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:
5/8/2012

Project Type: NSDI Agreement

Project ID:
OR_CVO-Burns_2011

Project Description:
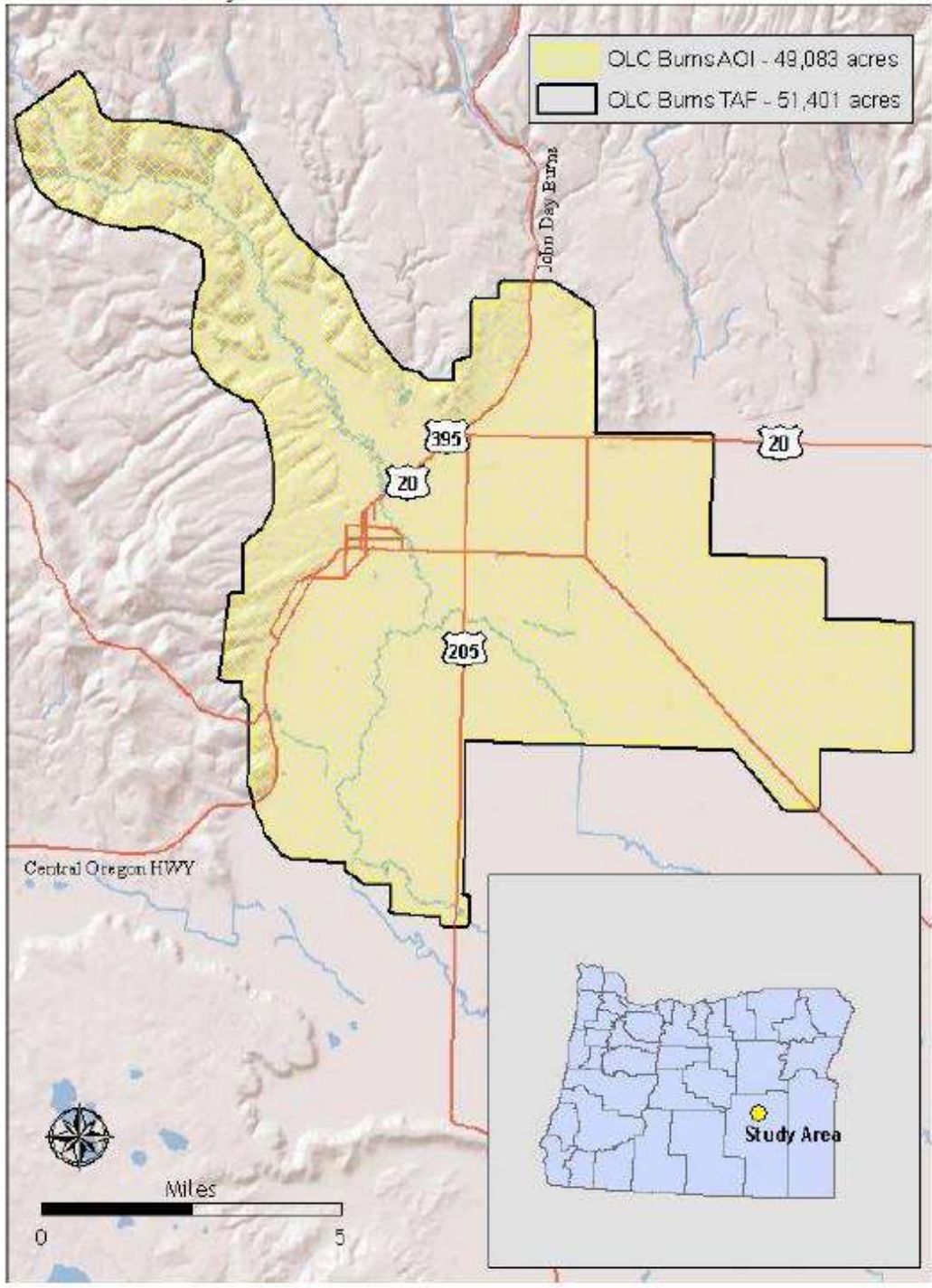
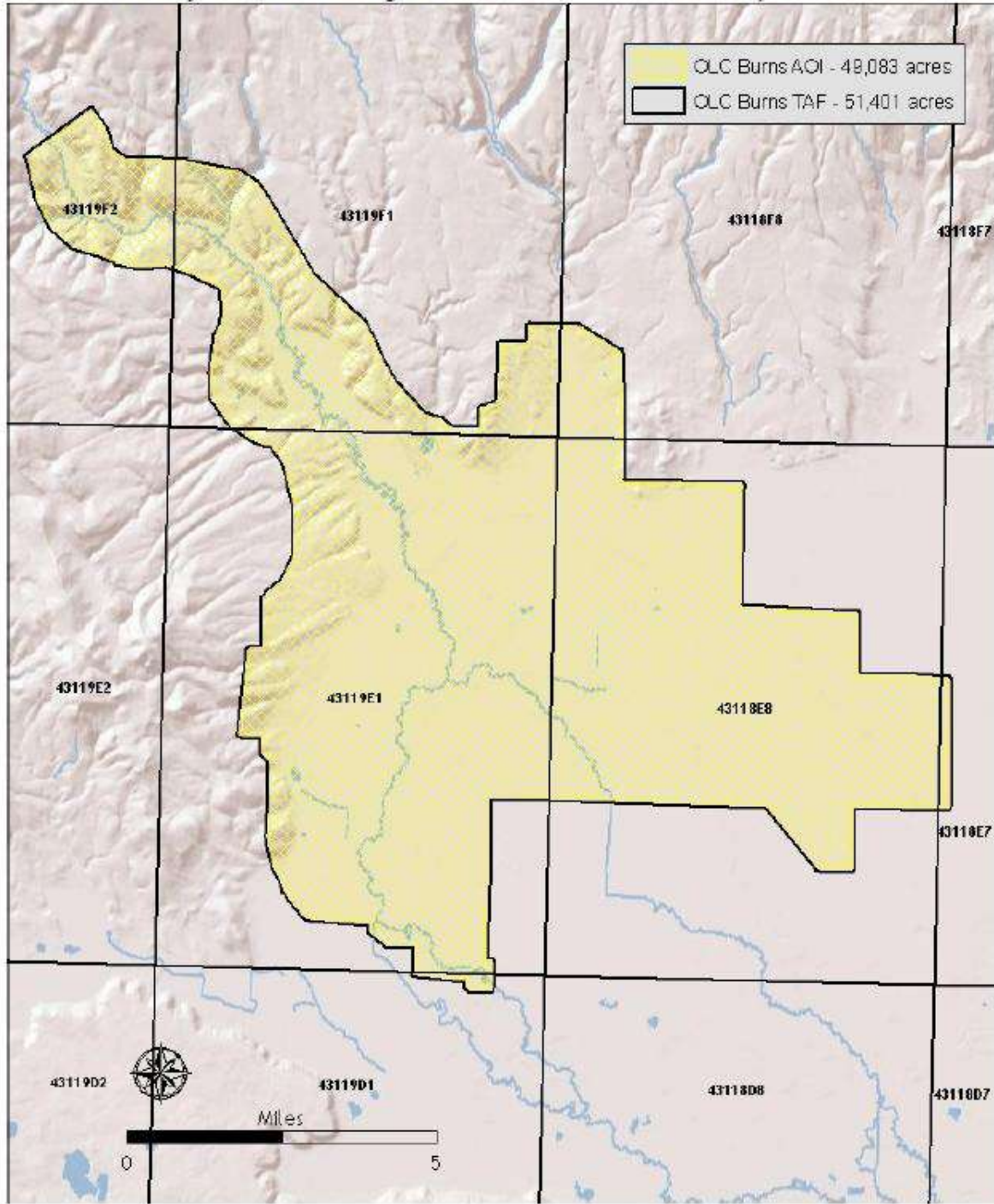Project Alias(es):

Year of Collection: 2011

Lot 1 of 1 lots.

Project Extent:
☑ Project Extent image?

Figure 1.1. DOGAMI Burns Study Area.

Project Tiling Scheme:
☑ Project Tiling Scheme image?

Figure 1.2. Burns Study Area, illustrating the delivered 7.5 minute USGS quads.

Contractor:

Watershed Sciences

Applicable Specification:

DOGAMI, NSSDA

Licensing Restrictions:

None

☐ Third Party Performed QA?

Project Points of Contact:

POC Name	Type	Primary Phone	E-Mail
Sheri Schneider	NSDI Liaison	503-251-3210	sschneider@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 Tiling Scheme Shapefile/Gdb
☑ Survey Report   ☐ Breakline Shapefile/Gdb
☑ Processing Report   ☐ Project XML Metadata
☑ QA/QC Report   ☐ Swath LAS XML Metadata
☐ Control and Calibration Points   ☐ Classified LAS XML Metadata
☑ Project Shapefile/Geodatabase   ☐ Breakline XML Metadata
☐ Control Point Shapefile/Gdb   ☑ Bare-Earth DEM XML Metadata

Multi-File Deliverables

File Type	Quantity
☐ Swath LAS Files	
☑ Intensity Image Files	190
☑ Tiled LAS Files	380
☐ Breakline Files	
☑ Bare-Earth DEM Files	7

Additional Deliverables

	Item
☑	Ground Density Rasters, 190 files
☑	RTK points, 2 files
☑	Trajectories, 1 file

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

Two project tiling schemes delivered to reviewer at
NGTOC. BURNS_TAF_7_5_QUAD_UTM83_Z11N.shp is the tiling scheme for the
DEMs, while BURNS_TAF_075_QUAD_UTM83_Z11N.shp is the tiling scheme for the
classified las files.

Project Geographic Information

Areal Extent: 76.84 Sq Mi

Grid Size: 1 meters

Tile Size: varies meters

Nominal Pulse Spacing: 1 meters

Vertical Datum: NAVD88 meters

Horizontal Datum: NAD83 meters

Project Projection/Coordinate Reference System: UTM Zone 11N 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

Check Point Shapefile/Geodatabase CRS

No checkpoint shapefile delivered to NGTOC

Project XML Metadata CRS

No project xml metadata delivered to NGTOC

Swath LAS XML Metadata CRS

No swath las xml metadata delivered to reviewer at NGTOC

Classified LAS XML Metadata CRS

No classified las xml metadata delivered to reviewer at NGTOC

Breakline XML Metadata CRS

No breakline xml metadata delivered to reviewer at NGTOC

Swath LAS Files CRS

No swath las files delivered to reviewer at NGTOC

Breakline Files CRS

No breakline files delivered to reviewer at NGTOC

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:

H. Boggs

Review Start Date:

5/10/2012

Action to Contractor Date	Issue Description	Return Date

Review Complete: 5/11/2012

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 with errors.

No project level xml metadata delivered to reviewer at NGTOC. Reviewer ran project extent metadata through the metadata parser and found the following errors:

Executing: mp G:\LiDAR\Projects\Oregon\OLC_BURNS_2011
\VECTORS\BURNS_TAF_UTM83_Z11N.shp.xml # # #
Start Time: Thu May 10 13:16:26 2012
Running script mp...
"C:\ArcGIS\bin\mp.exe" BURNS_TAF_UTM83_Z11N.shp.xml 2>&1
mp BURNS_TAF_UTM83_Z11N.shp.xml
: mp 2.9.6 - Peter N. Schweitzer (U.S. Geological Survey)
: Info: input file = BURNS_TAF_UTM83_Z11N.shp.xml
: Error (line 3): Lineage is not permitted in Metadata
: Error (line 3): Process_Step is required in Lineage
: Error (line 3): improper value for Publication_Date
: Error (line 5): improper value for Beginning_Date
: Error (line 5): improper value for Ending_Date
: Error (line 6): Place_Keyword_Thesaurus is required in Place
: Error (line 6): Place_Keyword is required in Place
: Error (line 6): Stratum_Keyword_Thesaurus is required in Stratum

: Error (line 6): Stratum_Keyword is required in Stratum
: Error (line 6): Temporal_Keyword_Thesaurus is required in Temporal
: Error (line 6): Temporal_Keyword is required in Temporal
: Error (line 6): Address_Type is required in Contact_Address
: Error (line 6): Originator is required in Citation_Information
: Error (line 6): Title is required in Citation_Information
: Error (line 6): improper value for Publication_Date
: Error (line 6): Completeness_Report is required in Data_Quality_Information
: Error (line 6): Distribution_Liability is required in Distribution_Information
: Error (line 6): Fees is required in Standard_Order_Process
: Error (line 6): Digital_Transfer_Option is required in Digital_Form
: Error (line 6): Format_Name is required in Digital_Transfer_Information
: Error (line 6): Contact_Address is required in Contact_Information
: Error (line 6): Contact_Voice_Telephone is required in Contact_Information
: Error (line 6): improper value for Abscissa_Resolution
: Error (line 6): improper value for Ordinate_Resolution
: Error (line 6): Entity_Type_Definition is required in Entity_Type
: Error (line 6): Entity_Type_Definition_Source is required in Entity_Type
: Error (line 6): Attribute_Definition is required in Attribute
: Error (line 6): Attribute_Definition_Source is required in Attribute
: Error (line 6): Attribute_Domain_Values is required in Attribute
: 30 errors: 1 misplaced, 22 missing, 1 empty, 6 bad_value
Completed script mp...
Executed (mp) successfully.
End Time: Thu May 10 13:16:26 2012 (Elapsed Time: 0.00 seconds)

Reviewer at NGTOC corrected as many errors as possible and again ran the file through metadata parser with the following results:

Executing: mp G:\LiDAR\Projects\Oregon\OLC_BURNS_2011
\VECTORS\BURNS_TAF_UTM83_Z11N.shp.xml # # #
Start Time: Thu May 10 13:32:11 2012
Running script mp...
"C:\ArcGIS\bin\mp.exe" BURNS_TAF_UTM83_Z11N.shp.xml 2>&1
mp BURNS_TAF_UTM83_Z11N.shp.xml
: mp 2.9.6 - Peter N. Schweitzer (U.S. Geological Survey)
: Info: input file = BURNS_TAF_UTM83_Z11N.shp.xml
: Error (line 3): Lineage is not permitted in Metadata
: Error (line 3): Process_Step is required in Lineage
: Error (line 3): improper value for Publication_Date
: Error (line 3): improper value for Publication_Time
: Error (line 6): Address_Type is required in Contact_Address
: Error (line 6): improper value for Publication_Date
: Error (line 6): improper value for Publication_Time
: Error (line 6): improper value for Source_Scale_Denominator
: Error (line 6): improper value for Horizontal_Positional_Accuracy_Value
: Error (line 6): improper value for Cloud_Cover
: Error (line 6): improper value for Metadata_Review_Date
: Error (line 6): improper value for Metadata_Future_Review_Date
: Error (line 6): improper value for Transfer_Size
: Error (line 6): improper value for Recording_Density
: Error (line 6): improper value for Abscissa_Resolution
: Error (line 6): improper value for Ordinate_Resolution
: Error (line 6): improper value for Depth_Resolution
: Error (line 6): improper value for Depth_Encoding_Method
: Error (line 6): improper value for Beginning_Date_of_Attribute_Values
: Error (line 6): improper value for Ending_Date_of_Attribute_Values

: Error (line 6): improper value for Attribute_Value_Accuracy
: Error (line 6): Attribute_Definition is required in Attribute
: Error (line 6): Attribute_Definition_Source is required in Attribute
: Error (line 6): Attribute_Domain_Values is required in Attribute
: 25 errors: 1 misplaced, 5 missing, 1 empty, 18 bad_value
Completed script mp...
Executed (mp) successfully.
End Time: Thu May 10 13:32:11 2012 (Elapsed Time: 0.00 seconds)

This is the BEST-USE metadata. Reviewer re-named the xml file: OR_CVO-Burns_2011. It is located in the METADATA-Documents folder.

The Bare-Earth DEM XML Metadata file parsed with errors.

Executing: mp G:\LiDAR\Projects\Oregon\OLC_BURNS_2011
\RASTERS\DEMS\BARE_EARTH\be43119d1\metadata.xml # # #
Start Time: Thu May 10 13:06:33 2012
Running script mp...
"C:\ArcGIS\bin\mp.exe" metadata.xml 2>&1
mp metadata.xml
: mp 2.9.6 - Peter N. Schweitzer (U.S. Geological Survey)
: Info: input file = metadata.xml
: Error: could not open input file metadata.xml
: Error: could not open input file metadata.xml
Completed script mp...
Executed (mp) successfully.
End Time: Thu May 10 13:06:34 2012 (Elapsed Time: 1.00 seconds)

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 not 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?

Land cover classes used to assess vertical accuracy were pasture/hay (138 checkpoints), short grass (100 checkpoints), and brush (104 checkpoints). Checkpoints were not delivered to reviewer.

☐ Image?

According to the OLC Burns, OR Delivery Acceptance Report delivered to the reviewer at NGTOC, "A total of 2,670 measured GCP's were obtained in the delivery region and compared with the LiDAR elevation grids. The data delivered to DOGAMI was found to have a mean vertical offset of -0.027 meters (-0.088 feet) and an RMSE value of 0.041 meters (0.135 feet)."

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: Select or type...

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		
Brush Lands and Low Trees		
Forested Areas Fully Covered by Trees		
Urban Areas with Dense Man-Made Structur...		

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.

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

☐ Image?

No LAS swath files delivered to reviewer at NGTOC

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?

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

☐ Image for error?

No breakline files delivered to reviewer at NGTOC.

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: ArcGrid

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 _____ .

Reported Accuracies

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

☐ QA performed Accuracy Calculations?

Based on this review, the USGS does not recommend 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

☐ Image?

Land cover classes used to assess vertical accuracy were pasture/hay (138 checkpoints), short grass (100 checkpoints), and brush (104 checkpoints). Checkpoints were not delivered to reviewer.
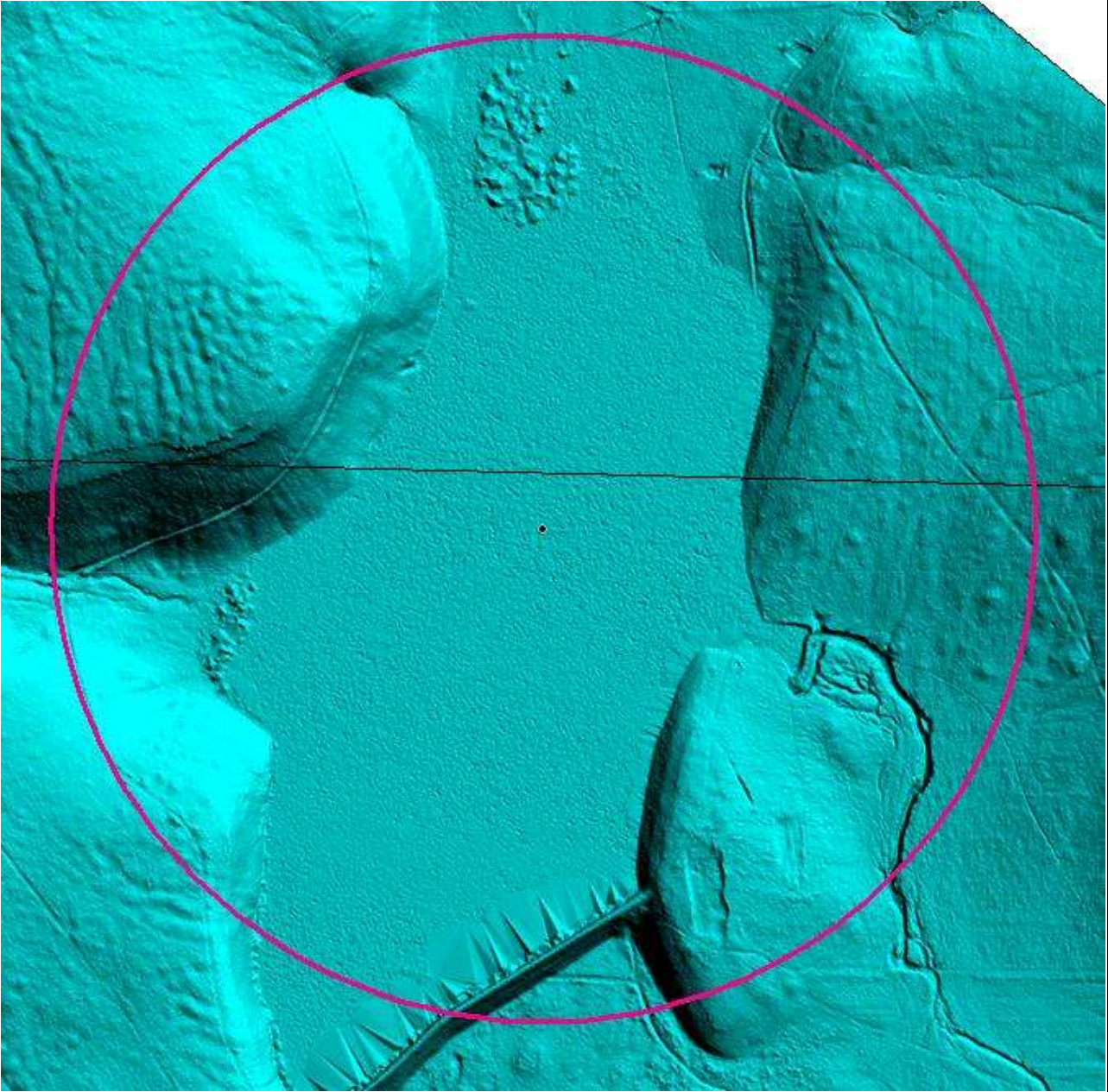
☐ Image?

According to the OLC Burns, OR Delivery Acceptance Report delivered to the reviewer at NGTOC, "A total of 2,670 measured GCP's were obtained in the delivery region and compared with the LiDAR elevation grids. The data delivered to DOGAMI was found to have a mean vertical offset of -0.027 meters (-0.088 feet) and an RMSE value of 0.041 meters (0.135 feet)."
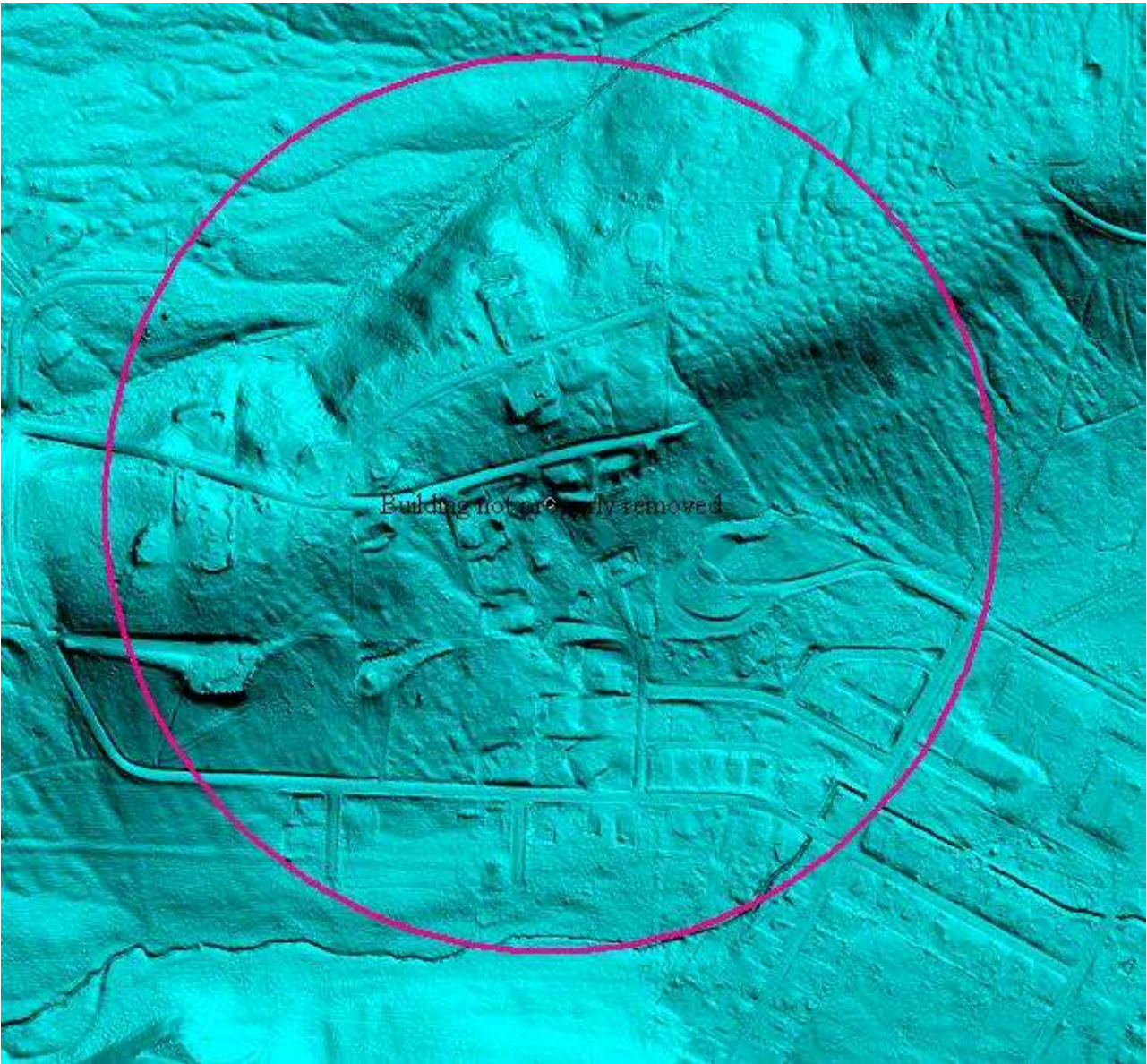
☐ Image?

No checkpoint distribution image delivered to reviewer at NGTOC.

Waterbody not flattened. Reviewer at NGTOC created an "errors" shapefile located in the METADATA-Shapefiles folder named errors.shp.

☑ Image?

Buildings not properly removed. Reviewer at NGTOC created an "errors" shapefile located in the METADATA-Shapefiles folder named errors.shp.

Internal Note:

Final mosaicked DEMs located in NED-FINAL TO NED-mosaic.

This is the end of the report.