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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:
10/16/2012

Project ID:
AR_FEMA-Bayou-Meto_2012

Project Alias(es):
FEMA VI - Bayou Meto

Project Type: GPSC

Project Description:

1. This task order is for Planning, Acquisition, processing, and derivative products of lidar data to be collected at a nominal pulse spacing (NPS) of 2.0 meters. Specifications listed below are based on the ***"U.S. Geological Survey National Geospatial Program Base Lidar Specification, Version 13 (ILMF)",*** of which sections I through IV are incorporated by reference to this task order. This specification may be viewed at *http://lidar.cr.usgs.gov/USGS-NGP Lidar Guidelines and Base Specification v13(ILMF).pdf*. These lidar specifications are required baseline specifications. In addition to the requirements listed below, variations from the specifications will be shown and noted below. For any item which is not specifically addressed, the referenced Version 13 specifications will be the required specification

authority. This task is for lidar for a ***high resolution data set of lidar of 697 square miles, to assist in floodplain mapping of portions of Pulaski, Lonoke, Prairie, and Arkansas Counties in Central Arkansas.***
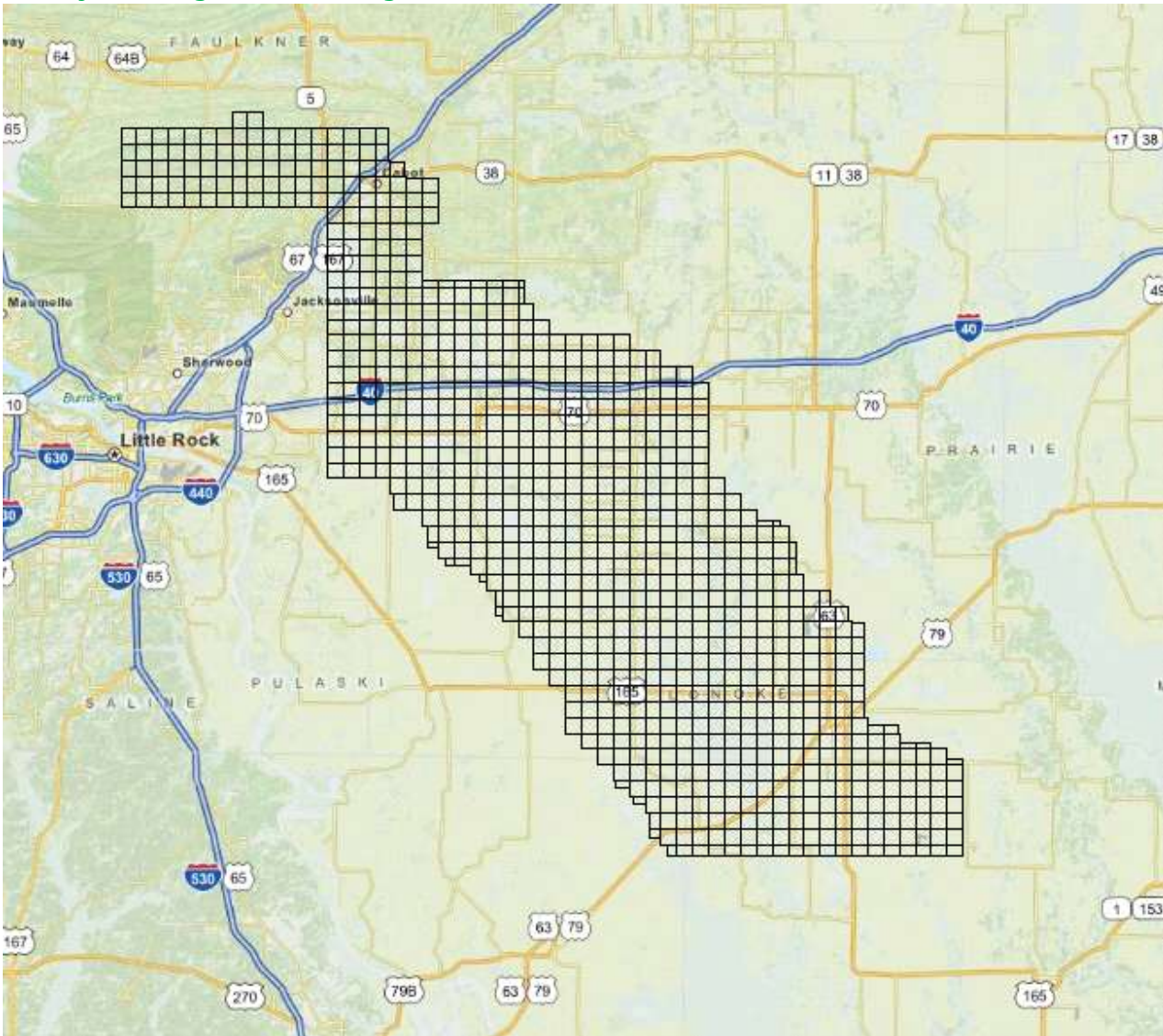
Year of Collection: 2012

Lot 1 of 1 lots.

Project Extent:

☑ Project Extent image?

Project Tiling Scheme:

☑ Project Tiling Scheme image?

Contractor:

Dewberry

Applicable Specification:

V13

Licensing Restrictions:

None

☐ Third Party Performed QA?

Project Points of Contact:

POC Name	Type	Primary Phone	E-Mail
Robert Kelly	CPT	x3612	ckelly@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?	65
☑ Intensity Image Files ☐ Required?	893
☑ Tiled LAS Files ☑ Required? ☑ XML Metadata?	893
☑ Breakline Files ☑ Required? ☑ XML Metadata?	2
☑ Bare-Earth DEM Files ☑ Required? ☑ XML Metadata?	893

Additional Deliverables

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

None.

Project Geographic Information

Areal Extent:

696

Sq Mi
Grid Size:

2.0

meters
Tile Size:

1500

 meters
Nominal Pulse Spacing:

2.0

 meters
Vertical Datum: NAVD88 Select...
Horizontal Datum: NAD83 Select...

Project Projection/Coordinate Reference System: UTM Zone 15 meters.

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

☑ Project Shapefile/Geodatabase   ☑ Breaklines XML Metadata File
☑ Project Tiling Scheme Shapefile/Gdb   ☑ Bare-Earth DEM XML Metadata File
☑ Checkpoints Shapefile/Geodatabase   ☑ Swath LAS Files
☑ Project XML Metadata File   ☑ Classified LAS Files
☑ Swath LAS XML Metadata File   ☑ Breaklines Files
☑ Classified LAS XML Metadata File   ☑ 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:

K. Mantey

Review Start Date:

11/26/2012

Action to Contractor Date	Issue Description	Return Date
11/27/2012	Corrections	1/2/2013

Review Complete: 1/22/2013

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.

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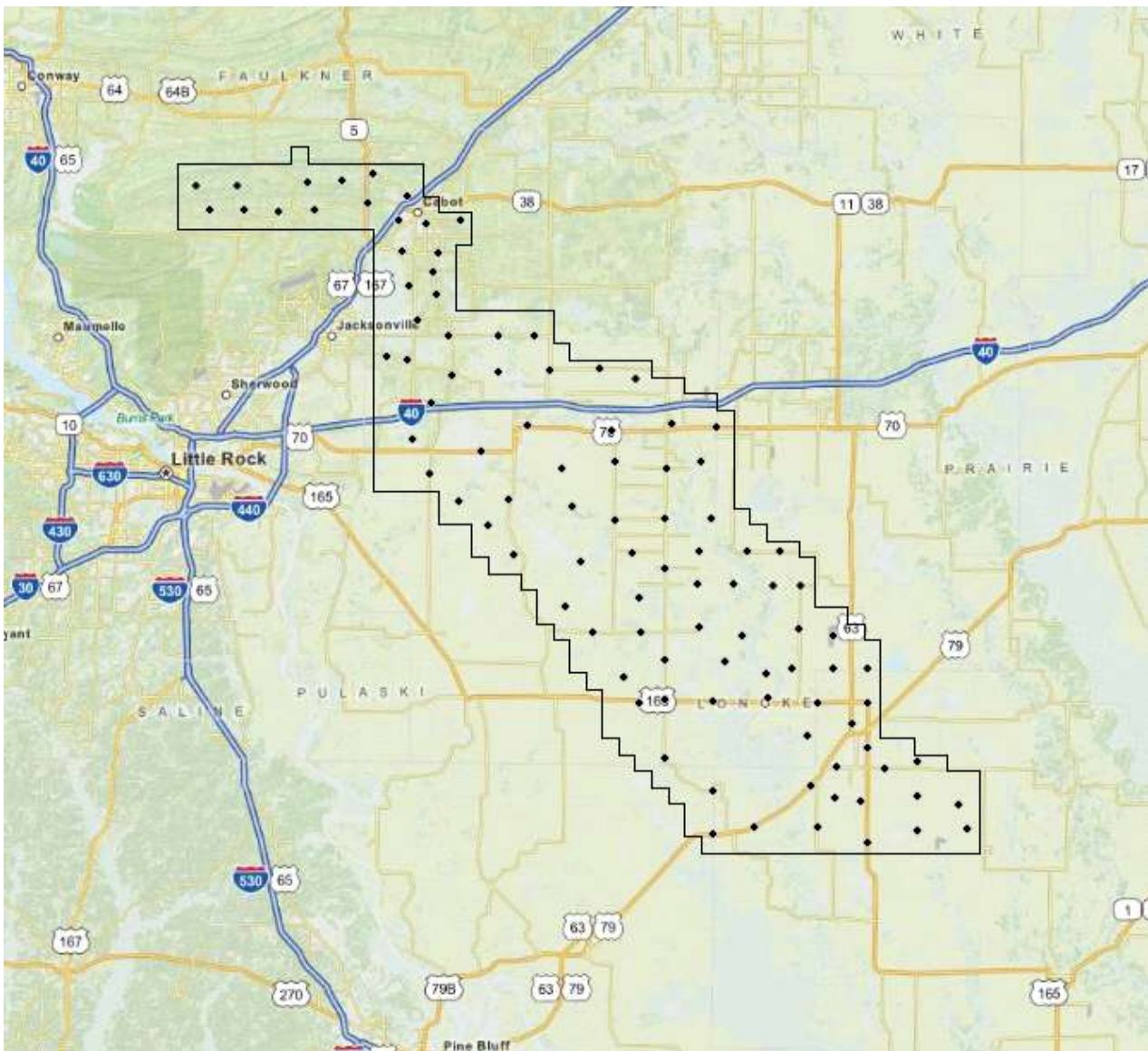
The following land cover classes are represented in this dataset (uncheck any that do not apply):

☑ 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?

Check point file location FEMA_VI_Bayou_Meto_Delivery_10112012\SURVEY_DATA

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 0.245 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 0.09 meters.

The reported FVA of the Bare-Earth DEM data is 0.09 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	0.10	meters
Brush Lands and Low Trees	0.14	meters
Forested Areas Fully Covered by Trees	0.24	meters
Urban Areas with Dense Man-Made Structu...	0.13	meters

The reported CVA of this data set is: 0.13 meters.

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 0.09 meters .

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

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

None.

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 <u>accepts</u> 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 <u>does not accept at this time</u> the breakline files.

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

☑ Image for error?

Water bodies not flattened
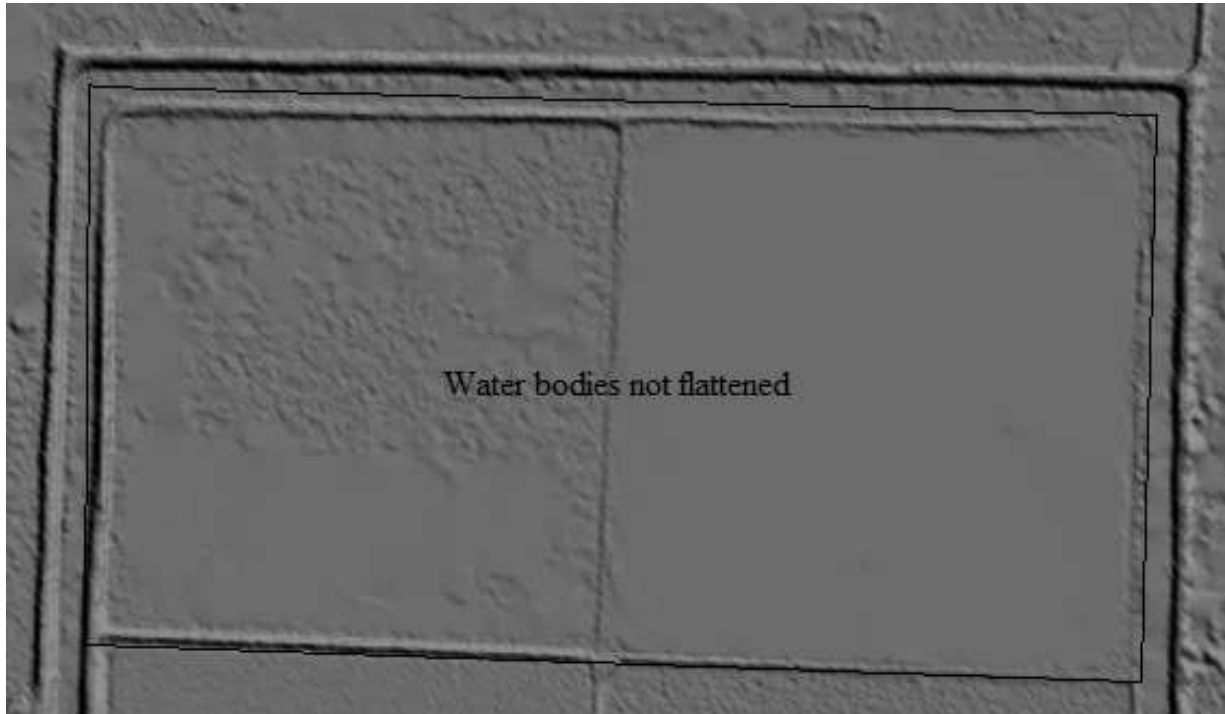
The above error is an example. There are several of these in the dataset, all marked in the errors shapefile provided with this report. There are water bodies that are greater than 2.0 acres in area that are not flattened. These were determined to be water bodies looking at both the DEM and the intensity imagery. This first image shows the hillshaded DEM, the second will show the intensity image.

☑ Image for error?
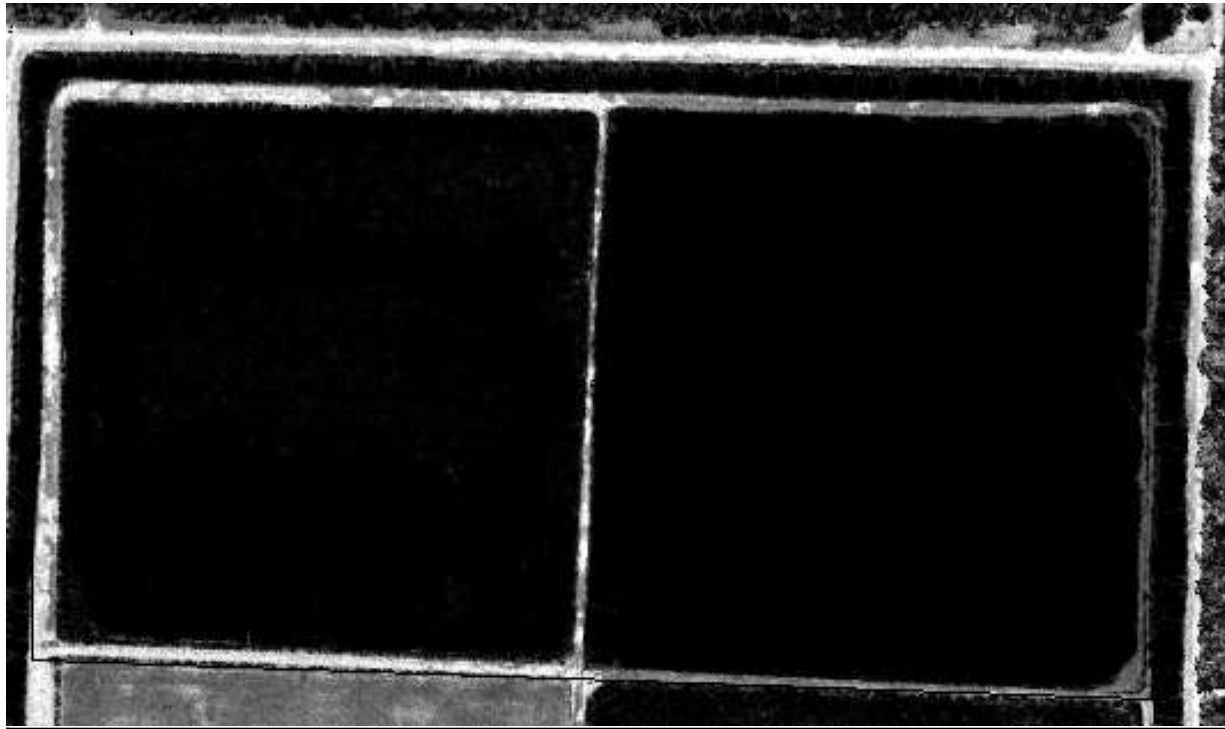
Same area as above, but using intensity imagery instead of the DEM.

☐ Image for error?

01/22/2012: Requested fixes on water bodies have been made. It should be noted that there are a great deal of features in this dataset that appear to be water, however upon closer inspection, may actually be swamp or wetlands. These have remained unflattened.

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 `meters` .

Reported Accuracies

Land Cover Category	# of Points	Fundamental Vertical Accuracy @95% Confidence Interval (Accuracy$_z$) Required FVA = 0.245 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	21	0.09		
Tall Weeds and Crops	20		0.10	
Brush Lands and Low Trees	20		0.14	
Forested Areas Fully Covered by Trees	20		0.24	
Urban Areas with Dense Man-Made Structures	19		0.13	
Consolidated	100			0.13

☑ QA performed Accuracy Calculations?

Calculated Accuracies

Land Cover Category	# of Points	Fundamental Vertical Accuracy @95% Confidence Interval (Accuracy$_z$) Required FVA = 0.245 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	21	0.0916		
Tall Weeds and Crops	20		0.09	

Brush Lands and Low Trees	20		0.14	
Forested Areas Fully Covered by Trees	20		0.21	
Urban Areas with Dense Man-Made Structures	19		0.11	
Consolidated	100			0.125

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 does not accept at this time the bare-earth DEM files.

Bare-Earth DEM Anomalies, Errors, Other Issues

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

☐ Image?

Only 19 checkpoints were provided for the Urban SVA class. The SVA and CVA will still be accepted, but a minimum of 20 checkpoints is required for each landcover category. Dewberry also reported that 20 checkpoints were collected for this land cover class. There is one checkpoint U_OT that appears to be used for both urban and open terrain. For testing purposes, this checkpoint was only used in Open terrain by the NGTOC.
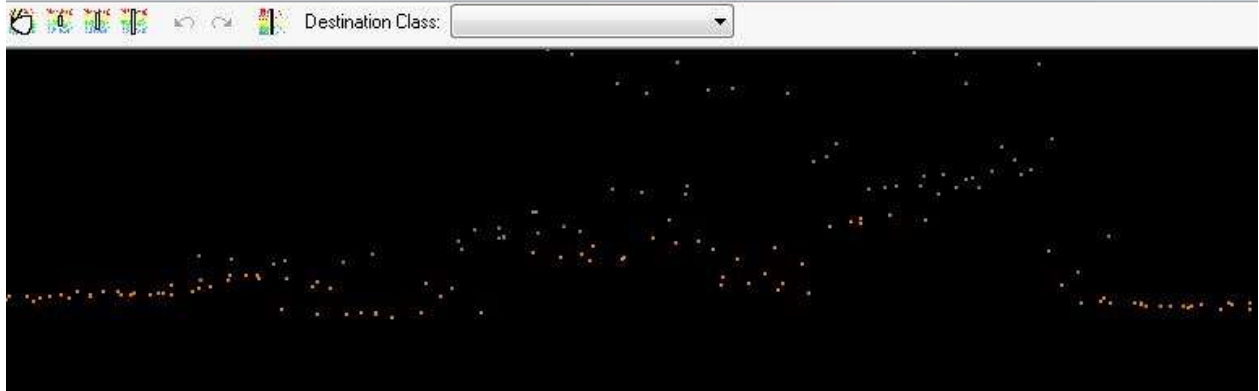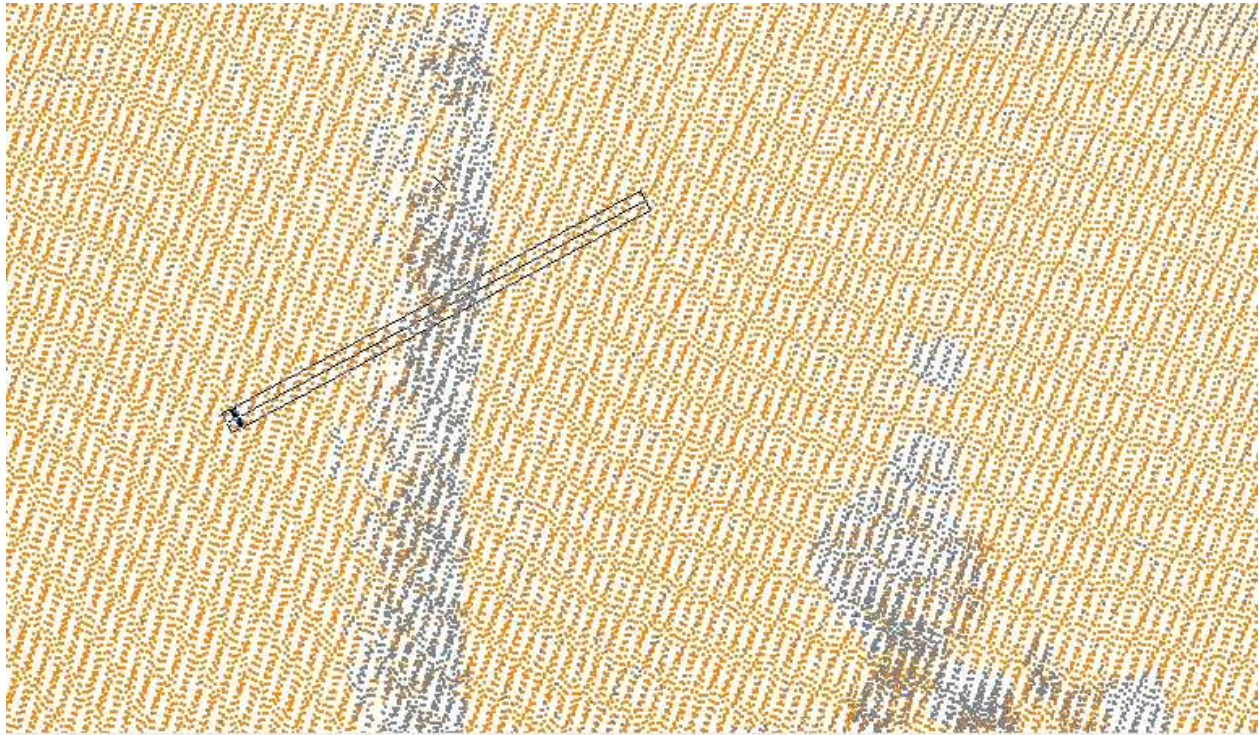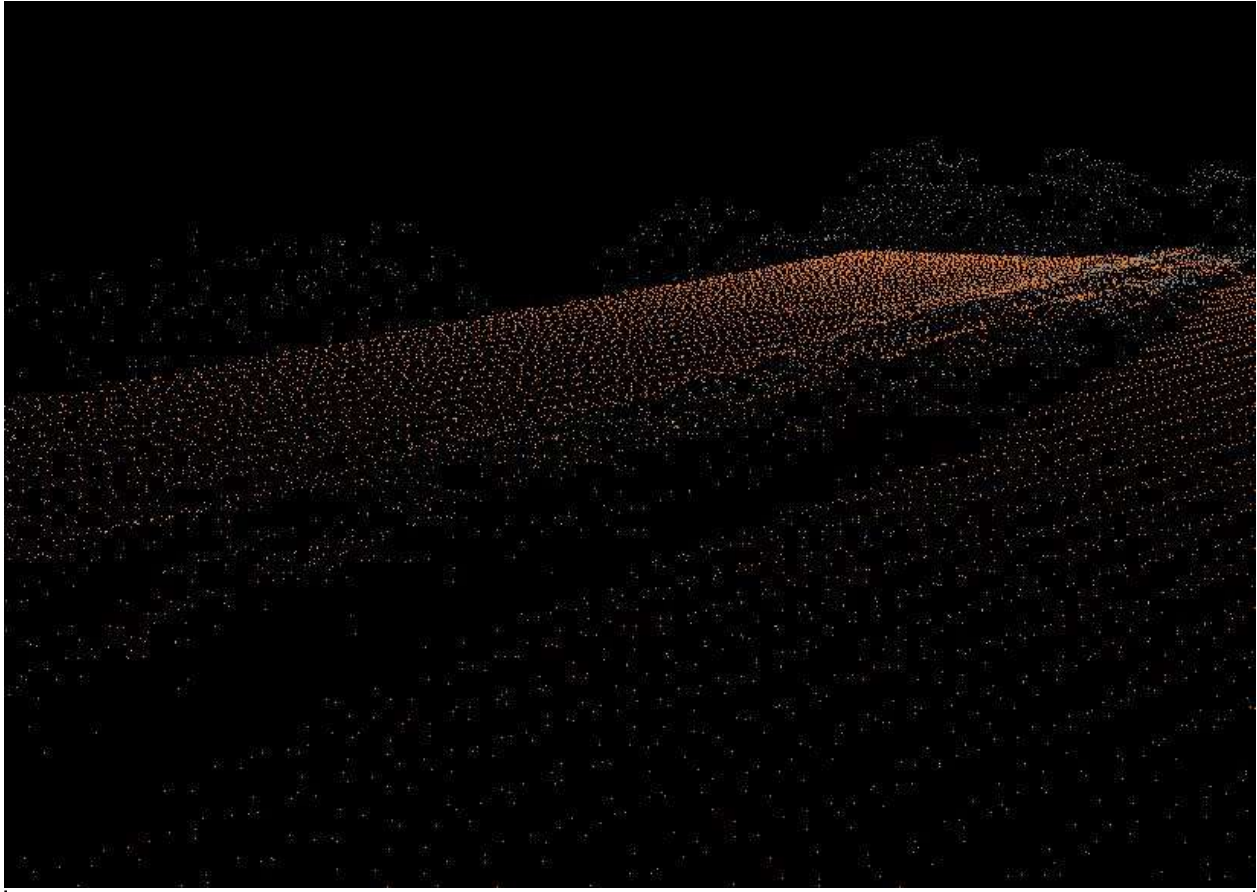
☑ Image?

vegetation classified as bare ea*

There were two instances were points that appear to be non bare earth were classified as ground, and therefore are included in the DEM. The above image shows an example of the affected area in the DEM, and the subsequent images show the areas in the LAS files.

☑ Image?

Destination Class:

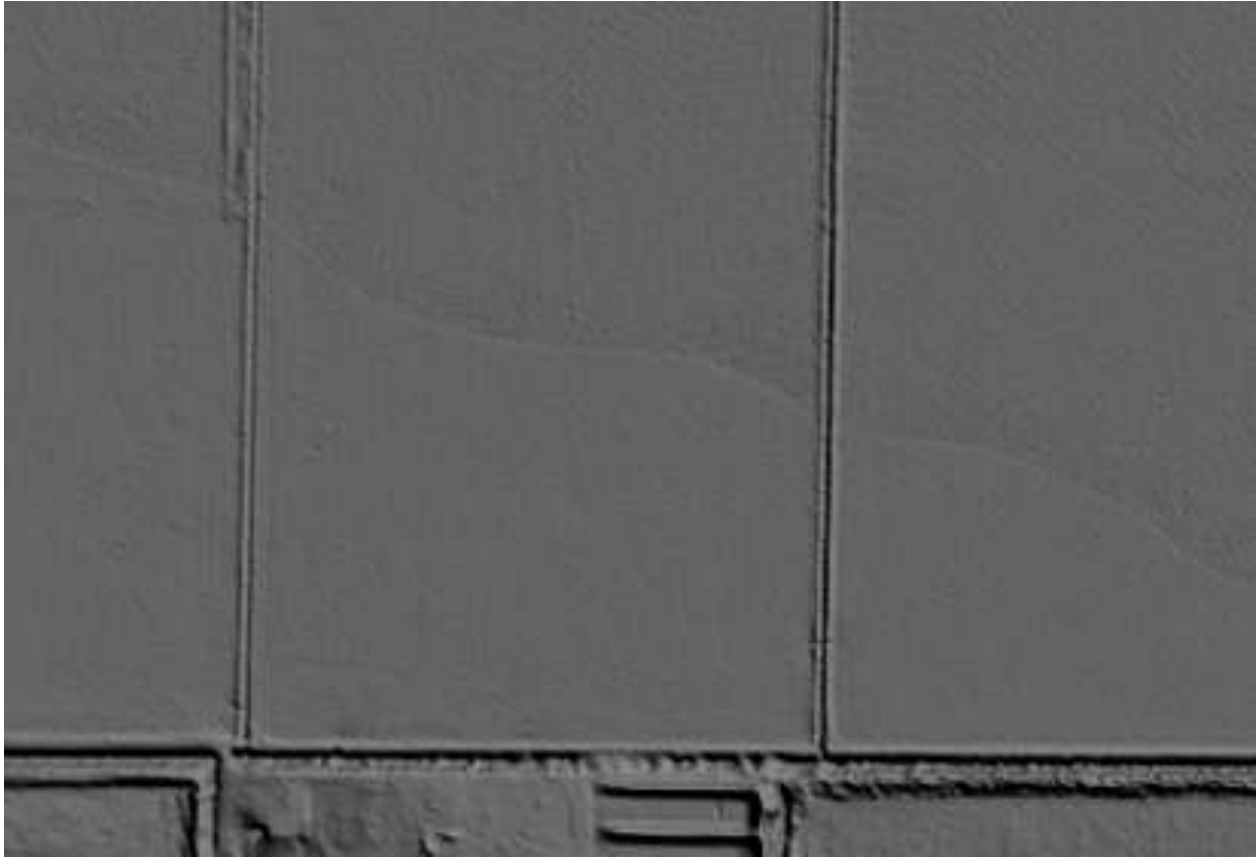This is the same area as above, but in the LAS files as a profile view.

☑ Image?

Same area as in previous images, as a 3D view.

☑ Image?

The next example is not an error, but an item worth noting. In areas of overlap coverage between swaths, the boundaries of the overlap appear in the DEM. This is not affecting the quality of the data and has a negligible affect on the elevation. The above image shows the DEM, the subsequent images the same area in the LAS files.
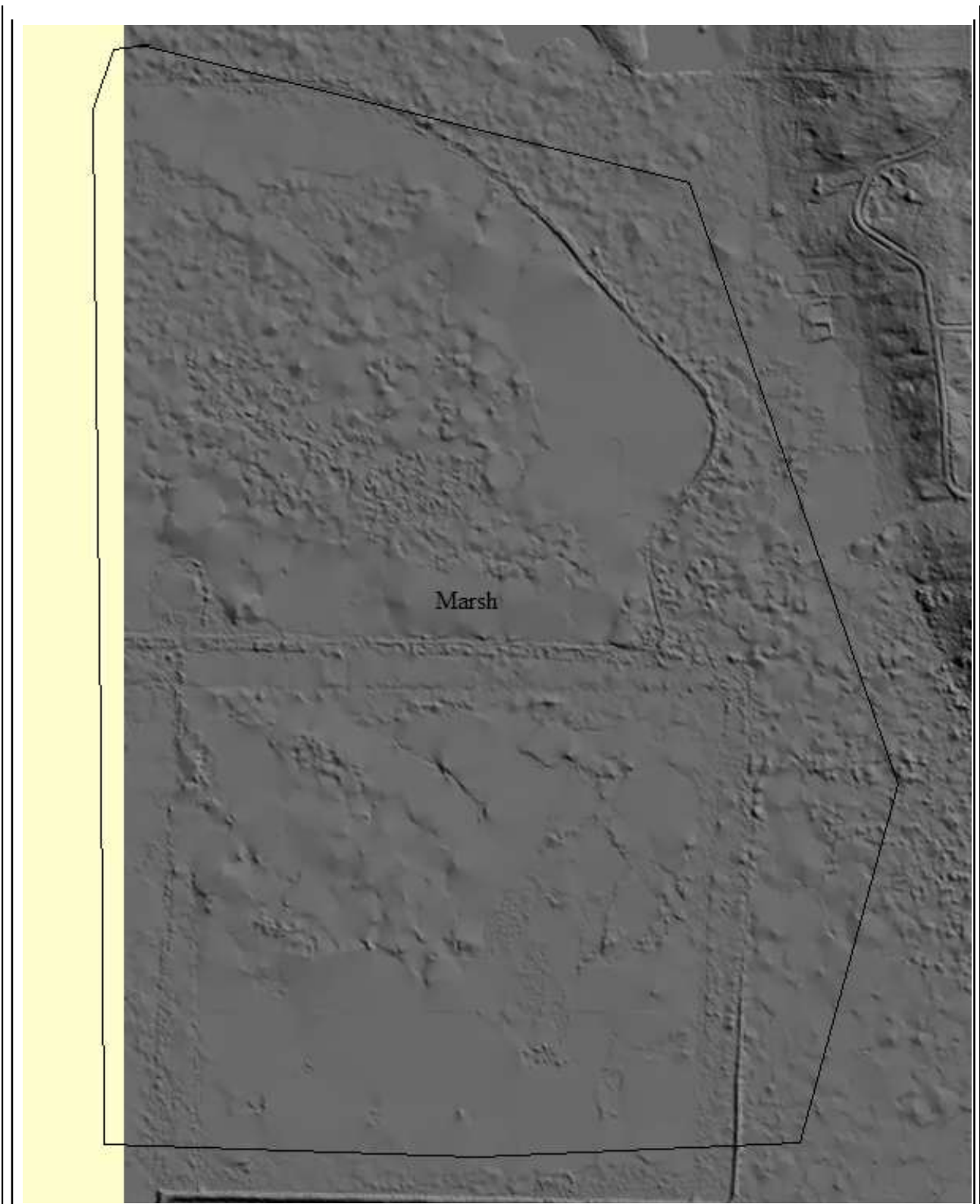
☑ Image?
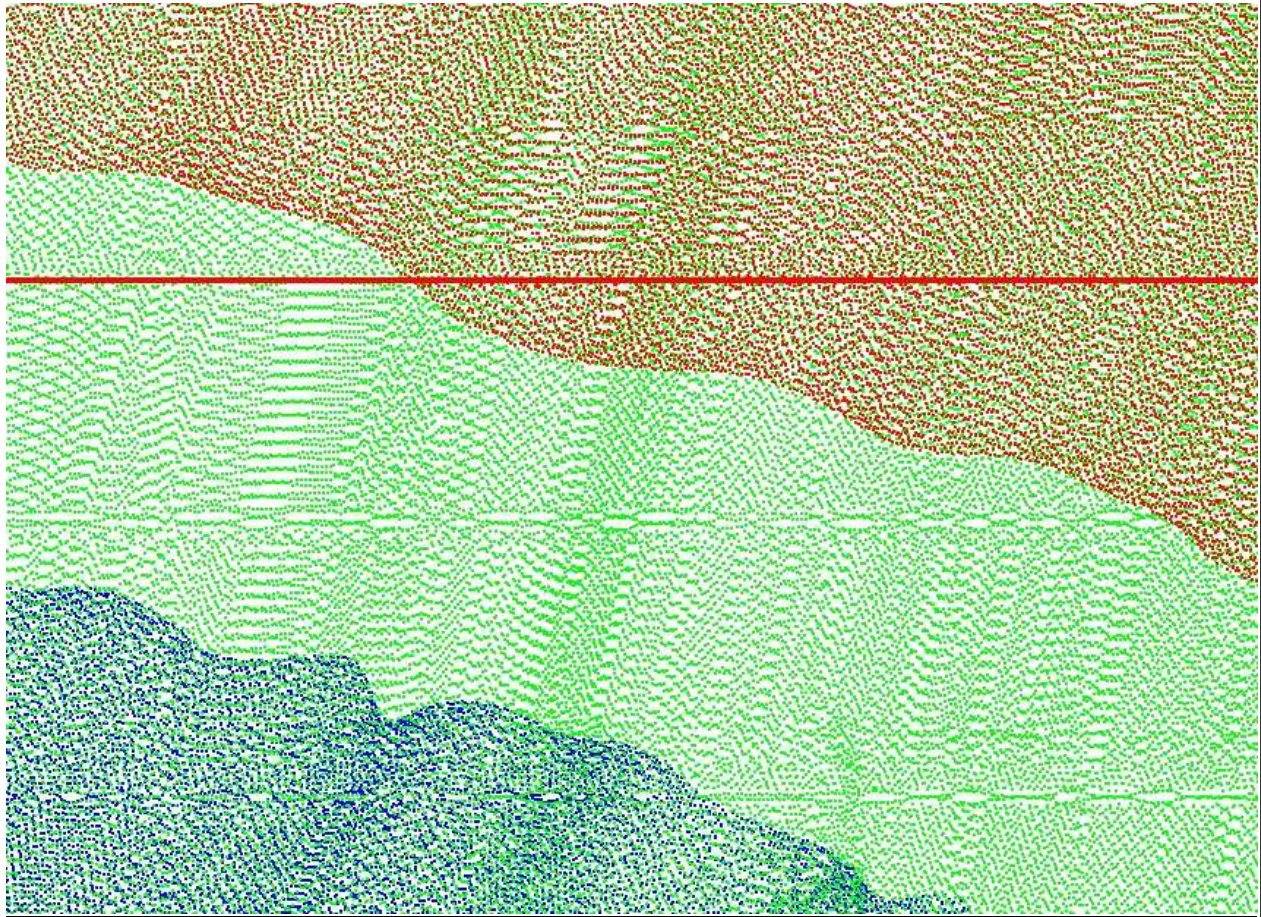
Same area but in the LAS files, symbolizing the points by point source ID.

☑ Image?

Marsh

The area of interest contains a substantial amount of marsh land cover types. For marshes, there is some tinning that exists in the DEM, however, because there is a large amount of ground points in these areas, these regions have not been hydro-flattened. This is not an error, and will be accepted by the NGTOC. The above image shows marsh in the DEM, and the next image will show the same area using intensity imagery.

☑ Image?
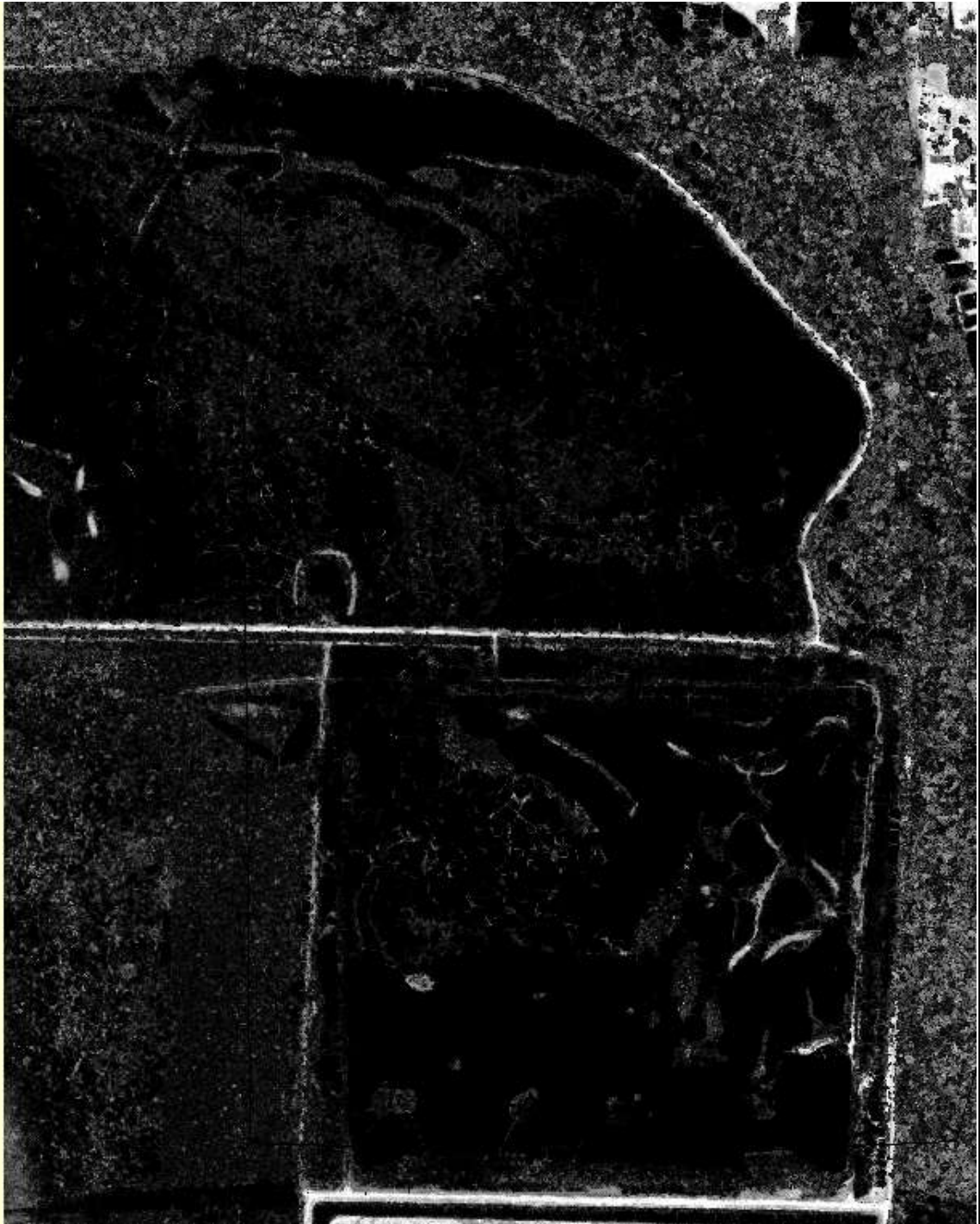
Same area as above, only using intensity imagery instead of the DEM.

☑ Image?

Bunkers

The final item of note is that there are some military installations in this area, reported by Dewberry. These installations contain bunkers in some areas. The bunkers have been classified as ground. The NGTOC agrees that this is the proper procedure for bunkers, and this has been accepted.

☐ Image?

The following areas need to be corrected before acceptance:

1. Metadata files or project report need to be corrected to reflect proper vertical accuracy values.

2. Water bodies that were not hydro flattened need to be flattened.

3. Vegetation/non bare earth areas need to be removed from the DEM.

☐ Image?

01/22/2012: Vegetation has been removed from DEM. Project is accepted.

Based on this review, the deliverables provided <u>meet</u> the Task Order requirements.

Internal Note:

<u>This is the end of the report.</u>

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