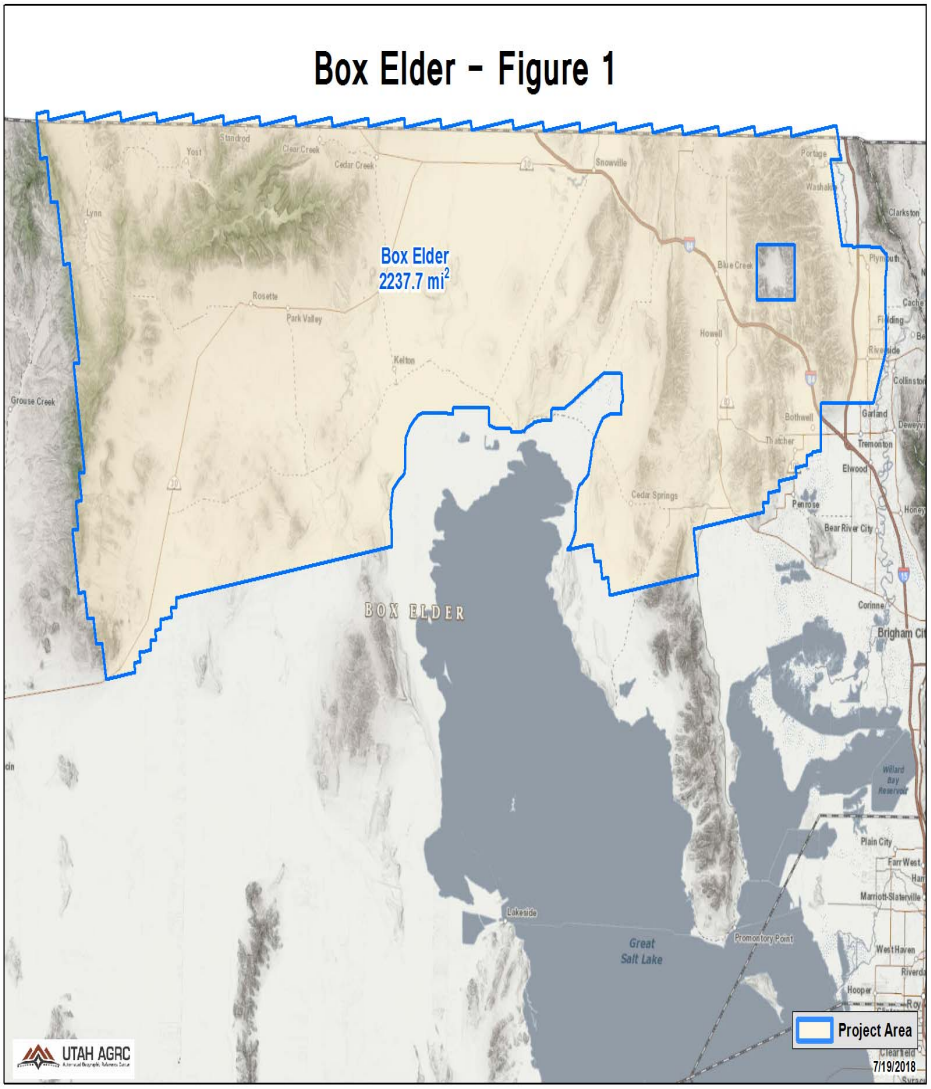
LiDAR Quality Assessment Report

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.

UT_BoxElder_2018

NGTOC
2019-04-23
Erik Ahl



Project Information

Project: UT_BoxElder_2018

Contractor: Aero-Graphics, Inc.

Project Type:
Partnership

Applicable Specification:
Other
Lidar Base Spec 1.3

Project Points of Contact:

Name:	***Type:***	***Email:***
Diana Thunen	CPT	dthunen@usgs.gov

REPORT QUALIFICATION SUMMARY:

Task Order Overall:
Meets Requirements

Metadata:
1 of 1 Reviews Accepted
0 Reviews Not Accepted

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

Project Subdivision: Lots

List Subdivision:
•
of: 11

Dates Collected Range:
Collection Start: *9/4/2018*
Collection End: *3/19/2019*

Project Aliases:
UT_StateWide_2018_A18

Licensing:
Public Domain

Project Description:
Utah 2018 Lidar project called for the planning, acquisition, processing and derivative products of lidar data to be collected at a nominal pulse spacing (NPS) of 0.35 meters. Project specifications are based on the U.S. Geological Survey National Geospatial Program Base Lidar Specification, Version 1.3. The data was developed based on a horizontal projection/datum of NAD83 (2011), Albers Conical Equal Area, meters and vertical datum of NAVD88 (GEOID12B), meters. Lidar data was delivered as processed Classified LASv1.4 files, formatted to 6,274 individual 1,000 m x 1,000 m tiles, as tiled intensity imagery, and as tiled bare-earth DEMs; as tiled intensity imagery, as tiled bare-earth DEMs, and as tiled first-return DSMs, with a 1,000 meter x 1,000 meter tiling schema (6,274 tiles).

Review Information

Reviewer:	Erik Ahl	*Date Delivered:*	3/25/2019
3rd Party QA Performed:	☐	*Date Assigned:*	4/12/2019

Action To Contractor Date:	*Issue Description:*	*Return Date:*
4/12/2018	4 issues in DEM: 3 Bridge calls Fixed 1 Vegetation call Fixed WKT for Las is invalid format Fixed Metadata has invalid formatting Fixed	4/11/2020

Review Complete:

4/23/2019

Dates Project Worked:

Start:	4/12/2019
End:	4/23/2019

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:	☐		☐	*Select...*		
Survey Report:	☐		☐	*Select...*		
Processing Report:	☐		☐	*Select...*		
QA/QC Report:	☐		☐	*Select...*		
Project Level XML Metadata:	☑		☑	*XML*	*1*	
Project Extent:	☑	☐	☑	*.shp*	*2*	AOI & BPA
Tile Scheme:	☑	☐	☑	*.shp*	*1*	
Control						

(Calibration) Points:	☑	☐	☑	*.shp*	*1*	
Check (Validation) Points:	☑	☐	☑	*.shp*	*2*	NVA & VVA
Additional Comments:						

LIDAR DATA

Deliverables	*Delivered*	*XML Metadata*	*Required*	*Format*	*Quantity*	*Additional Details*
Swath Data:	☐	☐	☐	Select...		N/A
Classified/ Tiled Data:	☑	☑	☑	.las	*6,274*	
Additional Comments:						

DERIVED DELIVERABLES

Deliverables	*Delivered*	*XML Metadata*	*Required*	*Format*	*Quantity*	*Additional Details*
DEM Tiles:	☑	☑	☑	TIF	*6,274*	
Breaklines:	☑	☑	☑	.shp	*2*	Bridges & Waterbodies
Additional Comments:						

OTHER

Additional Deliverables	*Delivered*	*XML Metadata*	*Required*	*Format*	*Quantity*	*Additional Details*
Intensity_Rasters	☑	☑	☐	TIF	6,274	
First_Return_Rasters	☑	☑	☐	TIF	6,274	
Additional Comments:						

Geographic Information

Area Extent: 2252 *Sq. Miles*

Tile Size: 1,000 x 1,000 *Meters*

DEM/DTM Grid Spacing: 0.5 *Meters*

Coordinate Reference System:

GCS_NAD_1983_2011

Projection: NAD_1983_2011_Contiguous_USA_Albers

Horizontal Datum: NAD83 / 2011

- (•) Meters
- ( ) U.S. Feet
- ( ) Int'l Feet

Vertical Datum: NAVD88 / GEOID12B

- (•) Meters
- ( ) U.S. Feet
- ( ) Int'l Feet

THIS PROJECTION COORDINATE REFERENCE SYSTEM IS CONSISTENT ACROSS THE FOLLOWING DELIVERABLES

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

Additional Comments:

Collection Information

Quality Level: ***1***

Configured Nominal Pulse Spacing:

0.35 Meters

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 with errors.

```
Info: process date = 20190412
Info: process time = 13:25:28
Warning (line 3): Missing Entity_and_Attribute_Information is mandatory if applicable in Metadata
Warning (line 3): Missing Distribution_Information is mandatory if applicable in Metadata
Error (line 138): Improper value for West_Bounding_Coordinate
Error (line 139): Improper value for East_Bounding_Coordinate
Error (line 140): Improper value for North_Bounding_Coordinate
Error (line 141): Improper value for South_Bounding_Coordinate
4 errors: 4 bad_value
```

Check if 'Best Use' metadata for NED: ☐

The Classified XML Metadata parsed with errors.

Warning (line 3): Missing Entity_and_Attribute_Information is mandatory if applicable in Metadata
Warning (line 3): Missing Distribution_Information is mandatory if applicable in Metadata
Error (line 104): Improper value for West_Bounding_Coordinate
Error (line 105): Improper value for East_Bounding_Coordinate
Error (line 106): Improper value for North_Bounding_Coordinate
Error (line 107): Improper value for South_Bounding_Coordinate
4 errors: 4 bad_value

Check if 'Best Use' metadata for NED: ☐

The DEM XML Metadata parsed with errors.

Info: process date = 20190412
Info: process time = 13:28:22
Warning (line 3): Missing Entity_and_Attribute_Information is mandatory if applicable in Metadata
Warning (line 3): Missing Distribution_Information is mandatory if applicable in Metadata
Error (line 40): Improper value for West_Bounding_Coordinate
Error (line 41): Improper value for East_Bounding_Coordinate
Error (line 42): Improper value for North_Bounding_Coordinate
Error (line 43): Improper value for South_Bounding_Coordinate
4 errors: 4 bad_value

Check if 'Best Use' metadata for NED: ☐

The Breakline XML Metadata parsed with errors.

Info: process date = 20190412
Info: process time = 13:28:55
Warning (line 3): Missing Entity_and_Attribute_Information is mandatory if applicable in Metadata
Warning (line 3): Missing Distribution_Information is mandatory if applicable in Metadata
Error (line 39): Improper value for West_Bounding_Coordinate
Error (line 40): Improper value for East_Bounding_Coordinate
Error (line 41): Improper value for North_Bounding_Coordinate
Error (line 42): Improper value for South_Bounding_Coordinate
4 errors: 4 bad_value

Check if 'Best Use' metadata for NED: ☐

Additional Comments: **All above XML was returned with corrections and passed the parser without errors**

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

End of Metadata Review

Vertical Accuracy 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.

Required Vertical Accuracy

◉ *Yes* ○ *No*

REQUIRED NON-VEGETATED VERTICAL ACCURACY FOR SWATH AND DEM FILES

Required Unit:	Meters
Required # of checkpoints:	
Required RMSEz:	0.10
*Required Vertical Accuracy (RMSEz * 95th CI)*	0.196

REQUIRED VEGETATED VERTICAL ACCURACY FOR DEM FILES

Required Unit:	Meters
Required # of checkpoints:	
Required Vertical Accuracy (@ 95th percentile)	0.3
Additional Required Vertical Accuracy Information:	

Reported Vertical Accuracy

◉ *Yes* ○ *No*

REPORTED NON-VEGETATED VERTICAL ACCURACY FOR SWATH LIDAR FILES

Reported Unit:	Select or type...
Reported # of checkpoints:	
Reported RMSEz:	
*Reported Vertical Accuracy (RMSEz * 95th CI)*	

REPORTED NON-VEGETATED VERTICAL ACCURACY FOR DEM FILES

Reported Unit:	Meters
Reported # of checkpoints:	606
Reported RMSEz:	
*Reported Vertical Accuracy (RMSEz * 95th CI)*	0.092

REPORTED VEGETATED VERTICAL ACCURACY FOR DEM FILES

Reported Unit:	Select or type...
Reported # of checkpoints:	107
Reported Vertical Accuracy (95th percentile)	0.163

Additional Reported Vertical Accuracy Information:

Reviewed Vertical Accuracy

○ *Yes* ◉ *No*

Vertical Accuracy information was not or could not be reviewed.

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

End of Vertical Accuracy Review

Raw-Swath LiDAR 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 Non-Vegetated Vertical Accuracy using ground control checkpoints measured in clear open terrain (*see Vertical Accuracy Review Section*).

Review Required: ○ *Yes* ◉ *No* *Not Delivered*

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: 1.4

Point Record Format: 6

*If specified, *.wpd files for full waveform data have been provided:* Select...

☑ *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, including the use of OGC 2001 Well Known Text (WKT).*

WKT is not well formed, syntax does not comply with base specs or OGC.
"HEIGHT_MODEL["US Geoid Model 2012B"]," this line doesn't belong in any version of WKT
These next two examples have syntax issues:
VERT_CS["NAVD88 height - Geoid12B (metre)",
AXIS["Gravity-related height",UP],

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

☑ *Classified LAS tile files have no points classified as '12' (Overlap) and correctly use overlap bit.*

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

Code	Description	Used
1	Processed, but unclassified	☑
2	Bare-earth/Ground	☑
7	Noise (low, 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	☐
17	Bridges	☑
18	Noise (high, manually identified, if needed)	☑

Additional comments:

WKT returned with corrections is well formed and meets specs

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 Proprietary waterbody level techniques.

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

☑ Single Line Breaklines.

Lines are:

- ☐ Single Line Streams
- ☑ Bridge Cuts
- ☐ Culvert Connectors

Downstream SLS Flow is Not Applicable .

☑ No missing or misplaced breaklines.

ADDITIONAL COMMENTS, ERRORS, ANOMALIES, OR OTHER ISSUES:

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: TIF

Raster Cell Size: 0.5 Meters

Tile bit depth/pixel Type: 32_BIT_FLOAT

Interpolation or Resampling Technique: Triangulated Irregular Network (TIN)

☑ 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

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

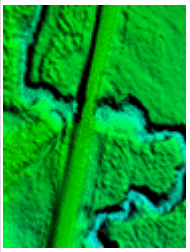
☑ Tidal Boundaries/Shorelines are flattened

☑ No missing islands 1 Acre or larger

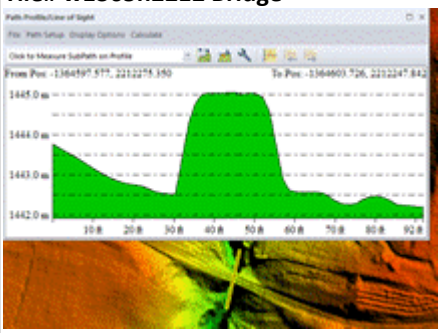
☐ Bridges/Overpasses are properly removed

3 calls on Bridges that require attention

Tile# w1452n2241 Bridge



Tile# w1365n2212 Bridge



Tile# w1325n2206 Bridge

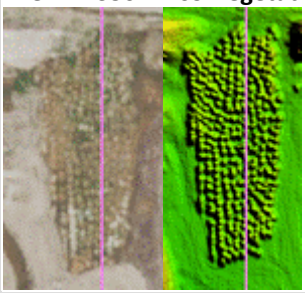
☑ Culverts are maintained (Not Hydro Enforced)

☑ Depressions, Sinks, are not filled in (Not Hydro Conditioned)

☐ Vegetation properly removed

1 call on vegetation

Tile# w1350n2209 Vegetation



☑ 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

Based on this review, the provided delivery Meets the Contract and/or Task Order requirements.

Additional Comments:

DEM Review calls were accepted with corrections

INTERNAL COMMENTS

END OF REPORT (v2.4.0)