



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 NGTOCooperations@usgs.gov.

Materials Received:

12/17/2012

Project ID:

Saginaw Bay MI_0.7M_Lidar_2011

Project Alias(es):

(NRCS) Saginaw Bay, MI LiDAR Task Or...

Project Type: GPSC

Project Description:

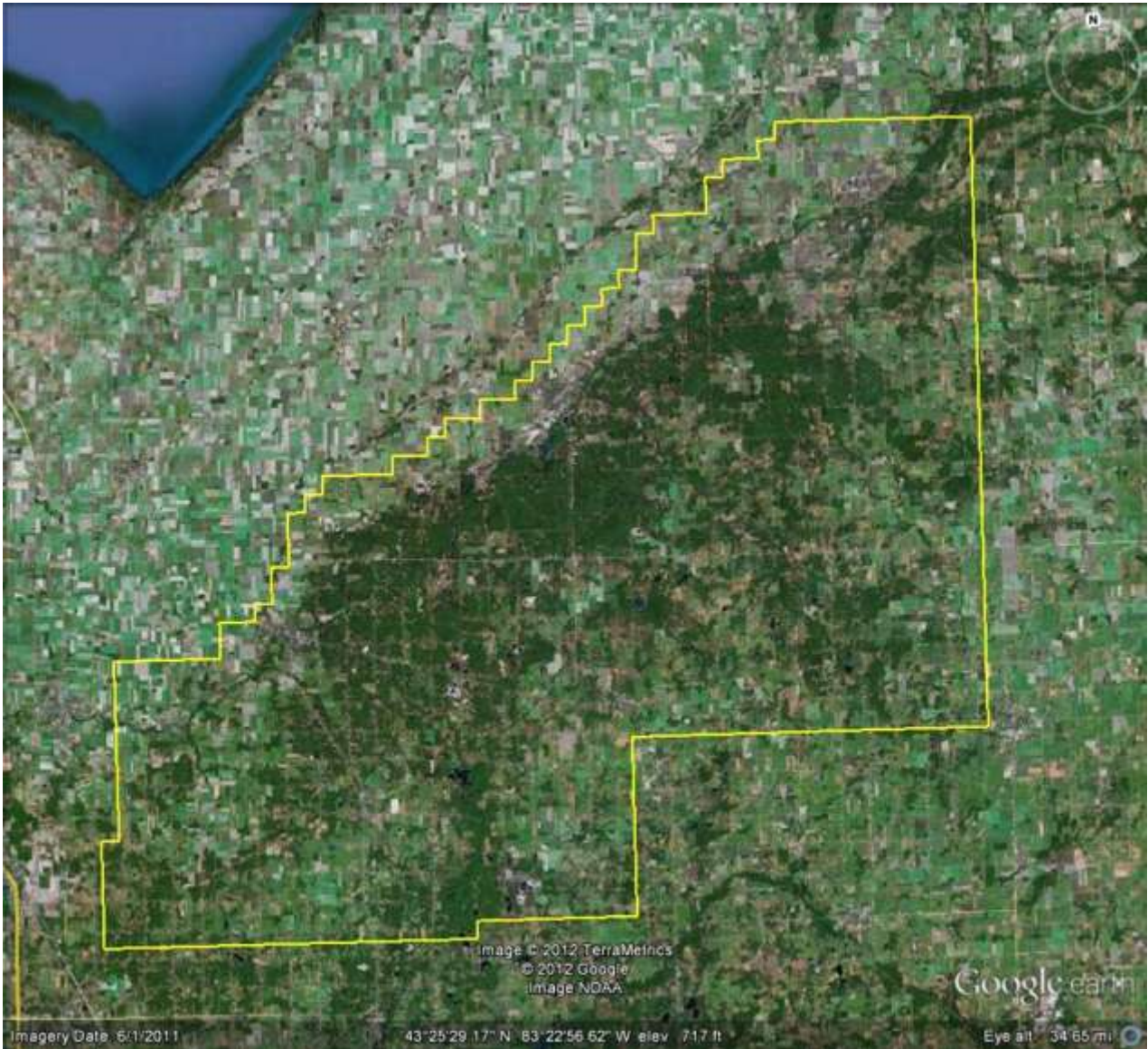
This task order is for planning, acquisition, processing, and derivative products of lidar data to be collected at a nominal pulse spacing (NPS) of 0.7 meters. Specifications are based on the "U.S. Geological Survey National Geospatial Program Base Lidar Specification, Version 13 (ILMF)." This task is for fall acquisition of high resolution lidar data for an area of approximately 1632 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.

Year of Collection: 2012

Lot 3 of 3 lots.

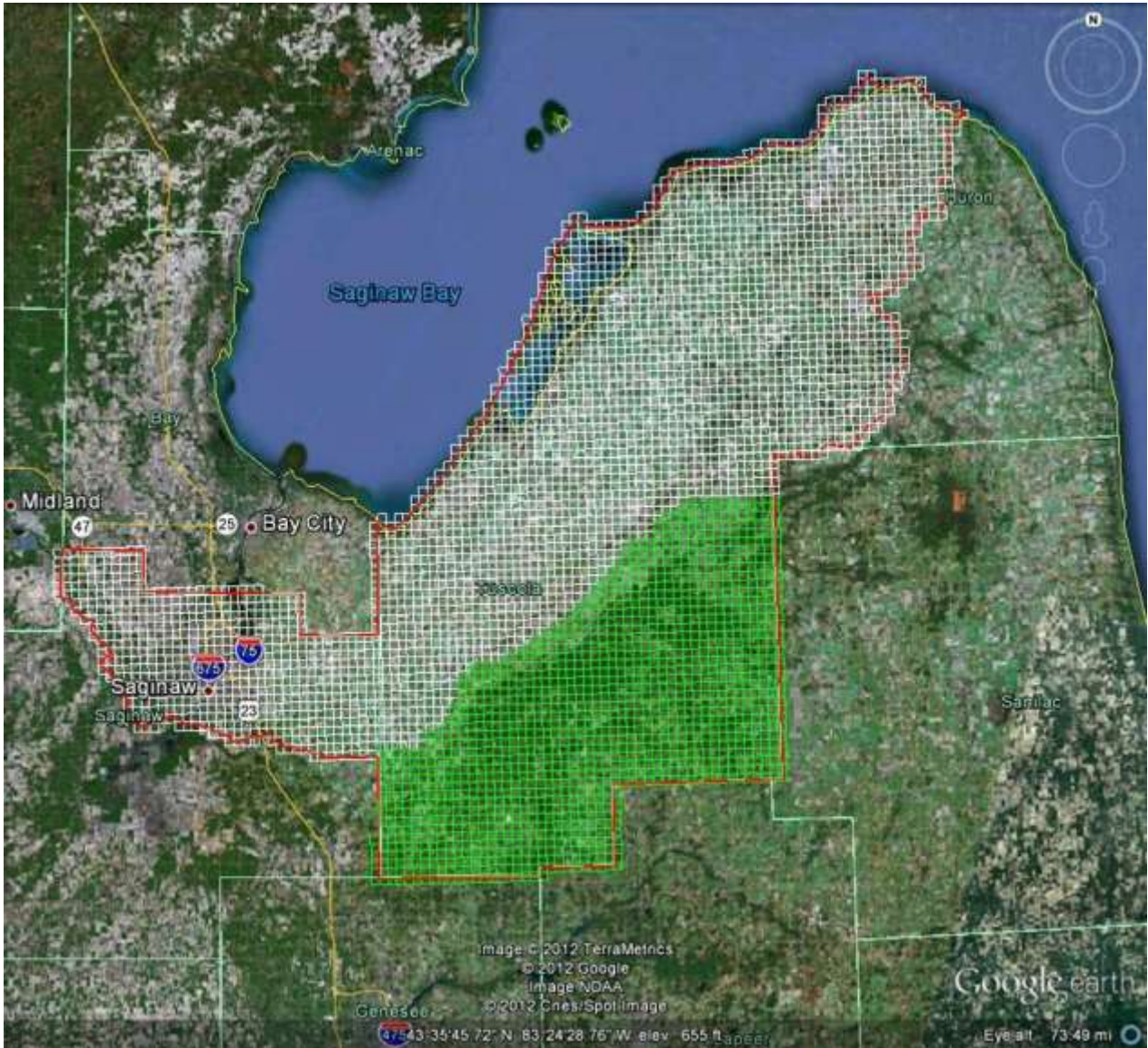
Project Extent:

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

Multi-File Deliverables

File Type	Quantity
<input checked="" type="checkbox"/> Swath LAS Files <input checked="" type="checkbox"/> Required? <input checked="" type="checkbox"/> XML Metadata?	618
<input checked="" type="checkbox"/> Intensity Image Files <input checked="" type="checkbox"/> Required?	1366
<input checked="" type="checkbox"/> Tiled LAS Files <input checked="" type="checkbox"/> Required? <input checked="" type="checkbox"/> XML Metadata?	1366
<input checked="" type="checkbox"/> Breakline Files <input checked="" type="checkbox"/> Required? <input checked="" type="checkbox"/> XML Metadata?	2
<input checked="" type="checkbox"/> Bare-Earth DEM Files <input checked="" type="checkbox"/> Required? <input type="checkbox"/> XML Metadata?	1366

Additional Deliverables

	Item
<input checked="" type="checkbox"/>	First Return Surface
<input checked="" type="checkbox"/>	Intensity Images

Errors, Anomalies, Other Issues to document? Yes No

None.

Project Geographic Information

Areal Extent:

527.4155

Sq Mi

Grid Size:

1.0

meters

Tile Size:

1000

meters

Nominal Pulse Spacing:

0.7

meters

Vertical Datum: meters

Horizontal Datum: meters

Project Projection/Coordinate Reference System: meters.

This Projection Coordinate Reference System is consistent across the following deliverables:

- | | |
|---|--|
| <input checked="" type="checkbox"/> Project Shapefile/Geodatabase | <input checked="" type="checkbox"/> Breaklines XML Metadata File |
| <input checked="" type="checkbox"/> Project Tiling Scheme Shapefile/Gdb | <input checked="" type="checkbox"/> Bare-Earth DEM XML Metadata File |
| <input checked="" type="checkbox"/> Checkpoints Shapefile/Geodatabase | <input type="checkbox"/> Swath LAS Files |
| <input checked="" type="checkbox"/> Project XML Metadata File | <input checked="" type="checkbox"/> Classified LAS Files |
| <input checked="" type="checkbox"/> Swath LAS XML Metadata File | <input checked="" type="checkbox"/> Breaklines Files |
| <input checked="" type="checkbox"/> Classified LAS XML Metadata File | <input checked="" type="checkbox"/> Bare-Earth DEM Files |

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:

12/31/2012

Action to Contractor Date	Issue Description	Return Date
1/3/2013	Assign Coordinate System to Swath Files.	1/28/2013

Review Complete: 1/30/2013

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 without errors.

The Swath LAS XML Metadata file parsed without errors.

The Classified LAS XML Metadata file parsed without errors.

The Breakline 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.

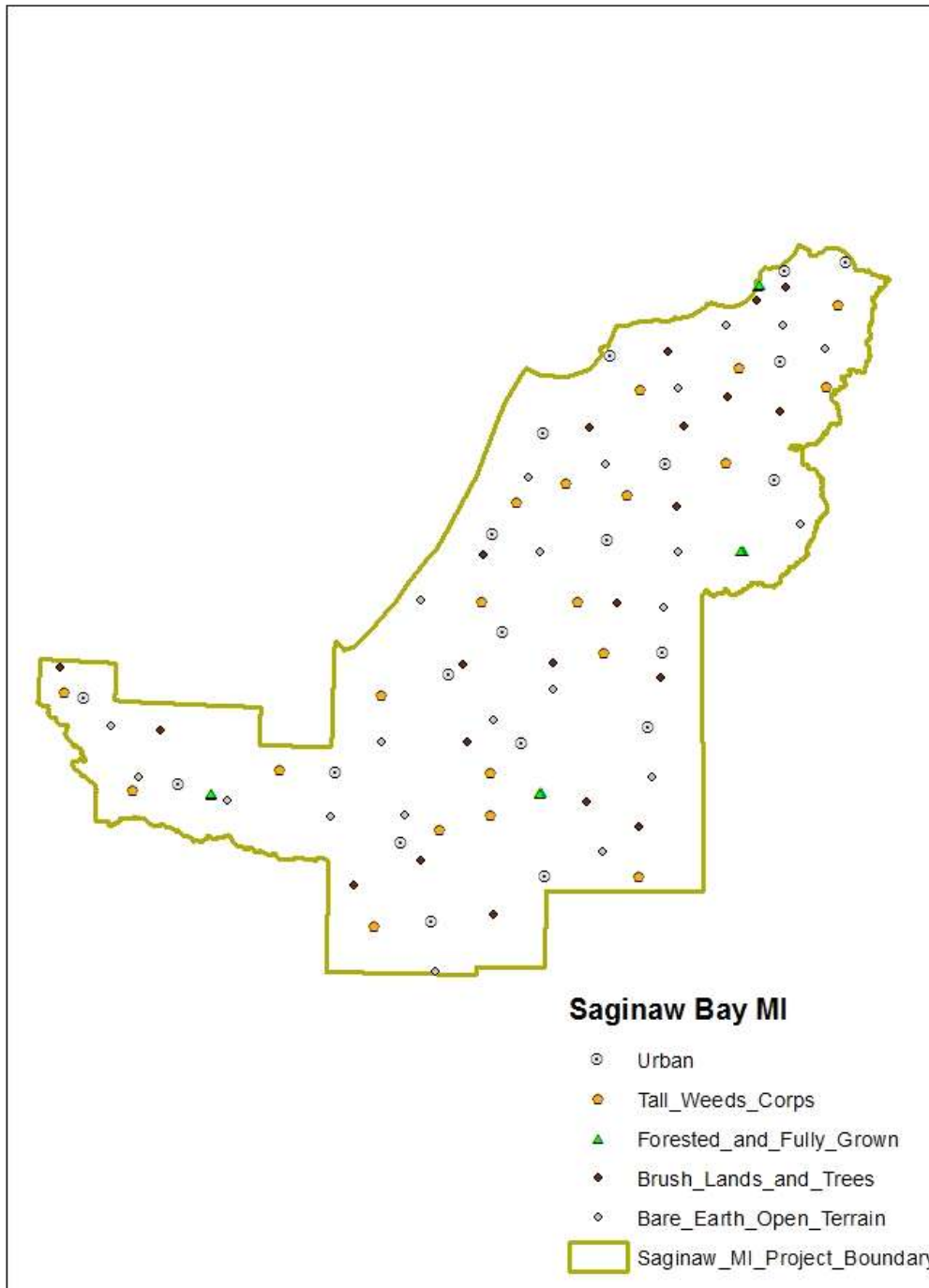
NSSDA and ASPRS require that a minimum of twenty checkpoints (thirty is preferred) are collected for each major land cover category represented in the LiDAR data. Checkpoints should be selected on flat terrain, or on uniformly sloping terrain in all directions from each checkpoint. They should not be 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?

Saginaw Bay MI LiDAR AOI and QC Checkpoints



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

None.

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:

Required FVA Value is or less.

Target SVA Value is or less.

Required CVA Value is or less.

The reported FVA of the LAS Swath data is .

The reported FVA of the Bare-Earth DEM data is .

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	<input type="text" value="18.7"/>	<input type="text" value="centimeters"/>
Brush Lands and Low Trees	<input type="text" value="19.0"/>	<input type="text" value="centimeters"/>
Forested Areas Fully Covered by Trees	<input type="text" value="18.5"/>	<input type="text" value="centimeters"/>
Urban Areas with Dense Man-Made Structu...	<input type="text" value="09.4"/>	<input type="text" value="centimeters"/>

The reported CVA of this data set is: .

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

- Separate folder for LAS swath files
 Each swath files <= 2GB
 *If specified, *.wdp files for full waveform have been provided

The reported FVA of the LAS swath data is .

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

Yes No

Image?

No CRS defined. The NGTOC calculated FVA of the LAS swath data is 11.0 centimeters.

1/28/2013 - All LAS Swath Files now have CRS information in the headers.

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

<input checked="" type="checkbox"/>	17	-	Overlap Default
<input checked="" type="checkbox"/>	18	-	Overlap Ground

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

Errors, Anomalies, Other Issues to document? Yes No

None.

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	<u>Fundamental Vertical Accuracy @95% Confidence Interval (Accuracy_Z)</u> Required FVA = 18.2 or less.	<u>Supplemental Vertical Accuracy @95th Percentile Error</u> Target SVA = 26.86 or less.	<u>Consolidated Vertical Accuracy @95th Percentile Error</u> 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?

Calculated 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	12.1		
Tall Weeds and Crops	20		13.6	
Brush Lands and Low Trees	21		14.2	
Forested Areas Fully Covered by Trees	23		17.5	
Urban Areas with Dense Man-Made Structures	20		10.2	
Consolidated	106			16.2

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 meet the Task Order requirements.

Internal Note:

All swath files were delivered with the final data delivery (Lot 3/TOMIS Lot 7). All swath files have an Unknown Coordinate System; this will need to be appended to the header of each file and redelivered. All vertical accuracy checkpoints were delivered with this lot as well, and were calculated project wide.

1/28/2013 - All LAS Swath Data has been corrected. No data issues remain.

This is the end of the report.

QA Form V1.4 12OCT11.xsn