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:
12/17/2012

Project ID:
OR_OLCRogue_2012

Project Alias(es):
Rogue River

Project Type: Donated Data

Project Description:
WSI has collected Light Detection and Ranging (LiDAR) data of the Rogue River Study Area for the Oregon Department of Geology and Mineral Industries (DOGAMI). The Oregon LiDAR Consortium's Rogue River project area encompasses approximately 1.4 million acres in the southwestern region of the state. The area includes portions of the Siskiyou National Forest, the City of Grants Pass and the Rogue River.

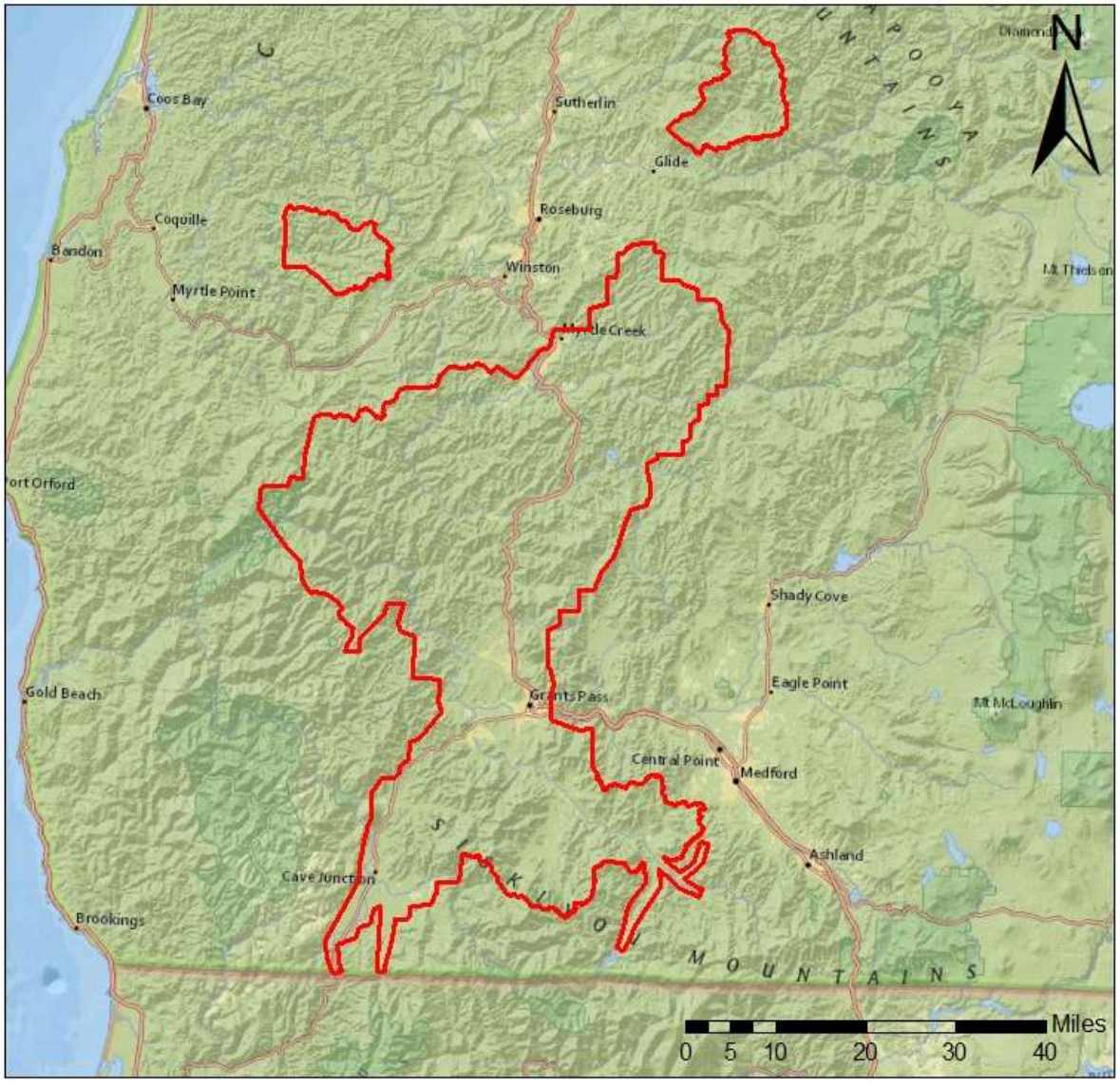
Year of Collection: 2012

Lot 1 of 1 lots.

Project Extent:

☑ Project Extent image?

OR_OLCRogue_2012



Date: 1/4/2013

Legend

ROGUE_RIVER_TAF_OGIC_HARN

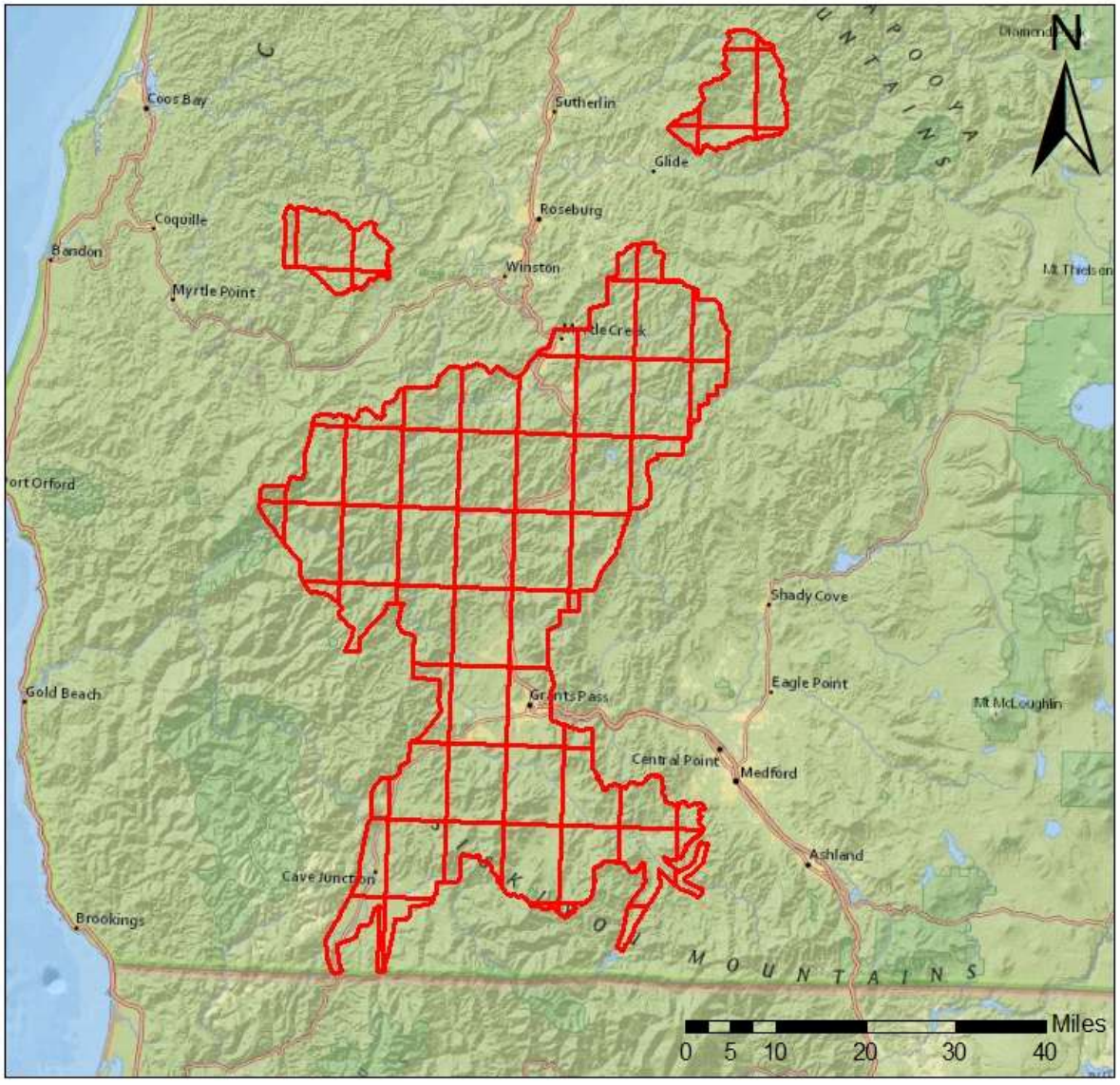
NatGeo_World_Map

Coordinate System: NAD 1983 HARN Oregon Statewide Lambert Feet Intl
Projection: Lambert Conformal Conic
Datum: North American 1983 HARN
False Easting: 1,312,335.9580
False Northing: 0.0000
Central Meridian: -120.5000
Standard Parallel 1: 43.0000
Standard Parallel 2: 45.5000
Latitude Of Origin: 41.7500
Units: Foot

Project Tiling Scheme:

☑ Project Tiling Scheme image?

OR_OLCRogue_2012



Date: 1/4/2013

Legend

ROGUE_RIVER_TAF_7_5_OGIC_HARN

NatGeo_World_Map

Coordinate System: NAD 1983 HARN Oregon Statewide Lambert Feet Intl
Projection: Lambert Conformal Conic
Datum: North American 1983 HARN
False Easting: 1,312,335.9580
False Northing: 0.0000
Central Meridian: -120.5000
Standard Parallel 1: 43.0000
Standard Parallel 2: 45.5000
Latitude Of Origin: 41.7500
Units: Foot

Contractor:

Applicable Specification:

Watershed Sciences Inc.	V13 +(DOGAMI)+(Partial FEMA)

Licensing Restrictions:

☐ Third Party Performed QA?

Project Points of Contact:

POC Name	Type	Primary Phone	E-Mail
Sheri Schneider	NSDI Liaison	503-310-1531	sschneid@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.

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

Multi-File Deliverables

File Type	Quantity
☐ Swath LAS Files ☐ Required? ☐ XML Metadata?	0
☑ Intensity Image Files ☐ Required?	4232
☑ Tiled LAS Files ☑ Required? ☐ XML Metadata?	4240
☑ Breakline Files ☑ Required? ☐ XML Metadata?	6
☑ Bare-Earth DEM Files ☑ Required? ☐ XML Metadata?	73

Additional Deliverables

	Item
☑	Trajectory (Shapefile), UTM z10N
☑	LAS Tile Shapefile, 750 x 750 Meter Tile Size, or 100th Quad
☑	Highest Hit or DSM Models, ESRI GRID, (73)
☑	Ground Density Rasters, ESRI GRID,(4236)
☑	Bare Earth LAS, Ground Only Points, .las, (4236)

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

Intensity Files are 100th Quad, different sized tiles for various deliverables, DEM follow a 7.5' Tiling Scheme.

DEM Tiles were delivered such that all 73 tiles had a bare earth version in which no hydro flattening was completed and select tiles also had a hydro flattened version, the final mosaic created combines the two types so that the mosaic is hydro flattened. This is why there are more than 73 tiles in the be-rasters NED folder (73 be tiles + 35 bh tiles for a total of 108)

The contractor states the following in regards to why there are more all point (classified) las files than bare earth las files. "There were small a + b sliver bins that contained no grounds points, but contain default points. This explains why there are more All POINT bins than GROUND POINT bins."

No .xml Metadata Available for this Project.

Project Geographic Information

Areal Extent:

2127.69

Sq Mi

Grid Size:

3

Int'l Feet

Tile Size:

7.5' Quad

Select...

Nominal Pulse Spacing: 0.35 meters

Vertical Datum: NAVD88 int'l feet

Horizontal Datum: NAD83_HARN int'l feet

Project Projection/Coordinate Reference System: Oregon Lambert (Statewide) international feet.

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

- [x] Project Shapefile/Geodatabase
- [x] 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
- [x] Classified LAS Files
- [x] Breaklines Files
- [x] Bare-Earth DEM Files

Check Point Shapefile/Geodatabase CRS

UTM z10N, NAD 1983, Meters

Project XML Metadata CRS

Not Delivered, Created Data is Oregon Lambert
Swath LAS XML Metadata CRS
Not Delivered
Classified LAS XML Metadata CRS
Not Delivered
Breakline XML Metadata CRS
Not Delivered
DEM XML Metadata CRS
Not Delivered
Swath LAS Files CRS
Not Delivered

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.

Review Start Date:
12/27/2012

Action to Contractor Date	Issue Description	Return Date

Review Complete: 1/23/2013

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.

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.

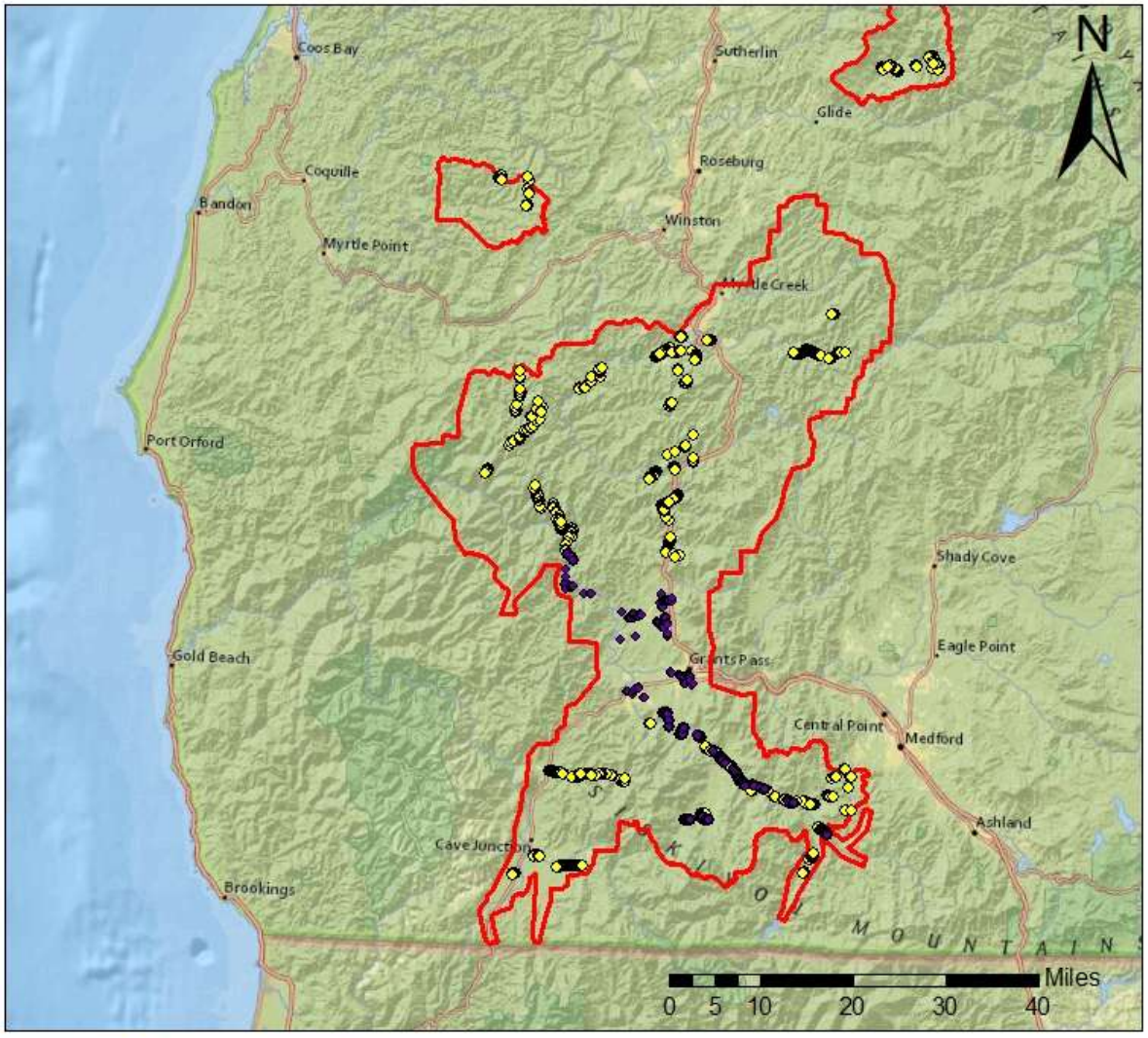
NSSDA and ASPRS require that a minimum of twenty checkpoints (thirty is preferred) are collected for each major land cover category represented in the LiDAR data. Checkpoints should be selected on flat terrain, or on uniformly sloping terrain in all directions from each checkpoint. They should not be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

OR_OLCRogue_2012



Date: 1/4/2013

Legend

- OR_OLCRogue_2012_HardSurfaceRTK_NGTOC_copy_ArcExtract
- OR_OLCRogue_2012_LandcoverRTK_NGTOC_copy
- ROGUE_RIVER_TAF_OGIC_HARN

NatGeo_World_Map

Coordinate System: NAD 1983 HARN Oregon Statewide Lambert Feet Intl
Projection: Lambert Conformal Conic
Datum: North American 1983 HARN
False Easting: 1,312,335.9580
False Northing: 0.0000
Central Meridian: -120.5000
Standard Parallel 1: 43.0000
Standard Parallel 2: 45.5000
Latitude Of Origin: 41.7500
Units: Foot

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

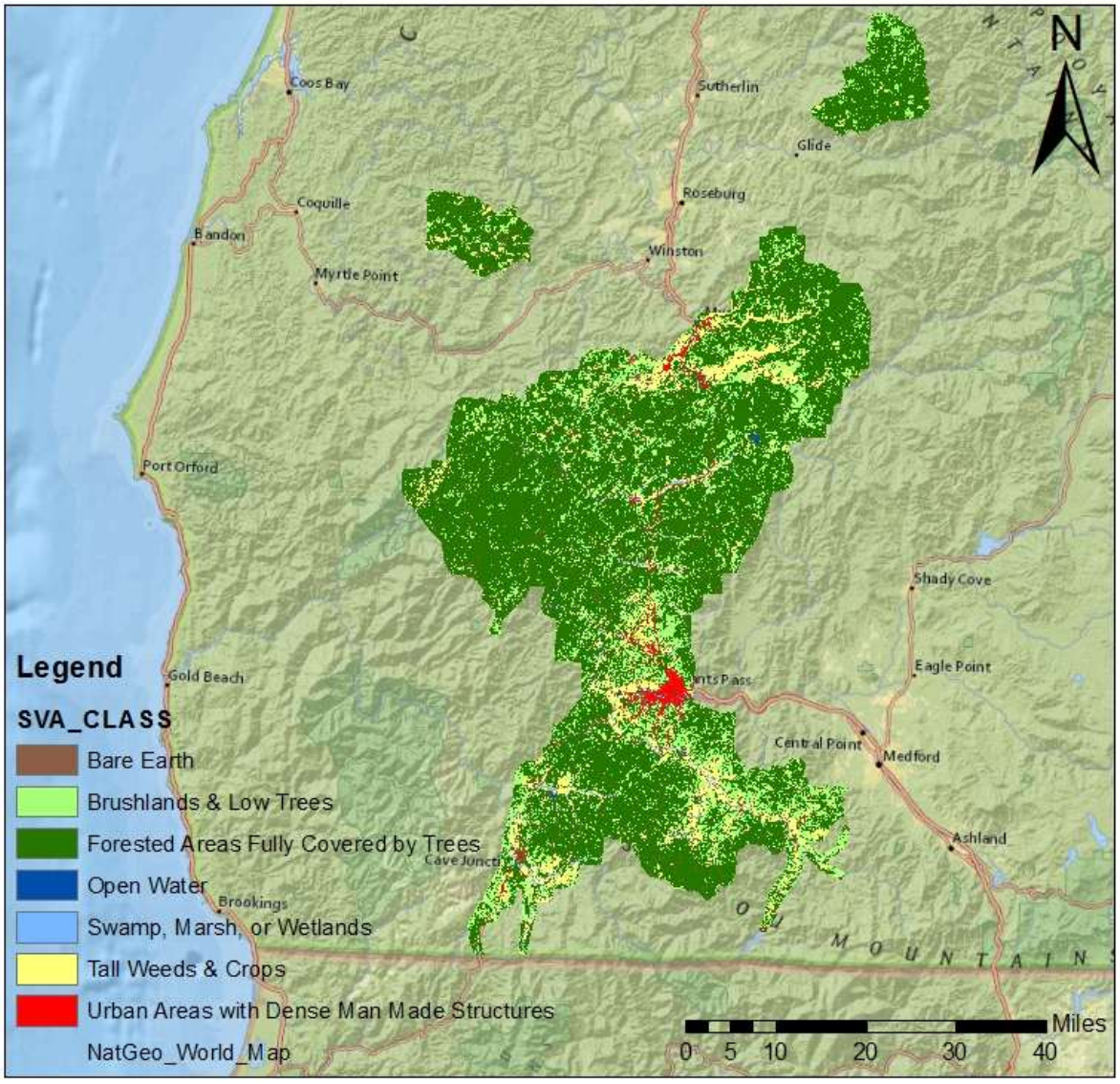
- [x] Bare Earth
- [x] Tall Weeds and Crops
- [x] Brush Lands and Low Trees
- [x] Forested Areas Fully Covered by Trees
- [x] Urban Areas with Dense Man-Made Structures

There are a minimum of 20 checkpoints for each land cover class represented. Points within each class are uniformly distributed throughout the dataset. USGS wasable to locate independent checkpoints for this analysis. USGS acceptsthe quality of the checkpoint data for these LiDAR datasets.

Errors, Anomalies, Other Issues to document? (•) Yes ( ) No

- [x] Image?

OR_OLCRogue_2012



Coordinate System: NAD 1983 HARN Oregon Statewide Lambert Feet Intl
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Latitude Of Origin: 41.7500
Units: Foot

Date: 1/4/2013

Lidar Landcover Categories from aggregated 2006 NLCD. Categories occupying more than 10% of the total area include:
Brushlands & Low Trees (16.84%)
Forested Areas Fully Covered by Trees (68.01%)

☐ Image?

FVA Values below are for delivery 1, FVA required value is taken from OLC Rogue River Delivery 1 LIDAR QA Acceptance Report and is the maximum acceptable mean vertical offset (0.20 Meters) multiplied by 1.96. n=4418, RMSEz=0.069, NSSDA= 0.13524

☐ Image?

Delivery 2:
RMSE value of 0.041 meters, FVA=0.08036 Meters, n=1286

☐ Image?

Delivery 3:
RMSE value of 0.056 meters, FVA= 0.10976 Meters, n=2156

☐ Image?

FEMA Vert Acc for delivery 1 (Central Coast area aprox 279 SqMi.). From DOGAMI n=5442, CVA RMSEz = 0.098, SVA classes from Watershed Sciences:
FVA: 0.134, n=4417
SVA Deciduous: 0.111, n=5
SVA Forest Mix: 0.099, n=62
SVA Grass: 0.242, n=6
SVA Res Low: 0.081, n=100
SVA Residential: 0.159, n=116
SVA Short grass: 0.345, n=240
SVA Shrubland: 0.267, n=241
SVA Tree: 0.210, n=159
SVA Up Shrub: 0.354, n=93
CVA: 0.191, n=5442

☐ Image?

Watershed Sciences Reports the following for Vertical Accuracy for the entire project:
Lidar was "Compiled to meet 0.34 ft. (0.10m) accuracy at 95% confidence level in open terrain"
"12,307 RTK points were collected for the data delivered to date. For this project, no independent survey data were collected, nor were reserved points collected for testing. As such, vertical accuracy statistics are reported as "Compiled to Meet," in accordance with the ASPRS Guidelines for Vertical Accuracy Reporting for LiDAR Data V1.0"
Sample Size (n): 12,307
RMSE: 0.18ft
1 SD: 0.17 ft
2 SD: 0.36 ft
Average Deviation: 0.04 ft
Minimum Deviation: -0.96 ft
Maximum Deviations 0.71 ft
SVA Classes:
Herbaceous-Less than 2ft in height, n=220, RMSE=0.56 ft
Shrubland-Woody vegetation more than 6 ft in height, n=269, RMSE=0.64 ft
Forest-Full coverage of mature forest, n=219, RMSE=0.21 ft
Developed-Permanent dwellings and other structures, n=220, RMSE=0.20 ft
**These Values will be reported below

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: meters

Required FVA Value is 0.20 meters or less.
Target SVA Value is 0.363 meters or less.
Required CVA Value is 0.363 meters or less.

The reported FVA of the LAS Swath data is **Not Reported** meters.

The reported FVA of the Bare-Earth DEM data is 0.1075 meters.
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	0.33454848	meters
Brush Lands and Low Trees	**0.38234112**	meters
Forested Areas Fully Covered by Trees	0.12545568	meters
Urban Areas with Dense Man-Made Structur...	0.1194816	meters

The reported CVA of this data set is: **Not Reported** meters.

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

☐ Image?

Points Contain RGB Values from 2009 NAIP Imagery.

☐ Image?

Classes used include 1 and 2.

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?

See DEM review section regarding possible missing breaklines for a river in the southern portion of the dataset.

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 meters.

Reported Accuracies

Land Cover Category	# of Points	Fundamental Vertical Accuracy @95% Confidence Interval ($Accuracy_z$) Required FVA = 0.20 or less.	Supplemental Vertical Accuracy @95th Percentile Error Target SVA = 0.363 or less.	Consolidated Vertical Accuracy @95th Percentile Error Required CVA = 0.363 or less.
Open Terrain	12,307	0.1075		
Tall Weeds and Crops	220		0.33454848	
Brush Lands and Low Trees	269		**0.38234112**	
Forested Areas Fully Covered by Trees	219		0.12545568	
Urban Areas with Dense Man-Made Structures	220		0.1194816	
Consolidated	13,235			**Not Reported**

☑ QA performed Accuracy Calculations?

Calculated Accuracies

Land Cover Category	# of	Fundamental Vertical Accuracy @95% Confidence Interval	Supplemental Vertical Accuracy @95th Percentile Error	Consolidated Vertical Accuracy @95th Percentile Error

	Points	($Accuracy_z$) Required FVA = 0.20 or less.	Target SVA = 0.363 or less.	Required CVA = 0.363 or less.
Open Terrain	16,284	0.1328		
Tall Weeds and Crops	236		0.3170	
Brush Lands and Low Trees	241		**0.4084**	
Forested Areas Fully Covered by Trees	141		0.2164	
Urban Areas with Dense Man-Made Structures	116		0.1602	
Consolidated	17,018			0.1280

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.

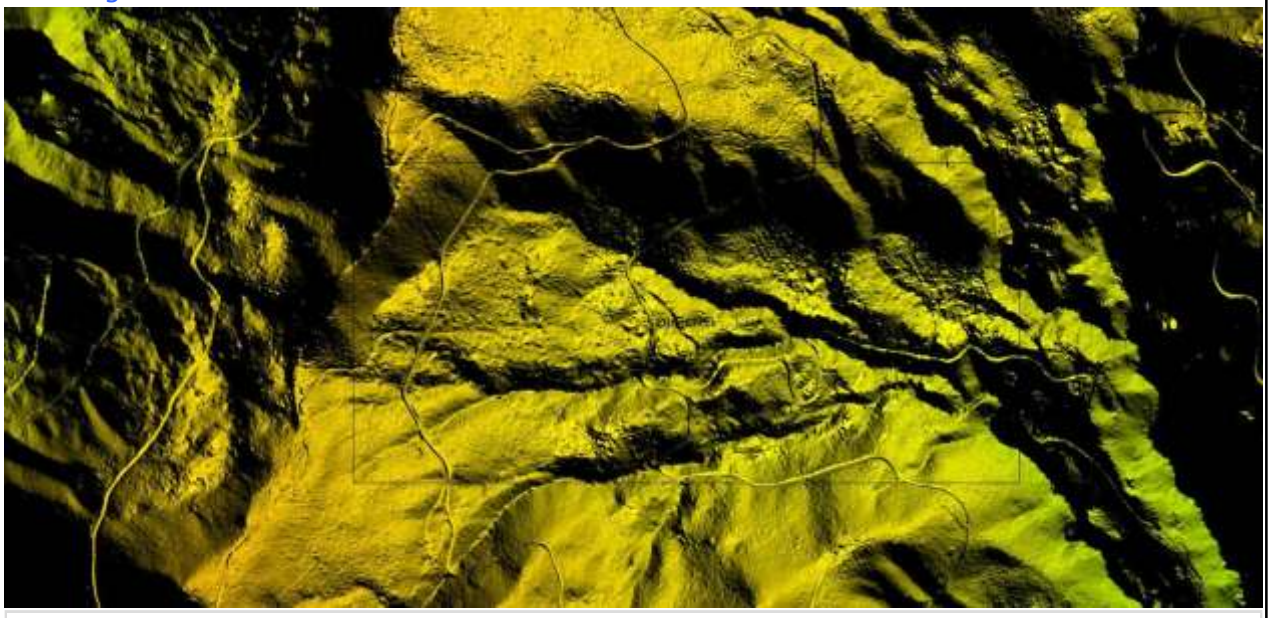
Bare-Earth DEM Anomalies, Errors, Other Issues

Errors, Anomalies, Other Issues to document? (•) Yes ( ) No

☐ Image?

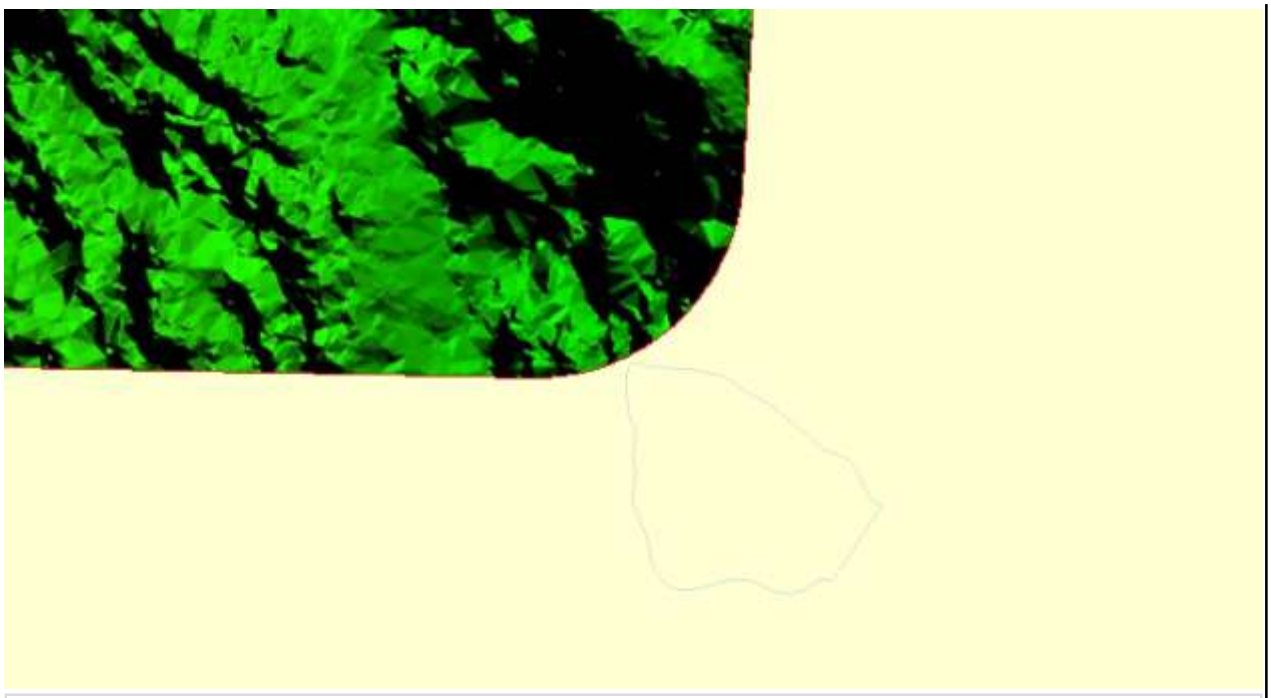
Regarding the Vertical Accuracy Testing Performed by the NGTOC:
-The delivered control points contained a wide number of landcover classes, some of which did not make sense as landcover categories, (ex: HC_WHITE_LINE_E). While all points were used in calculation of CVA not all categories are reported here for SVA. Please see the File OR_OLCRogue_2012_HardSurfaceRTK_and_Landcover_NGTOC_copy_VertAcc_Stats.txt in the NGTOC_Created_Metadata Folder for a detailed report.
The key below shows which classes below are matched to our standard SVA Landcover Classes:
-Open Terrain= hardsurface
-Tall Weeds and Crops= SHORT_GRASS
-Brush Lands and Low Trees= SHRUBLAND
-Forested Areas Fully Covered by Trees= TREE
-Urban Areas with Dense Man-Made Structures= RESIDENTIAL
**Lastly, it should be noted that this project was required to have no error exceeding a vertical offset of .2 M for FVA, this passes the requirement for Ver 1.0 of the Lidar Base Specification, the SVA and CVA results also pass the NGP Base Specification.

☑ Image?



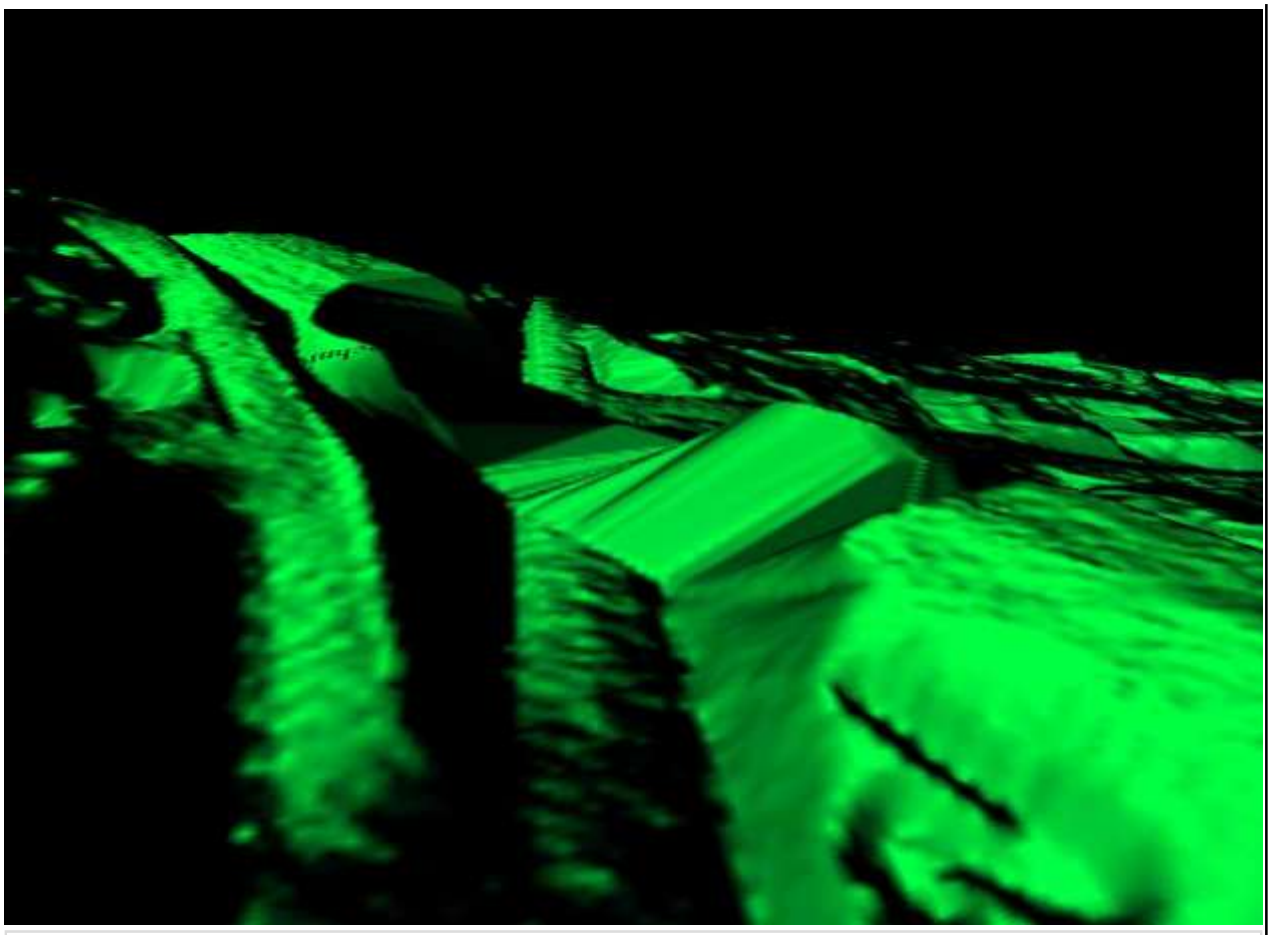
Hard to see in the image above, there are a few areas where bare earth terrain has a heavily "tinny" character than surrounding terrain. This is characteristic of many areas throughout the dataset. This is largely due to the heavy forest canopy interrupting many pulses in their way to the ground. Subsequent examination of the point cloud was used to see if the ground filters used in these areas were aggressive enough in classifying points to bare earth. It was found that the filtering done was adequate and that the surface models are the best representation of the bare earth from the LAS data.

☑ Image?



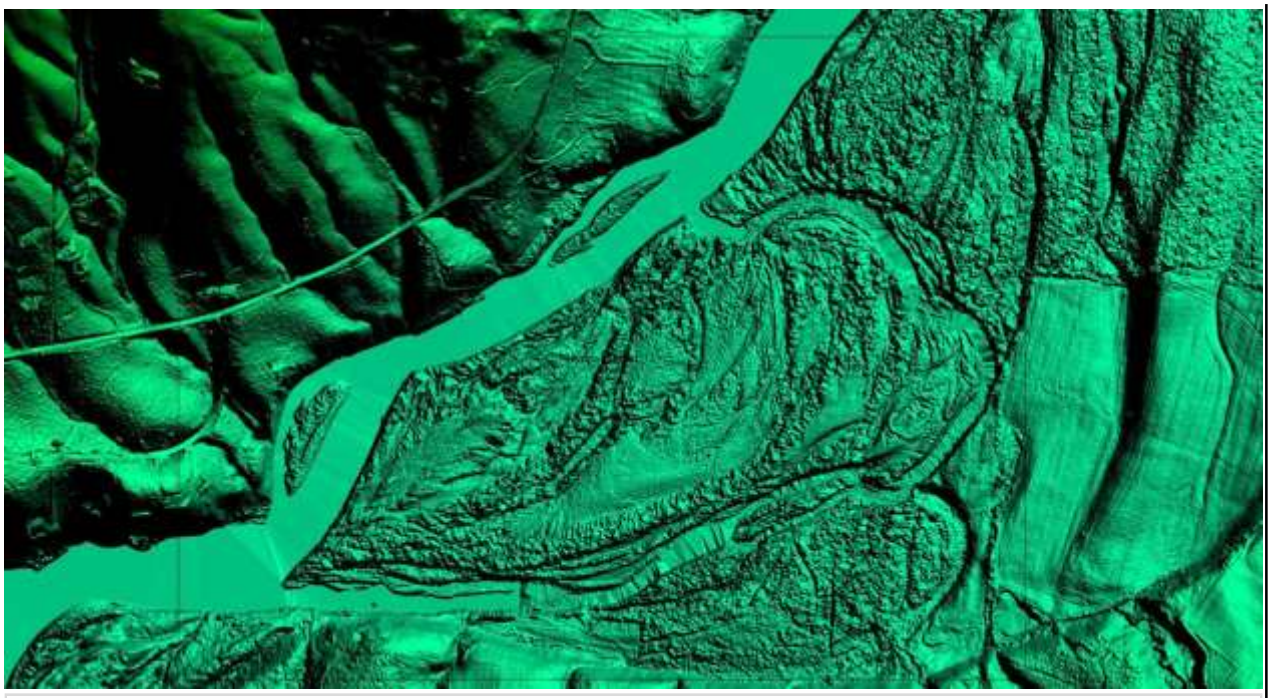
There was an instance of a Breakline falling outside the delivered DEM data, issue is of little consequence to DEMs.

☑ Image?



There were several instances of Bridges that could have been removed more cleanly (via Breaklines, etc…); however the bridges have been adequately removed for the project.

☑ Image?

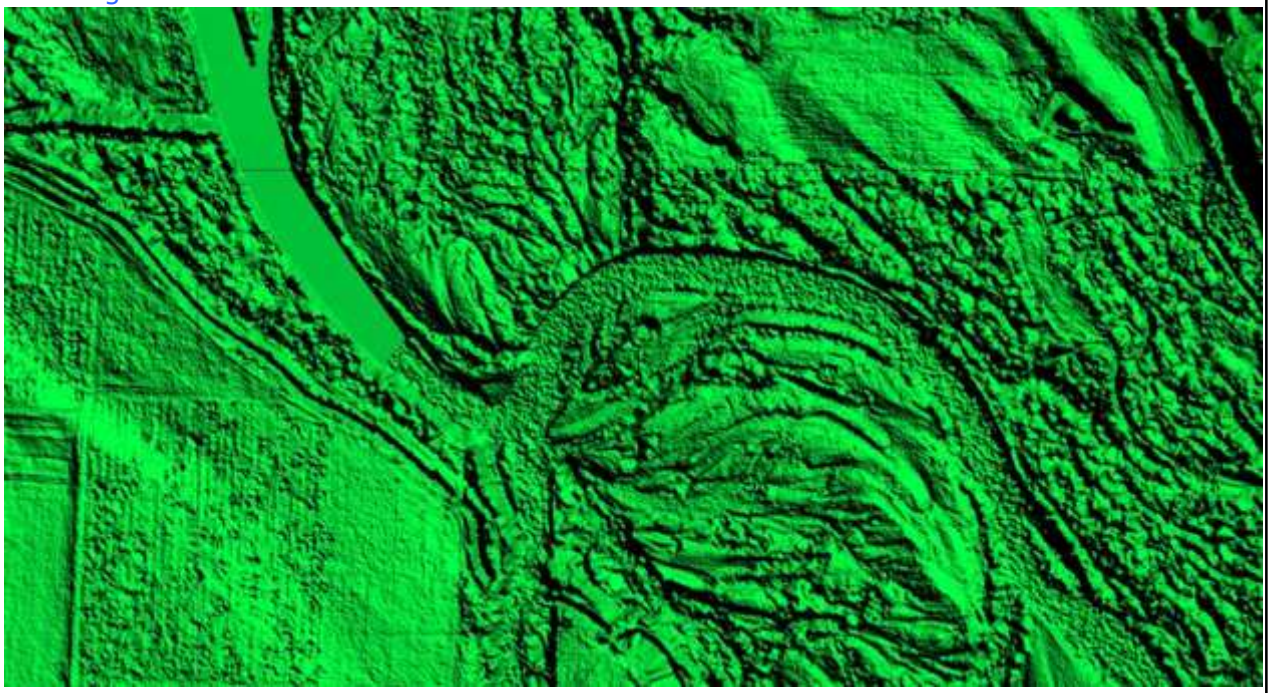


All Water bodies greater than 2 Acres were hydroflattened. Likewise, the vast majority of sloping streams greater than 100ft width were flattened in a downstream monotonic manner as well; however, there were several instances where the water could have been flattened or flattening is called into question, see the image above and those below. Pictured above is a channel breaking off from the main hydro flattened stream that was not flattened. The most recent NAIP Imagery shows this area as being connected. These instances are few in number throughout the project.

☑ Image?

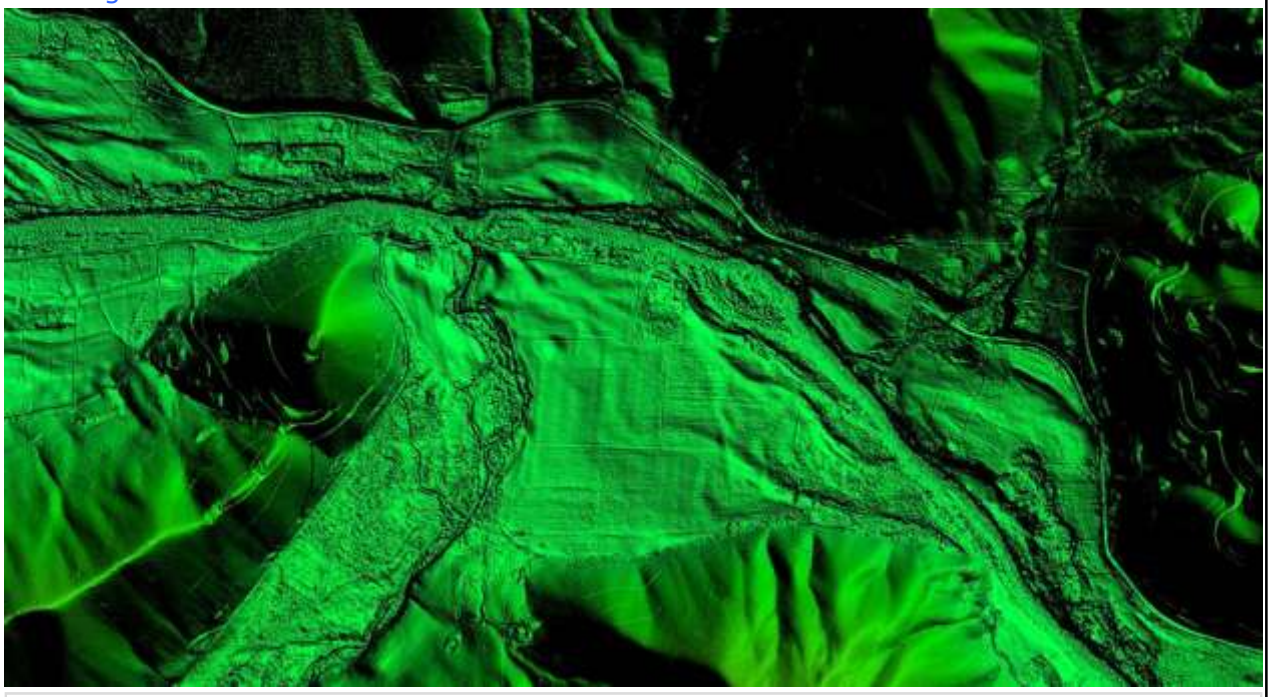
Area Above with Digital Globe Imagery Overlay.

☑ Image?



This is the location where hydroflattening stops for the "Applegate River" and everything south of this river is not flattened. The density of the stream bed suggests that the water level may have been very shallow or dry at the time of capture and would not require flattening if that were the case. NAIP Imagery shows both dry conditions and wet conditions for this river south of this location, images below will show the character of river in the DEMs.

☑ Image?



A section of the river with greater than 100ft banks that is not hydro flattened. The river lacks heavy tinning suggesting dry or shallow conditions, however this must be balanced with the fact that the density of the dataset is also very high. As the majority of the rivers are well flattened for the project, it is highly probably that this river was not missed, but consciously not flattened due to shallow or dry conditions. The data is acceptable.

☑ Image?

This image of the previous DEM area appears to be a blend from two separate dates and shows the river in both wet and dry conditions.

This is the end of the report.

QA Form V1.4 12OCT11.xsn