



LiDAR Quality Assessment Report

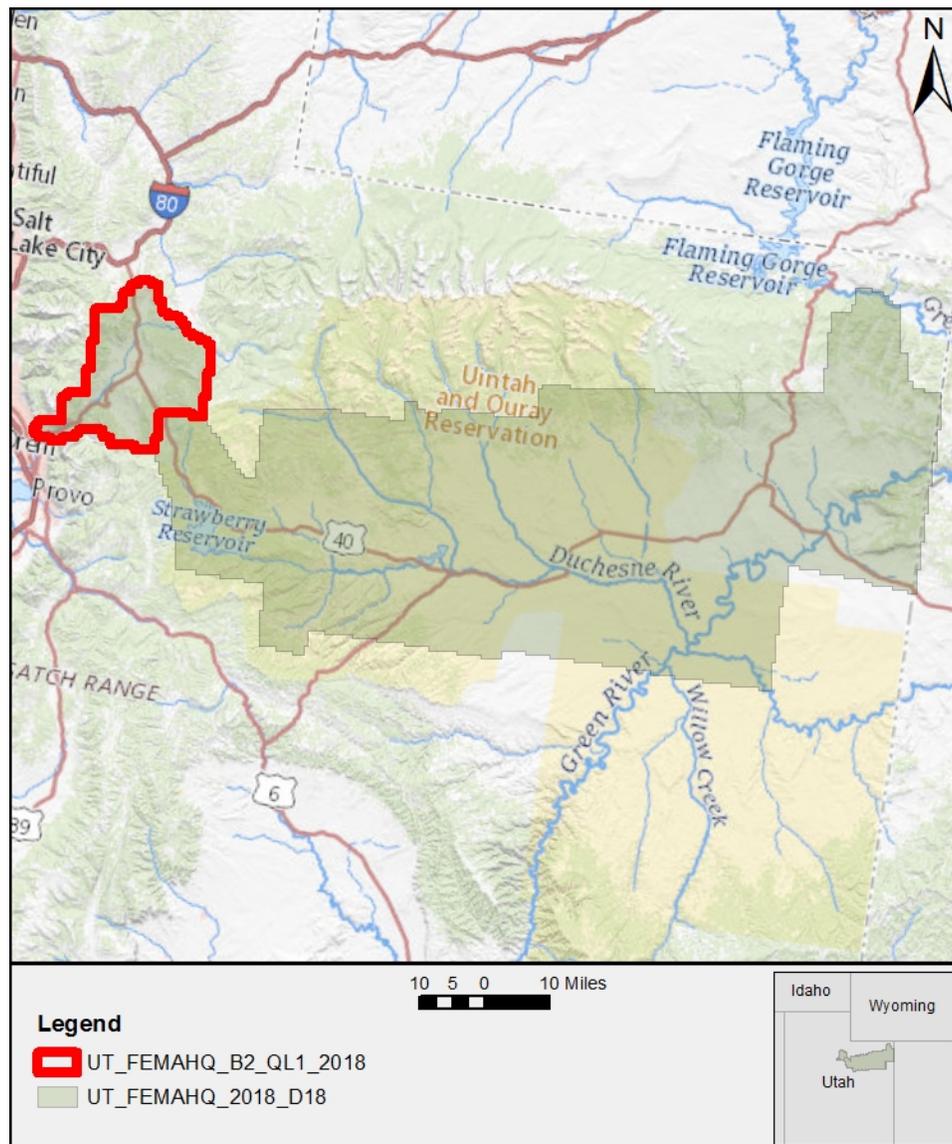
The USGS National Geospatial Technical Operations Center, Data Operations Branch is responsible for conducting reviews of all Light Detection and Ranging (LiDAR) point-cloud data and derived products delivered by a data supplier before it is approved for inclusion in the National Elevation Dataset. The 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_FEMAHQ_B2_QL1_2018

NGTOC

2019-05-17

Tim Willingham



Project Information

Project:

Contractor:

Project Type:
GPSC

Applicable Specification:
Other

Project Points of Contact:

| Name: | Type: | Email: |
|-----------------|-------|--------------------|
| Leslie Lansbery | CPT | llansbery@usgs.gov |

| REPORT QUALIFICATION SUMMARY: |
|--|
| Task Order Overall: <i>Meets Requirements</i> |
| Metadata: 1 of 1 Reviews Accepted 0 Reviews Not Accepted |
| Vertical Accuracy: 1 of 1 Reviews Accepted 0 Reviews Not Accepted |
| Swath/Raw LAS: 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:

List Subdivision:

- 2

of:

Dates Collected Range:

Collection Start:

Collection End:

Project Aliases:

Licensing:

Public Domain

Project Description:

This report is for Block 2 QL1 only.

USGS requests a spring 2018 lidar survey to be collected over one (1) distinct Area of Interest (AOI) in northeastern Utah identified as Uintah_Heber. The AOI covers approximately 4693 square miles in total and covers the partial counties of Summit, Utah, Salt Lake, Wasatch, Duchesne, Uintah, Daggett and Moffat (Colorado).
This project will support the 3D Elevation Program (3DEP) mission, the Federal Emergency Management Agency (FEMA) Risk Mapping, Assessment and Planning (MAP) program and the State of Utah, Automated Geographic Reference Center (AGRC) and its partners.
This task order is for the planning, acquisition, processing, and derivative products of lidar data to be collected at an aggregate nominal pulse spacing (ANPS) of 0.35 meters (8 ppsm) for the western portion of Utah (~380 sq mi), including overlap, and 0.71 meters for the remainder of the AOI (~4,313 sq mi), including overlap.

Review Information

Reviewer: Date Delivered:

3rd Party QA Performed: Date Assigned:

| Action To Contractor Date: | Issue Description: | Return Date: |
|--|---------------------------------|----------------------|
| <input type="text" value="5/17/2019"/> | <input type="text" value="NA"/> | <input type="text"/> |

Review Complete:

Dates Project Worked:

| | | |
|--------|--|--|
| Start: | <input type="text" value="2/8/2019"/> | <input type="text" value="5/15/2019"/> |
| End: | <input type="text" value="2/15/2019"/> | <input type="text" value="5/17/2019"/> |

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: | <input checked="" type="checkbox"/> | | <input checked="" type="checkbox"/> | <u>PDF</u> | <input type="text" value="1"/> | <input type="text"/> |
| Survey Report: | <input type="checkbox"/> | | <input type="checkbox"/> | <u>Select...</u> | <input type="text" value="0"/> | <input type="text"/> |
| Processing Report: | <input checked="" type="checkbox"/> | | <input checked="" type="checkbox"/> | <u>PDF</u> | <input type="text" value="1"/> | <input type="text"/> |
| QA/QC Report: | <input type="checkbox"/> | | <input type="checkbox"/> | <u>Select...</u> | <input type="text" value="0"/> | <input type="text"/> |
| Project Level XML Metadata: | <input type="checkbox"/> | | <input type="checkbox"/> | XML | <input type="text" value="0"/> | <input type="text"/> |
| Project Extent: | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input checked="" type="checkbox"/> | <u>.shp</u> | <input type="text" value="1"/> | <input type="text"/> |
| Tile Scheme: | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input checked="" type="checkbox"/> | <u>.shp</u> | <input type="text" value="1"/> | <input type="text"/> |
| Control (Calibration) Points: | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input checked="" type="checkbox"/> | <u>.shp</u> | <input type="text" value="1"/> | <input type="text"/> |

| | | | | | | |
|----------------------------|-------------------------------------|--------------------------|-------------------------------------|-------------|---|--|
| Check (Validation) Points: | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input checked="" type="checkbox"/> | <u>.shp</u> | 1 | |
| Additional Comments: | | | | | | |

LIDAR DATA

| Deliverables | Delivered | XML Metadata | Required | Format | Quantity | Additional Details |
|-------------------------|-------------------------------------|-------------------------------------|-------------------------------------|-----------|----------|--------------------|
| Swath Data: | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | Select... | 0 | |
| Classified/ Tiled Data: | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | .las | 985 | |
| Additional Comments: | | | | | | |

DERIVED DELIVERABLES

| Deliverables | Delivered | XML Metadata | Required | Format | Quantity | Additional Details |
|----------------------|-------------------------------------|-------------------------------------|-------------------------------------|--------|----------|--------------------|
| DEM Tiles: | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | IMG | 985 | |
| Breaklines: | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | FGD | 1 | |
| Additional Comments: | | | | | | |

OTHER

| Additional Deliverables | Delivered | XML Metadata | Required | Format | Quantity | Additional Details |
|----------------------------|-------------------------------------|-------------------------------------|-------------------------------------|--------|----------|--------------------|
| Intensity Imagery | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | TIFF | 985 | |
| Classified LPC 100m Buffer | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | LAS | 816 | |
| Flight Lines | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input checked="" type="checkbox"/> | SHP | 1 | |
| Additional Comments: | | | | | | |

Geographic Information

Area Extent: Sq. Miles

Tile Size: Meters

DEM/DTM Grid Spacing: Meters

Coordinate Reference System:

Projection:

Horizontal Datum: Meters U.S. Feet Int'l Feet

Vertical Datum: Meters U.S. Feet Int'l Feet

THIS PROJECTION COORDINATE REFERENCE SYSTEM IS CONSISTENT ACROSS THE FOLLOWING DELIVERABLES

- Project Extent
- Project Tile Scheme
- Control Points
- Checkpoints
- Tiled/Classified XML Metadata
- Tiled/Classified LiDAR
- DEM(s)
- DEM XML Metadata
- Breakline(s)
- Breakline XML Metadata

Additional Comments:

Collection Information

Quality Level: 1
Configured Nominal Pulse Spacing: Meters

Sensor Information:
 Sensor Type: Aerial Oscillating Mirror
 Sensor Used:
 Configured Scan Angle ± from nadir: Degrees
 Sensor Type: Aerial Rotating Prism
 Sensor Used:
 Configured Scan Angle ± from nadir: 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 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:

Corrected 5/14/2019
- QL1 Classified Las XMLs have classifications (3, 4, 5, 6, 8, and 13) that are not in the Project report or Las Files.

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 NON-VEGETATED VERTICAL ACCURACY FOR SWATH AND DEM FILES

| | |
|--|--|
| Required Unit: | <input type="text" value="Centimeters"/> |
| Required # of checkpoints: | <input type="text" value="115"/> |
| Required RMSEz: | <input type="text" value="10"/> |
| Required Vertical Accuracy (RMSEz * 95th CI) | <input type="text" value="19.6"/> |

REQUIRED VEGETATED VERTICAL ACCURACY FOR DEM FILES

Required Unit:

Required # of checkpoints:

Required Vertical Accuracy (@ 95th percentile)

Additional Required Vertical Accuracy Information:

Reported Vertical Accuracy

Yes No

REPORTED NON-VEGETATED VERTICAL ACCURACY FOR SWATH LIDAR FILES

Reported Unit:

Reported # of checkpoints:

Reported RMSEz:

Reported Vertical Accuracy (RMSEz * 95th CI)

REPORTED NON-VEGETATED VERTICAL ACCURACY FOR DEM FILES

Reported Unit:

Reported # of checkpoints:

Reported RMSEz:

Reported Vertical Accuracy (RMSEz * 95th CI)

REPORTED VEGETATED VERTICAL ACCURACY FOR DEM FILES

Reported Unit:

Reported # of checkpoints:

Reported Vertical Accuracy (95th 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 NON-VEGETATED VERTICAL ACCURACY FOR SWATH LIDAR FILES

Reviewed Unit:

Reviewed # of checkpoints:

Reviewed RMSEz:

Reviewed Vertical Accuracy (RMSEz * 95th CI)

REVIEWED NON-VEGETATED VERTICAL ACCURACY FOR DEM FILES

Reviewed Unit:

Reviewed # of checkpoints:

Reviewed RMSEz:

Reviewed Vertical Accuracy (RMSEz * 95th CI)

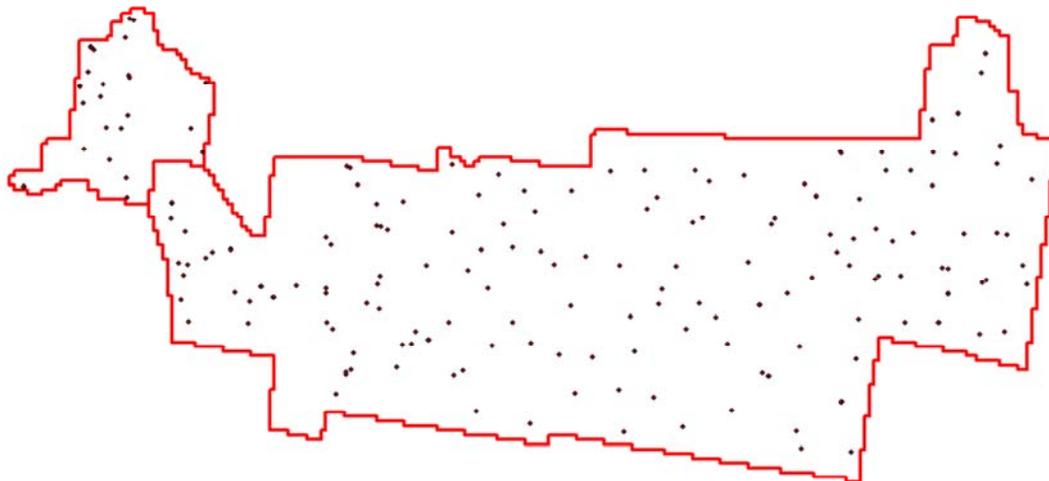
REVIEWED VEGETATED VERTICAL ACCURACY

Required Unit:

Required # of checkpoints:

Reviewed Vertical Accuracy (95th percentile)

Checkpoint Distribution Image

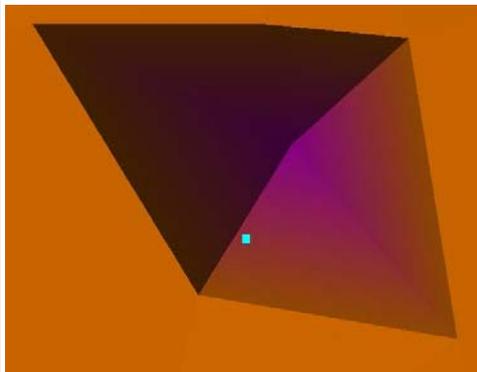
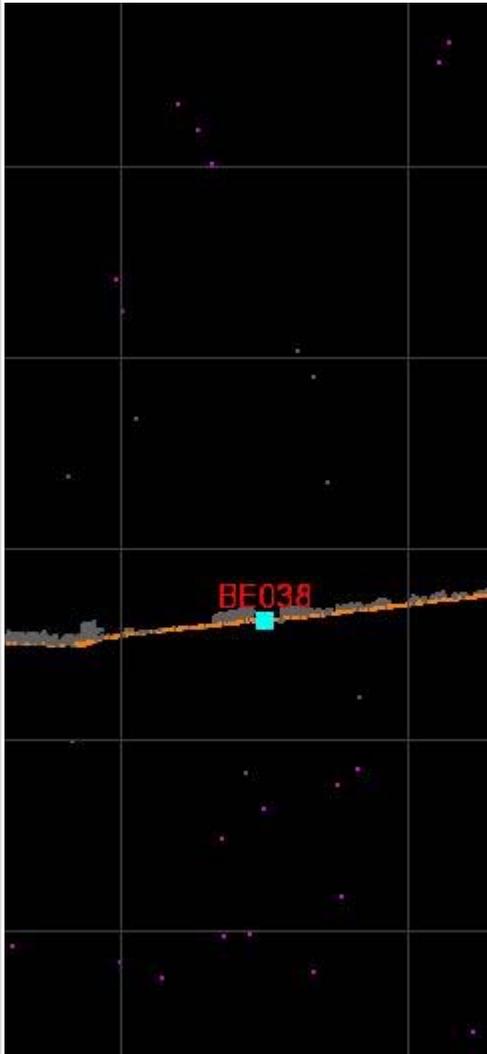


Vertical Accuracy Results:

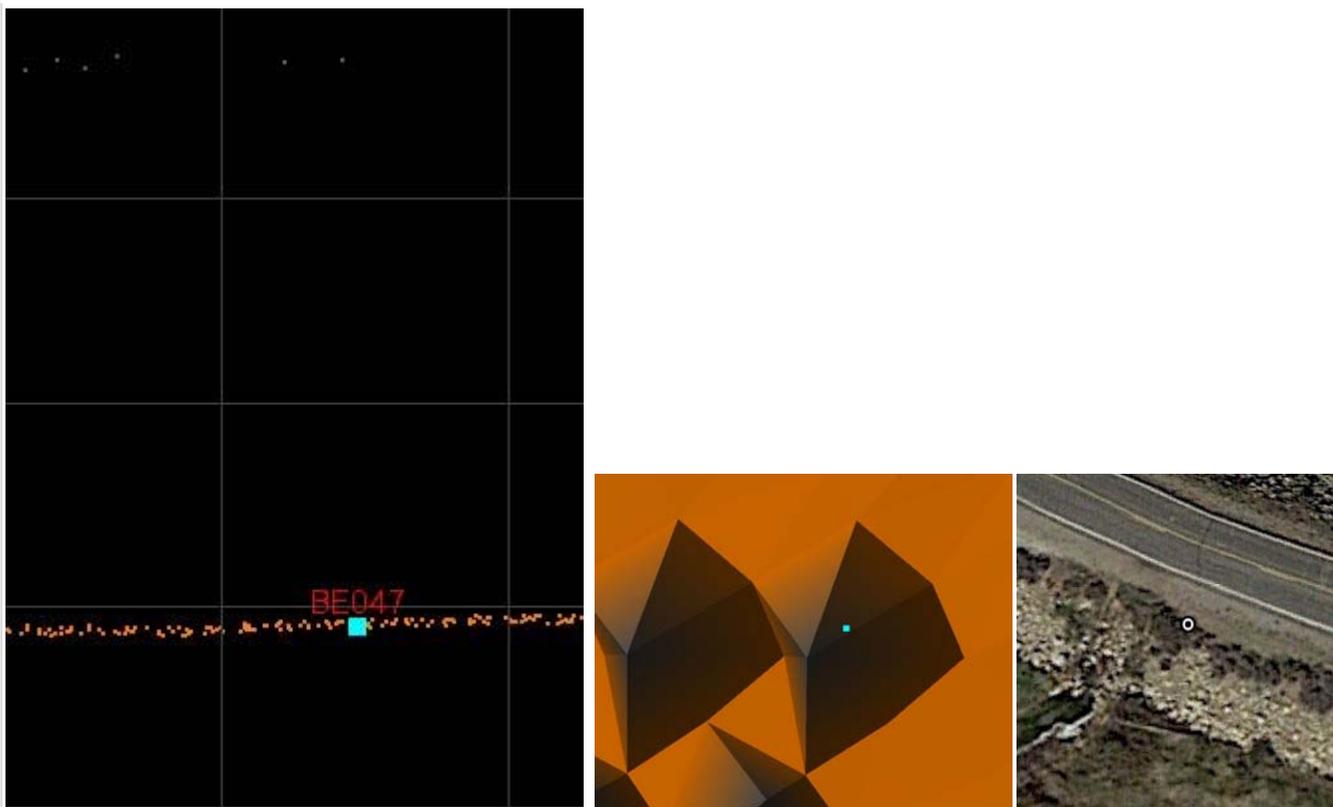
Corrected 5/15/2019 - Points removed from analysis by contractor
- BE38 and BE47 have a DeltaZ over 6.

All LPC Images below have withheld and overlap points removed.

BE38 -1246817.102 2020561.545 2213.710 2190.125 Control 23.585



BE47 -1212071.899 2009534.697 1788.150 1794.571 Control -6.421



If BE47 (zDiff = -6.421) is removed, the VA fails (RMSEz = 218.07 cm).

If BE38 (zDiff = 35.828) is removed, the VA fails (RMSEz = 58.0 cm).

If both BE38 and BE47 are removed, the VA passes (RMSEz = 3.3 cm).

Additional Reviewed
Vertical Accuracy
Information:

Based on this review, the USGS accepts 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: Not Required

- 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).

Corrected 5/14/2019
WKT is not well formed.

- 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 | <input checked="" type="checkbox"/> |
| 2 | Bare-earth/Ground | <input checked="" type="checkbox"/> |
| 7 | Noise (low, manually identified, if needed) | <input checked="" type="checkbox"/> |
| 8 | Model key points | <input type="checkbox"/> |
| 9 | Water | <input checked="" type="checkbox"/> |
| 10 | Ignored ground (breakline proximity) | <input checked="" type="checkbox"/> |
| 11 | Withheld (if the "Withheld Bit" is not implemented in the processing software) | <input checked="" type="checkbox"/> |
| 17 | Bridges | <input checked="" type="checkbox"/> |
| 18 | Noise (high, manually identified, if needed) | <input checked="" type="checkbox"/> |

Additional Classes:

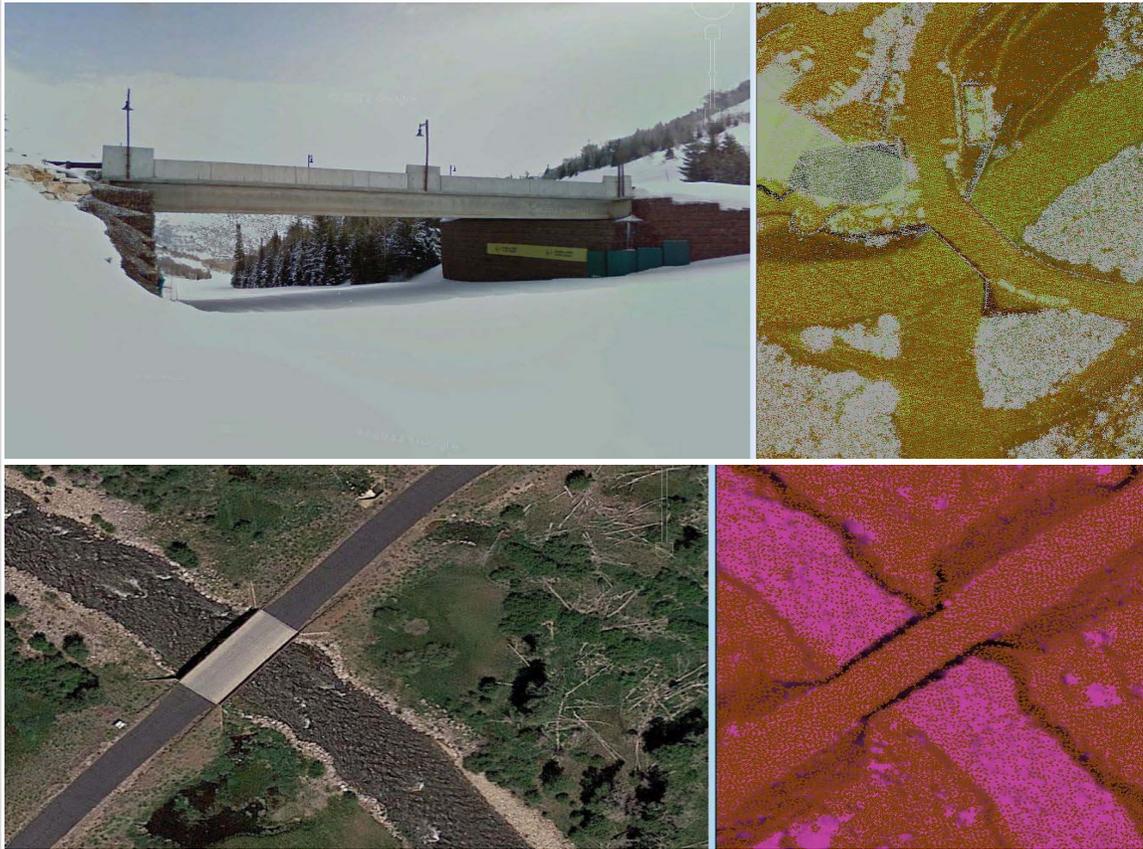
| Class | Description |
|-------|---------------|
| 20 | Ignore Ground |
| 14 | |

Additional comments:

Corrected 5/14/2019
- Las Files have classifications of 10 (1 Las tile), 11 (926 Las tiles), and 14(13 Las tiles). Project Report and Metadata XML's do not contain those classifications.

Corrected 5/14/2019
- Scan Angles appear to be incorrect for most Las tiles. Scan Angle Min's and Max's are above 30. Project Report and Metadata XML's have sensor's Field of View at 30 or Scan Angle at 15.

Corrected 5/14/2019
- 4 Bridge areas with points not classified correctly, causing bridges to be left in DEM, see UT_FEMAHQ_B2_QL1_Errors and UT_FEMAHQ_B2_QL2_Errors error shapefiles.
Examples:



Corrected 5/14/2019

- 2 Culvert areas with points not classified correctly, causing culverts to be removed from DEM, see UT_FEMAHQ_B2_QL1_Errors error shapefiles.

Example:



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 Geometry (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.

Lines are:

Single Line Streams

Bridge Cuts

Culvert Connectors

Downstream SLS Flow is Monotonic

- No missing or misplaced breaklines.

ADDITIONAL COMMENTS, ERRORS, ANOMALIES, OR OTHER ISSUES:

Corrected 5/14/2019

- 1 Breakline needs to be removed, feature is not a lake/pond and not hydroflattened, UT_FEMAHQ_B2_QL1_Errors shapefile.



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: 0.5 Meters

Tile bit depth/pixel Type: 32_BIT_FLOAT

Interpolation or Resampling Technique: Select...

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 corrowing

Hydro Treatment: hydro-flattened

DEM tiles are properly Hydro Flattened Yes No

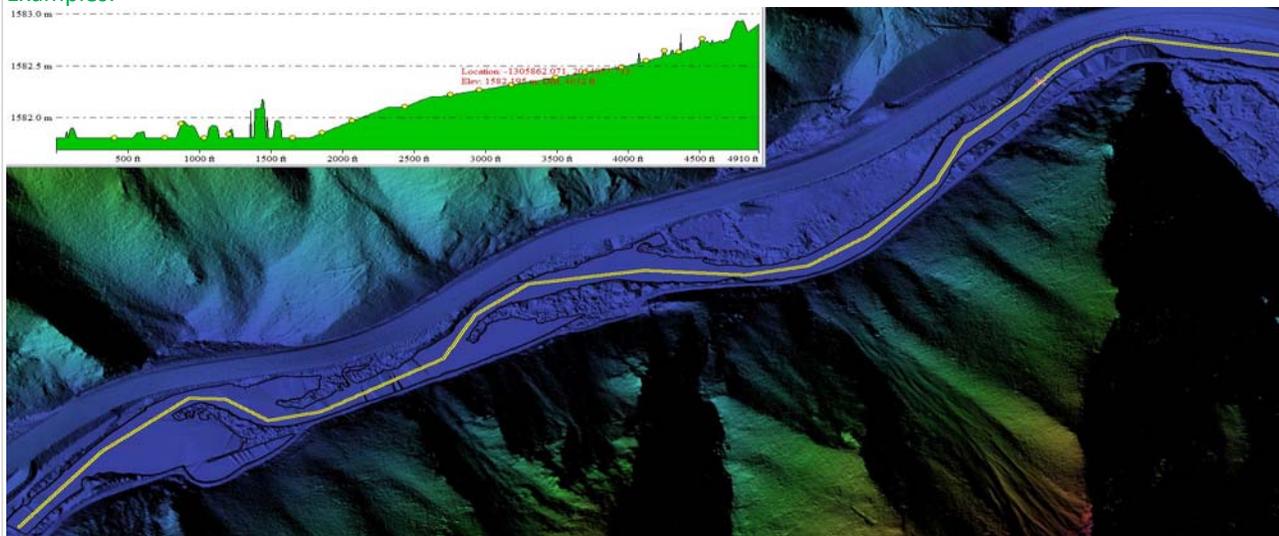
Waterbodies 2 Acres or greater are flattened

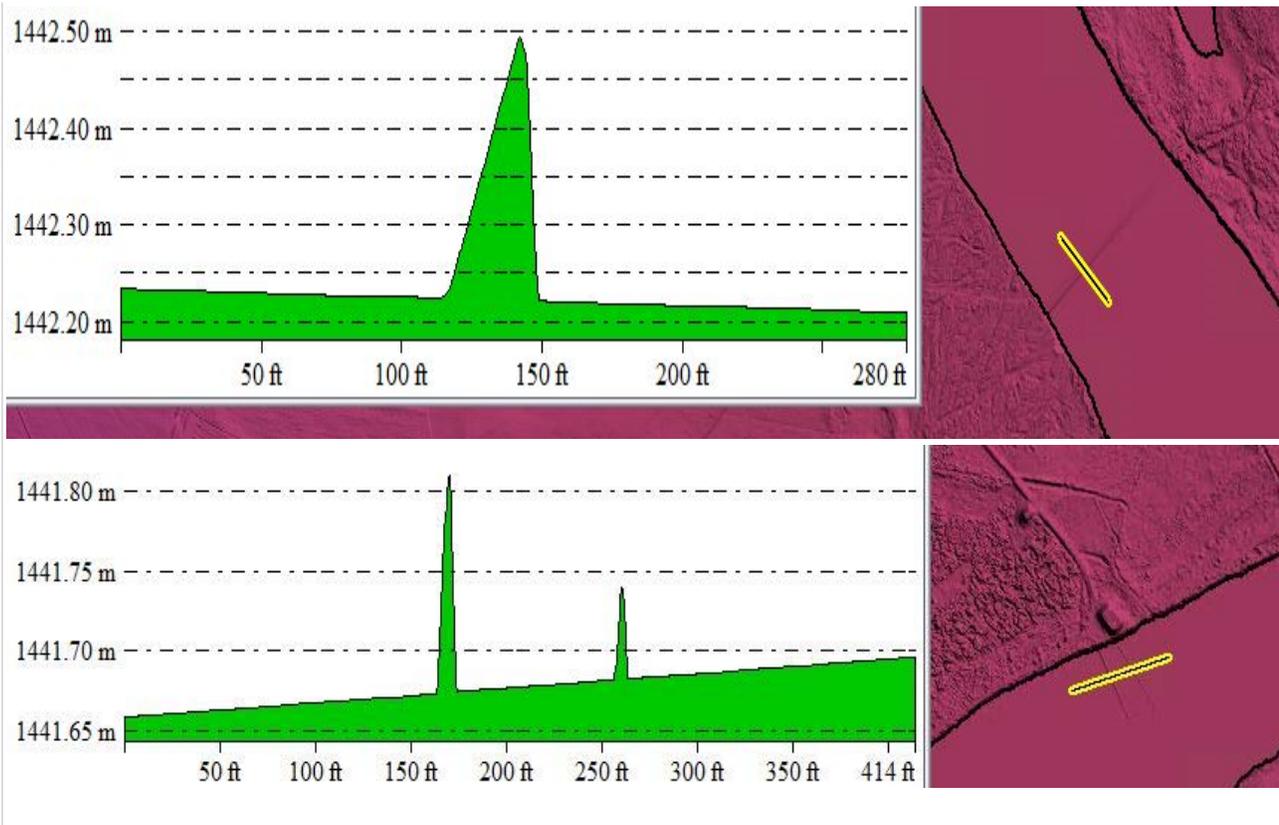
Streams 100 ft. or greater are flattened in a downstream manner

Corrected 5/14/2019

- 1 River section not hydroflattened, see UT_FEMAHQ_B2_QL1_Errors and UT_FEMAHQ_B2_QL2_Errors error shapefiles.

Examples:





- Tidal Boundaries/Shorelines are flattened
- No missing islands or larger
- Bridges/Overpasses are properly removed
- Culverts are maintained (Not Hydro Enforced)
- Depressions, Sinks, are not filled in (Not Hydro Conditioned)
- Vegetation properly removed
- Manmade structures properly removed

ADDITIONAL COMMENTS, ERRORS, ANOMALIES, OR OTHER ISSUES:

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:

INTERNAL COMMENTS

- Re-Delivered DEM tiles do not have the same NoDataValue as the original delivery.
- Work Unit boundary intersects with Tribal Lands.

END OF REPORT (v2.4.0)