles of coverage. This report covers the collection of LiDAR data over 1,223 square miles in Atchison, Holt & Andrew Counties in Missouri. The average laser ground sample distance required for this area is 1.0 meters.

Review Information

Reviewer:	Stephanie Fulk	*Date Delivered:*	
3rd Party QA Performed:	☐	*Date Assigned:*	12/15/2014

Action To Contractor Date:	*Issue Description:*	*Return Date:*
12/22/2014	See report	2/18/2015
2/20/2015	Swath must be re-delivered	1/29/2016

Review Complete:
2/16/2016

Dates Project Worked:

Start:	12/15/2014	2/18/2015	1/29/2016
End:	12/17/2014	2/19/2015	2/16/2016

Project Materials Received

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 Section supervisor and informed of the problem. Processing will resume after the COTR has coordinated the deposition of remaining deliverables.

METADATA

Deliverables	*Delivered*	*XML Metadata*	*Required*	*Format*	*Quantity*	*Additional Details*
Collection Report:	☑		☑	*PDF*	*1*	
Survey Report:	☑		☑	*PDF*	*1*	
Processing Report:	☑		☑	*PDF*	*1*	
QA/QC Report:	☑		☑	*PDF*	*1*	
Project Level XML Metadata:	☑		☑	*XML*	*1*	MO Counties lidar project
Project Extent:	☐	☐	☑	*.shp*	*1*	NGTOC created footprint
Tile Scheme:	☑	☐	☑	*Select...*	*1*	Atchison, Holt, Andrew tiles

Control (Calibration) Points:	☑	☐	☑	.shp	1	NW MO control survey
Check (Validation) Points:	☑	☐	☑	.shp	1	Atchison, Holt, Andrew survey
Additional Comments:						

LIDAR DATA

Deliverables	*Delivered*	*XML Metadata*	*Required*	*Format*	*Quantity*	*Additional Details*
Swath Data:	☑	☑	☑	.las	252	re-delivered full swath 1/29/2016
Classified/ Tiled Data:	☑	☑	☑	.las	198	TPC re-delivered 1/29/2016
Additional Comments:	require re-delivery on swath file: **LDR131202_180536_1.LAS**					

DERIVED DELIVERABLES

Deliverables	*Delivered*	*XML Metadata*	*Required*	*Format*	*Quantity*	*Additional Details*
DEM Tiles:	☑	☑	☑	IMG	193	
Breaklines:	☑	☑	☑	.shp	1	
Additional Comments:						

OTHER

Additional Deliverables	*Delivered*	*XML Metadata*	*Required*	*Format*	*Quantity*	*Additional Details*
Bare earth LAS	☑	☑	☐	.las	193	
First Return LAS	☑	☑	☐	.las	193	
Atchison, Holt, Andrew swaths	☑	☐	☐	.shp	1	
Additional Comments:						

Geographic Information

Area Extent: *Sq. Miles*

1311.31

Tile Size: 4500x4500 *Meters*

DEM/DTM Grid Spacing: 1 *Meters*

Coordinate Reference System:

UTM zone 15, Geoid 12A

Projection: Transverse Mercator

Horizontal Datum: NAD83

(●) Meters ( ) U.S. Feet ( ) Int'l Feet

Vertical Datum: NAVD88

(●) Meters ( ) U.S. Feet ( ) Int'l Feet

THIS PROJECTION COORDINATE REFERENCE SYSTEM IS CONSISTENT ACROSS THE FOLLOWING DELIVERABLES

- [x] *Project Tile Scheme*
- [x] *Control Points*
- [x] *Checkpoints*
- [x] *Project Level XML Metadata*
- [x] *Tiled/Classified XML Metadata*
- [x] *Tiled/Classified LiDAR*
- [x] *Swath/Raw LiDAR XML Metadata*
- [x] *Swath/Raw LiDAR*
- [x] *DEM(s)*
- [x] *DEM XML Metadata*
- [x] *Breakline(s)*
- [x] *Breakline XML Metadata*

Additional Comments:

Collection Information

Quality Level: 3

Configured Nominal Pulse Spacing:

1 Meters

Sensor Information:

Sensor Type:

Aerial Oscillating Mirror

Sensor Used:

Leica ALS70-IIHP

Configured Scan Angle ± from nadir:

20 *Degrees*

Additional Comments:

Metadata Review Accepted

Vendor 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.

Parser can be found @ http://geo-nsdi.er.usgs.gov/validation/

The Project Level XML Metadata parsed without errors.

Check if 'Best Use' metadata for NED: ☐

The Swath XML Metadata parsed without errors.

Check if 'Best Use' metadata for NED: ☐

The Classified XML Metadata parsed without errors.

Check if 'Best Use' metadata for NED: ☐

The DEM XML Metadata parsed without errors.

Check if 'Best Use' metadata for NED: ☑

The Breakline XML Metadata parsed without errors.

Check if 'Best Use' metadata for NED: ☐

Additional Comments:

Class 11 (withheld) not present in classified LAS point cloud. If class was removed it should not be referenced or defined in the metadata for Classified LAS. Please correct. *2/18/2015 vendor corrected*

DEM metadata states the use of "DEM points in Imagine *Grid* Format". DEMs are in IMAGINE image (.img). Please correct or clarify. *2/18/2015 vendor corrected*

2/19/2015
Grid XML, line 12: please remove or amend to reflect current project counties (Atchison, Andrew, Holt)

<onlink>\\sdxdomain\Projecthome\YDrive\2301114\documentation\deliverables\1_meter\metadata_bnds\Shannon.shp</onlink>

Hydro XML, line 135: please remove or amend to reflect current project counties (Atchison, Andrew, Holt)

<srcused>Y:\2301114\documentation\deliverables\1_meter\Shannon\metadata\Shannon_Hydro_metadata.xml</srcused>

2/20/2015 vendor corrected

Based on this review, the USGS accepts the xml metadata provided.

End of Metadata Review

Vertical Accuracy Review Accepted

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.

Required Vertical Accuracy

◉ *Yes* ○ *No*

REQUIRED FUNDAMENTAL VERTICAL ACCURACY FOR SWATH AND DEM FILES

Confidence Interval Required:	95 th % CI
Required Unit:	Meters
Required # of checkpoints:	20
Required RMSEz:	0.150
*Required Vertical Accuracy (RMSEz * .% CI)*	0.294

REQUIRED SUPPLEMENTAL VERTICAL ACCURACY FOR DEM FILES

SVA Statistic Required: Percentile

SVA Confidence Level/Percentile Required: 95

Class	*# of Checkpoints*	*SVA Required 95 th Percentile*	
Grass (G)	20	0.363	Meters
Trees (T)	20	0.363	Meters
Urban (U)	20	0.363	Meters

REQUIRED CONSOLIDATED VERTICAL ACCURACY FOR DEM FILES

CVA Statistic Required: Percentile

CVA Confidence Level/Percentile Required: 95

Total number of checkpoints: 80

Required CVA: 0.363 Meters *at the 95 th Percentile*

Additional Required Vertical Accuracy Information:

Reported Vertical Accuracy

◉ *Yes* ○ *No*

REPORTED FUNDAMENTAL VERTICAL ACCURACY FOR SWATH LIDAR FILES

Confidence Interval Reported:	95 th % CI
Reported Unit:	Meters
Reported # of checkpoints:	26
Reported RMSEz:	0.101
*Reported Vertical Accuracy (RMSEz * .% CI)*	0.198

REPORTED FUNDAMENTAL VERTICAL ACCURACY FOR DEM FILES

Confidence Interval Reported: 95 th % CI

Reported Unit: Meters

Reported # of checkpoints: 20

Reported RMSEz: 0.088

*Reported Vertical Accuracy (RMSEz * .% CI)* 0.173

REPORTED SUPPLEMENTAL VERTICAL ACCURACY FOR DEM FILES

SVA Statistic Reported: Percentile

SVA Confidence Level/Percentile Reported: 95

Class	# of Checkpoints	SVA Reported 95 th Percentile	
Grass (G)	20	0.183	Meters
Trees (T)	20	0.236	Meters
Urban (U)	20	0.200	Meters

REPORTED CONSOLIDATED VERTICAL ACCURACY FOR DEM FILES

CVA Statistic Reported: Percentile

CVA Confidence Level/Percentile Reported: 95

Total number of checkpoints: 80

Reported CVA: 0.228 Meters *at the* 95 th *Percentile*

Additional Reported Vertical Accuracy Information:

Reviewed Vertical Accuracy

◉ *Yes* ○ *No*

CHECKPOINT REVIEW

Checkpoints are well distributed? ☑

Enough checkpoints for task order? ☑

Checkpoints meet USGS LiDAR base-spec in quantity and quality? ☑

REVIEWED FUNDAMENTAL VERTICAL ACCURACY FOR SWATH LIDAR FILES

Confidence Interval Reviewed: 95 th % CI

Reviewed Unit: Meters

Reviewed # of checkpoints: 20

Reviewed RMSEz: 0.124

*Reviewed Vertical Accuracy (RMSEz * .% CI)* 0.242

REVIEWED FUNDAMENTAL VERTICAL ACCURACY FOR DEM FILES

Confidence Interval Reviewed: 95 th % CI

Reviewed Unit: Meters

Reviewed # of checkpoints: 20

Reviewed RMSEz: 0.933

*Reviewed Vertical Accuracy (RMSEz * .% CI)* 0.183

REVIEWED SUPPLEMENTAL VERTICAL ACCURACY

SVA Statistic Reviewed: Percentile

SVA Confidence Level/Percentile Reviewed: 95

Class	# of Checkpoints	SVA Reviewed 95 th Percentile	
Grass (G)	20	0.188	Meters
Trees (T)	20	0.281	Meters
Urban (U)	19	0.209	Meters

REVIEWED CONSOLIDATED VERTICAL ACCURACY

CVA Statistic Reviewed: Percentile

CVA Confidence Level/Percentile Reviewed: 95

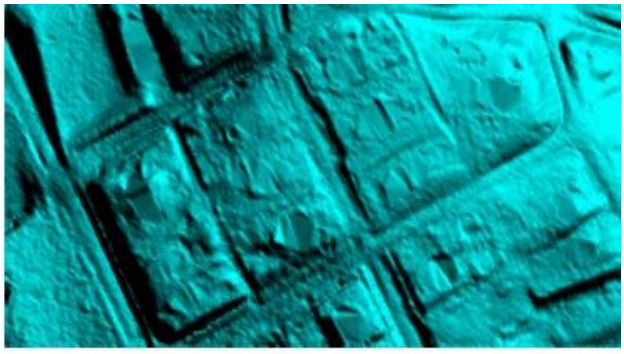
Total number of checkpoints: 79

Reviewed CVA: 0.258 Meters *at the* 95 th *Percentile*

Checkpoint Distribution Image

Vertical Accuracy Results:

Additional Reviewed Vertical Accuracy Information:	Point 2_27U was removed from Urban class. Point did not lie within the DEM area. See image.



Based on this review, the USGS accepts the vertical accuracy.

End of Vertical Accuracy Review

Raw-Swath LiDAR Review Accepted

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 (*see Vertical Accuracy Review Section*).

Review Required: ◉ *Yes* ○ *No*

RAW-SWATH LIDAR FILE CHARACTERISTICS

☑ *Separate folder for swath/raw LiDAR files*

LAS Version: 1.2

Point Record Format: 1

☑ *Each swath file ≤ 2 GB and properly segmented*

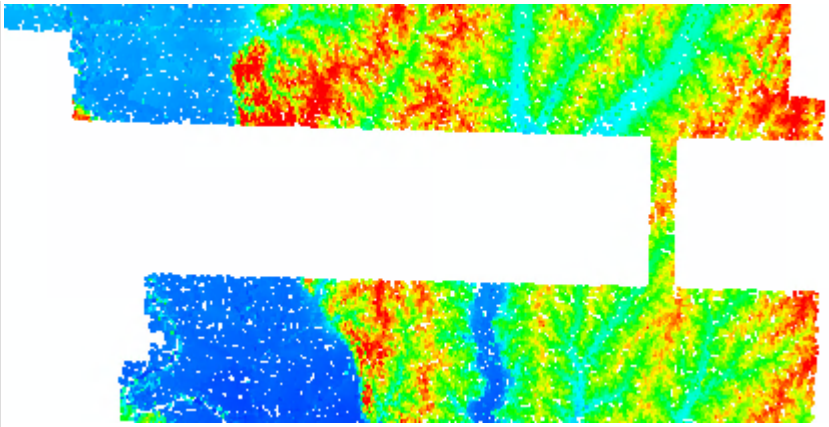
☑ *Correct and properly formatted georeference information is included in all LAS file headers*

☑ *Adjusted GPS time used with the global encoder id set to 1*

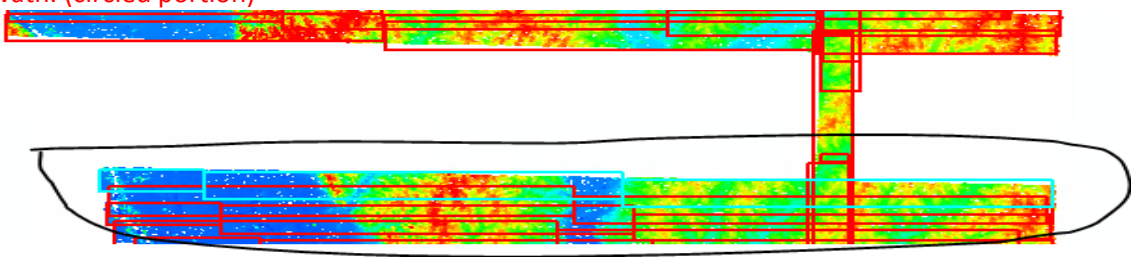
☑ *Scan Angles conform to USGS base-spec recommendations*

☑ *All points set to class '0' (not classified)*

Additional comments:



2/19/2015 Corrections which arrived in house 2-18-15 did not contain adequate amount of data to fill void in swath. (circled portion)



Complete re-delivery of all swath files is requested.

2-10-2016
Vendor corrected.

Based on this review, the USGS accepts the swath/raw LiDAR data.

End of Swath/Raw LiDAR Review

Tiled/Classified LiDAR Review Accepted

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. Classified LAS Tiles are comprised as follows, "all project swaths, returns, and collected points, fully calibrated, adjusted to ground, and classified and cut, by tiles, excluding calibration swaths, cross-ties, and other swaths not used, or intended to be used, in product generation".

Review Required: ◉ *Yes* ○ *No*

CLASSIFIED LIDAR TILE CHARACTERISTICS

☑ *Separate folder for classified/tiled LiDAR files*

LAS Version: 1.2

Point Record Format: 3

☑ *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*

☑ *Correct and properly formatted georeference information is included in all LAS file headers*

☑ *Adjusted GPS time used with the global encoder id set to 1*

☑ *Classified LAS tile files have no points classified as '12' (Overlap)*

☐ *Point classifications are limited to the standard values listed below:*

Code	Description	Used
1	Processed, but unclassified	☑
2	Bare-earth/Ground	☑
7	Noise(low or high, manually identified, if needed)	☑
8	Model key points	☐
9	Water	☑
10	Ignored ground (breakline proximity)	☑
11	Withheld (if the "Withheld Bit" is not implemented in the processing software	☐

Additional Classes:

Class	Description
17	Overlap

Additional comments:

Vendor delivered total point cloud (TPC) on 1-29-2016.

Based on this review, the USGS accepts classified/tiled LiDAR data.

End of Tiled/Classified LiDAR Review

Breakline Review Accepted

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

Review Required: ◉ *Yes* ○ *No*

BREAKLINE FILE CHARACTERISTICS:

☑ Separate folder for breakline files.

☑ Breaklines contain elevation values.

Elevation values stored in Geometery (ZEnabled) .

Units: Meters

☑ Waterbody Breaklines.

Polyline ☐ Polygon ☑

☑ Single elevation value per waterbody feature.

☑ Required.

Waterbody Elevations were created via Unknown waterbody level techniques.

☑ Double Line Stream Breaklines (Streams Approximately > 100 ft).

Polyline ☐ Polygon ☑

Downstream DLS Flow is Monotonic .

☑ Required.

☐ Single Line Breaklines.

☑ No missing or misplaced breaklines.

Based on this review, the USGS accepts the breakline files.

End of Breakline Review

DEM Review Accepted

The derived bare-earth file(s) receive a review of the vertical accuracies provided by the data supplier, vertical accuracies calculated by the USGS using supplied and independent checkpoints (*see the prior Vertical Accuracy Review Section*), and a thorough visual review for any anomalies or inconsistencies in assessing the quality of the DEM(s).

BARE-EARTH DEM TILE CHARACTERISTICS:

☑ Separate folder for bare-earth DEM files

Raster File Type: IMG

Raster Cell Size: 1 Meters

Tile bit depth/pixel Type: 32_BIT_FLOAT

Interpolation or Resampling Technique: Nearest Neighbor

☑ DEM tiles do not overlap

☑ DEM tiles conform to Project Tiling Scheme

☑ Quantity of DEM files conforms to Project Tiling Scheme

☑ DEM tiles are uniform in size

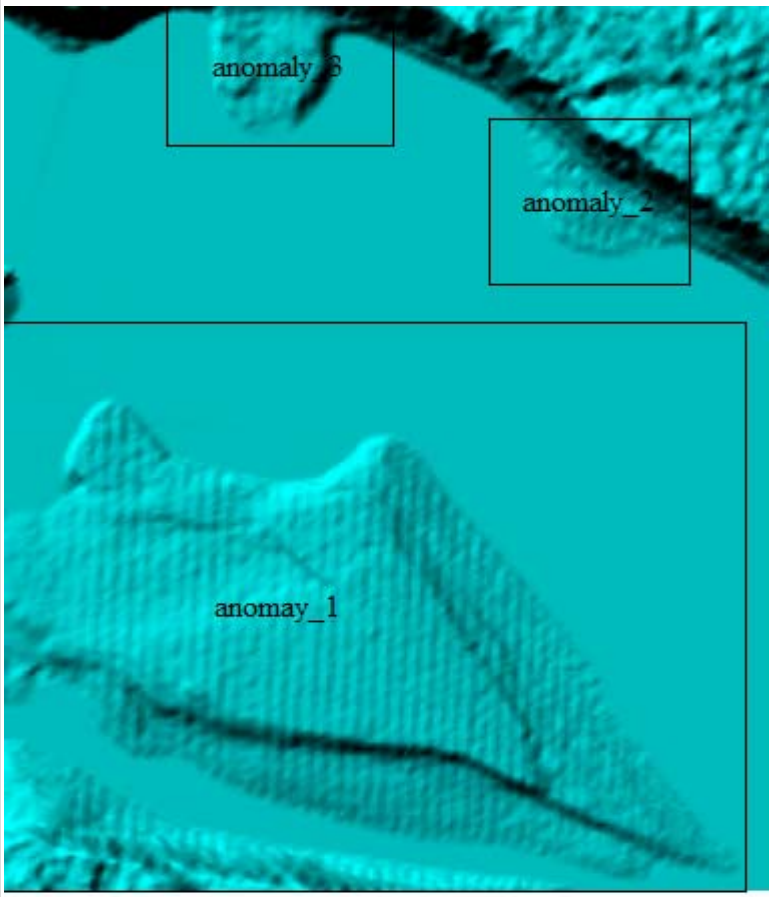
☑ DEM tiles properly edge match and free of edge artifacts

☑ Tiles are free from Spikes and Pits

☑ Tiles are free from Data Holidays (*voids due to processing or collection errors*)

☐ Tiles do not exhibit systematic sensor error or cornrowing

Possible sensor error may explain pattern change anomaly. Please correct.



2/18/2015 vendor corrected

Hydro Treatment: hydro-flattened

DEM tiles are properly Hydro Flattened ◉ Yes ○ No

☑ Waterbodies 2 Acres or greater are flattened

☐ Streams 100 ft. or greater are flattened in a downstream manner

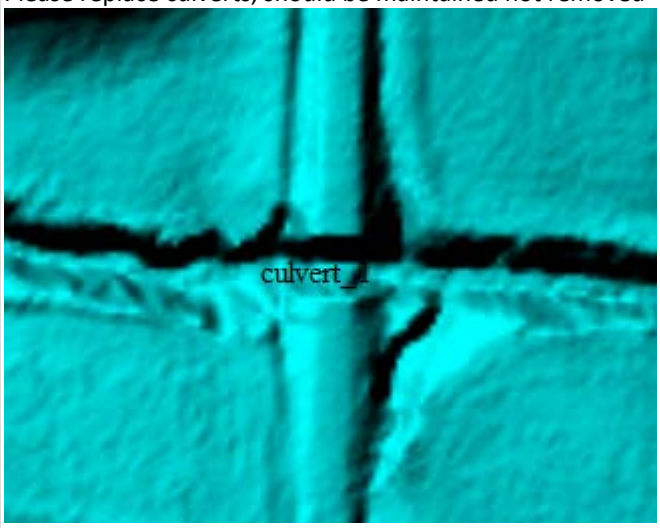
Stream/river 100 ft or wider should be appropriately hydroflattened

*2/18/2015 vendor did not correct on grounds - "Area appears to be dry so hydro flattening was not performed."
Vendor action accepted by reviewer.*

☑ Tidal Boundaries/Shorelines are flattened

☑ No missing islands 1 Acre or larger
☑ Bridges/Overpasses are properly removed
☐ Culverts are maintained (Not Hydro Enforced)

Please replace culverts, should be maintained not removed



2/18/2015 vendor corrected

☑ Depressions, Sinks, are not filled in (Not Hydro Conditioned)
☑ Vegetation properly removed
☑ Manmade structures properly removed

Tiles recommended for NED 1/3rd: ◉ Yes. ○ No.
Tiles recommended for NED 1/9th: ○ Yes. ○ No.
Tiles recommended for NED 1 Meter: ◉ Yes. ○ No.
LAS dataset recommended for distribution: tile classified

Based on this review, the USGS accepts the DEM tiles.

End of DEM Review

INTERNAL COMMENTS

END OF REPORT (v2.3.0)