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:
10/15/2012

Project ID:
(NRCS) Saginaw Bay, MI LiDAR Task Order

Project Alias(es):
MI_SaginawBay-Lot2_2011

Project Type: GPSC

Project Description:
This task is for fall acquisition of high resolution lidar data for an area of approximately 1132 square miles generally encompassing the Pigeon-Wiscoggin watershed in the eastern/central area of Michigan (Lower Peninsula) and is intended to adjoin previously collected lidar data of similar requirements. This task also covers an area of approximately 500 square miles to complete Tuscola County.
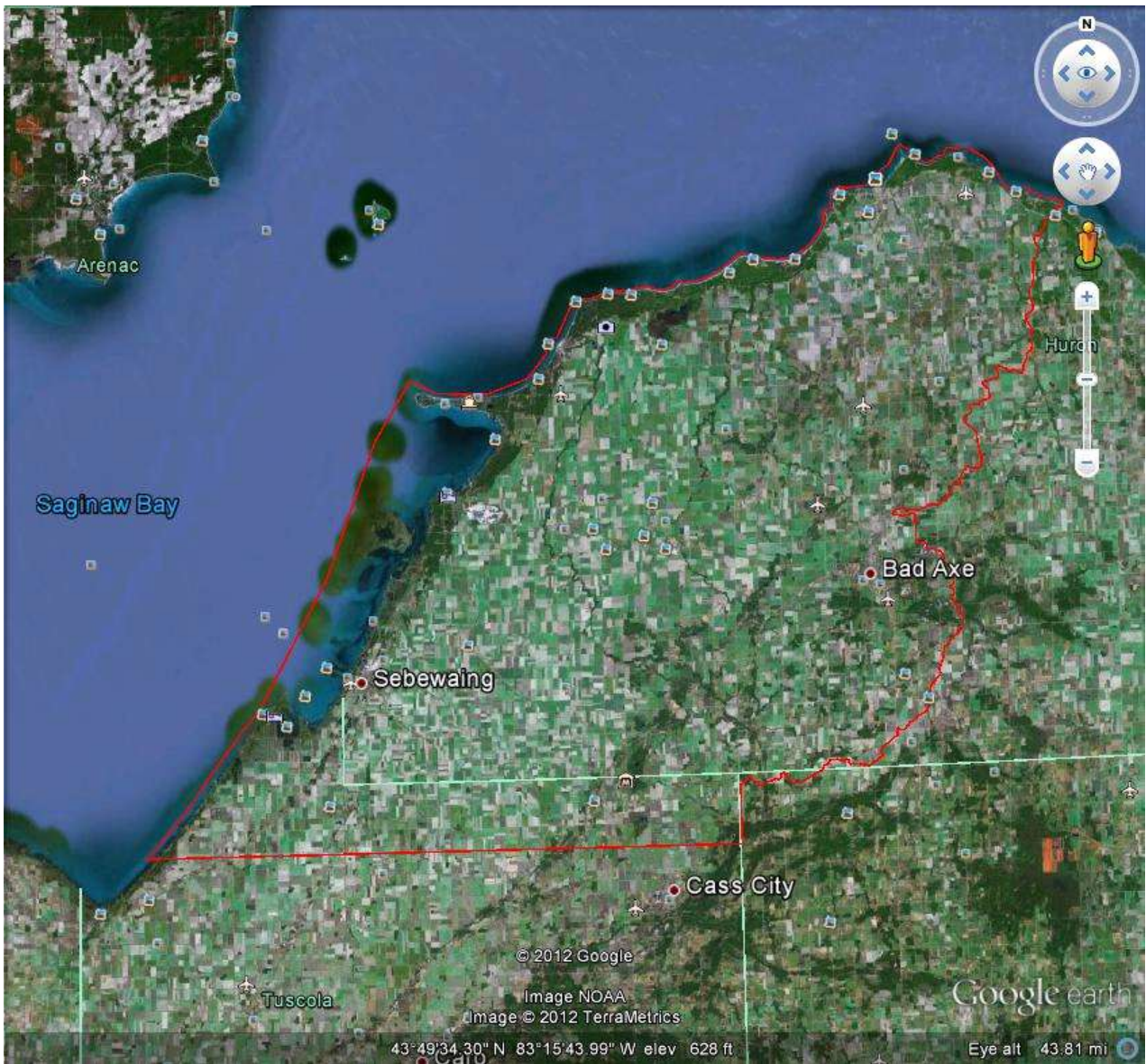
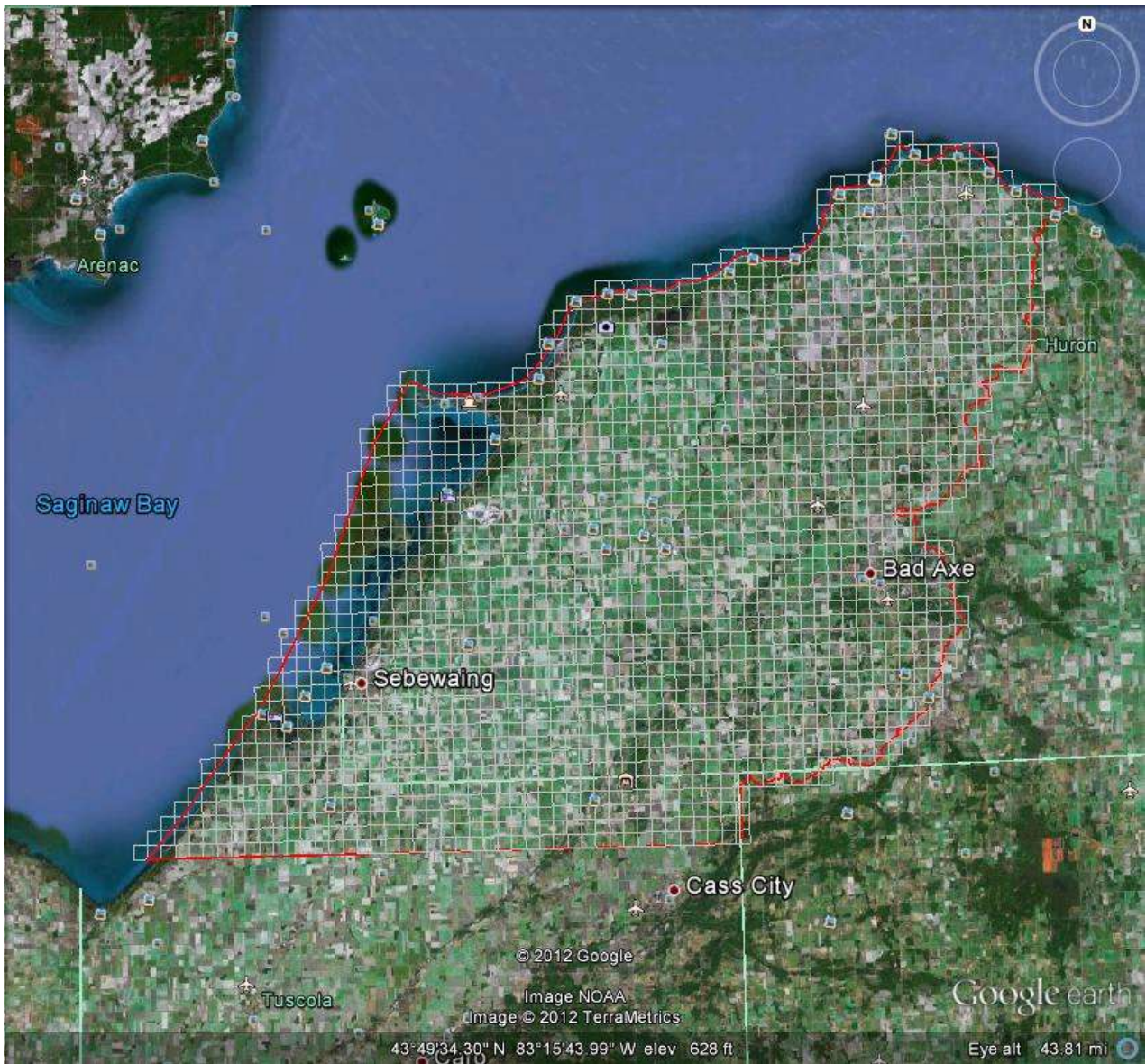**Year of Collection:** 2012

Lot 2 of 3 lots.

Project Extent:
☑ Project Extent image?

Project Tiling Scheme:
☑ Project Tiling Scheme image?

Contractor:

Woolpert, Inc.

Applicable Specification:

V13

Licensing Restrictions:

☐ Third Party Performed QA?

Project Points of Contact:

POC Name	Type	Primary Phone	E-Mail
Gail Dunn	CPT	573-308-3756	gdunn@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   ☑ Project Shapefile/Geodatabase
☐ Survey Report   ☑ Project Tiling Scheme Shapefile/Gdb
☐ Processing Report   ☑ Control Point Shapefile/Gdb
☐ QA/QC Report   ☑ Breakline Shapefile/Gdb
☐ Control and Calibration Points   ☐ Project XML Metadata

Multi-File Deliverables

File Type		Quantity
☐ Swath LAS Files ☐ Required? ☐ XML Metadata?		
☑ Intensity Image Files ☑ Required?		1920
☑ Tiled LAS Files ☑ Required? ☐ XML Metadata?		1920
☑ Breakline Files ☑ Required? ☐ XML Metadata?		2
☑ Bare-Earth DEM Files ☑ Required? ☐ XML Metadata?		1920

Additional Deliverables

	Item
☑	First Return Surface [.IMG]; Projection Coordinate Reference System is consistent

Errors, Anomalies, Other Issues to document? ◉ Yes ○ No

Project level metadata was delivered with first lot; revised metadata was delivered 10/15/2012; Swath data and reports will be delivered at the end of the project. I have detected some error and anomalies in the classified LAS and created a report to send to the Contractor to address and make necessary corrections. I have run a script against the classified LAS (lasfilecheck.exe) and discovered some errors and anomalies. These were provided to the contractor by way of a Word doc for review and correction. One tile (17TKJ860330.las) had header issues, abnormal average intensity and elevation values; point classes reported outside the ASPRS range; invalid return number of zero and points with scan angle values out of range. Several tiles reported bad GPS Time and others were found to contain no Edge Marker values.

(Replacement tiles were delivered on 10/24/2012)

Project Geographic Information

Areal Extent:

699.72

Sq Mi
Grid Size:

1

meters
Tile Size:

1000

 meters
Nominal Pulse Spacing:

0.7

 meters
Vertical Datum: NAVD88 meters
Horizontal Datum: NAD83 meters

Project Projection/Coordinate Reference System: UTM Zone 17 North meters.

This Projection Coordinate Reference System is consistent across the following deliverables:
- ☑ Project Shapefile/Geodatabase
- ☑ Project Tiling Scheme Shapefile/Gdb
- ☑ Checkpoints Shapefile/Geodatabase
- ☐ Project XML Metadata File
- ☐ Swath LAS XML Metadata File
- ☐ Classified LAS XML Metadata File
- ☐ Breaklines XML Metadata File
- ☐ Bare-Earth DEM XML Metadata File
- ☐ Swath LAS Files
- ☐ Classified LAS Files
- ☑ Breaklines Files
- ☑ Bare-Earth DEM Files

Project XML Metadata CRS

N/A

Swath LAS XML Metadata CRS

N/A

Classified LAS XML Metadata CRS

N/A

Breakline XML Metadata CRS

N/A

DEM XML Metadata CRS

N/A

Swath LAS Files CRS

N/A

Classified LAS Files CRS

NAD 83 UTM Zone 17N Meters and Unknown Coordinate System

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:

11/14/2012

Action to Contractor Date	Issue Description	Return Date
11/27/2012	LAS issues, See LAS Tile File Review Section for more information	

Review Complete:

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.

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?
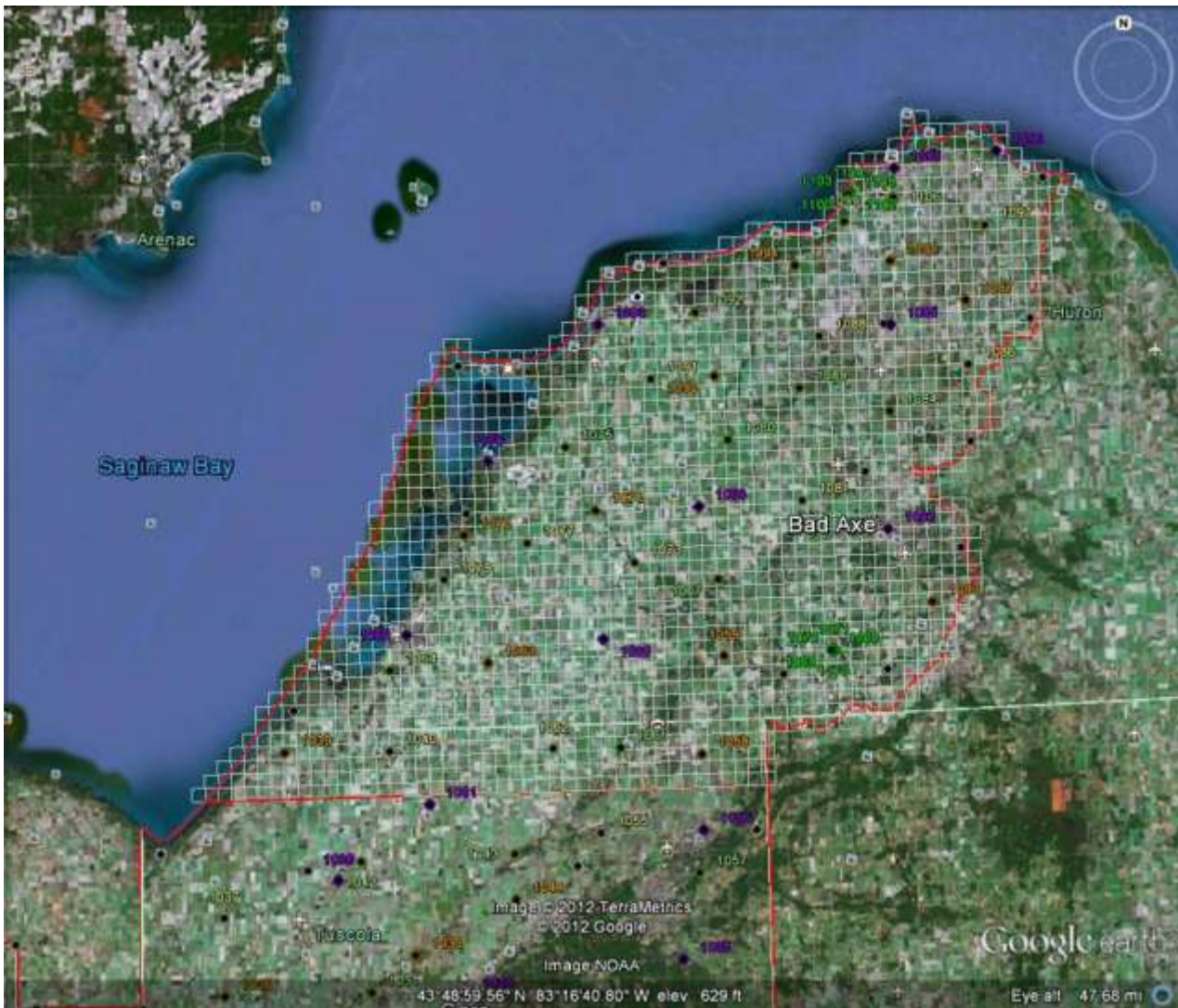
The following land cover classes are represented in this dataset (uncheck any that do not apply):

☑ 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?

The QC check point data is project wide

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: centimeters

Required FVA Value is 18.2 centimeters or less.
Target SVA Value is 26.86 centimeters or less.
Required CVA Value is 26.86 centimeters or less.

The reported FVA of the LAS Swath data is 13.5 centimeters.

The reported FVA of the Bare-Earth DEM data is 13.5 centimeters.
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		18.7		centimeters
Brush Lands and Low Trees		19.0		centimeters
Forested Areas Fully Covered by Trees		18.5		centimeters
Urban Areas with Dense Man-Made Structu...		09.4		centimeters

The reported CVA of this data set is: 14.7 centimeters.

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

☑	17	-	Overlap Default
☑	18	-	Overlap Ground

Based on this review, the USGS does not accept at this time the classified LAS tile file data.

Errors, Anomalies, Other Issues to document?   ⦿ Yes ○ No

☐ Image?

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When all delivered tiles are loaded into ArcMap using the LP360 add lidar data tool, a message displays that indicates that some of the tiles are of an Unknown Coordinate System, and some tiles are NAD 83 UTM Zone 17N. The files do all appear to load correctly; however, routine review tasks were not able to be run on the dataset as a whole. In particular, the LP360 Point Cloud Statistics Extractor will not run, and the following error message was given:

"Caller's Message:
Executing task(s) failed.
Exception Information:
HRESULT: 0x80004005
Source: LPFilters.LPStatsExtractor.1
Description:
Unable to calculate the area."

This is related to the fact that one LAS tiles only contains one point. This tile was identified and excluded from the process (17TLJ510690.las), and the error no longer occurred. This tile should be removed from the dataset.

When the results of the LP360 Point Cloud Statistics Extractor were reviewed, it was determined that one tile (17TLJ460800.las) has an Unknown Coordinate System. This tile needs to be recreated with correct header information.

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: 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 centimeters .

Reported Accuracies

Land Cover Category	# of Points	Fundamental Vertical Accuracy @95% Confidence Interval (Accuracy$_z$) Required FVA = 18.2 or less.	Supplemental Vertical Accuracy @95th Percentile Error Target SVA = 26.86 or less.	Consolidated Vertical Accuracy @95th Percentile Error Required CVA = 26.86 or less.
Open Terrain	22	13.5		
Tall Weeds and Crops	20		18.7	
Brush Lands and Low Trees	21		19.0	
Forested Areas Fully Covered by Trees	23		18.5	
Urban Areas with Dense Man-Made Structures	20		09.4	
Consolidated				

	106			14.7

☐ QA performed Accuracy Calculations?

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.

Based on this review, the deliverables provided do not meet at this time the Task Order requirements.

Internal Note:

Checkpoints for the entire project area were received, but all vertical accuracy calculations will not be performed until all data is received per the task order.

This is the end of the report.

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